

ISSNL = 1454-7376
(Print)-ISSN 1454-7376
(Online) = ISSN 2069-8275
(CD-ROM) = ISSN 2069 847X

**UNIVERSITATEA DE ȘTIINȚE AGRICOLE
ȘI MEDICINĂ VETERINARĂ
„ION IONESCU DE LA BRAD” DIN IAȘI**



**LUCRĂRI
ȘTIINȚIFICE
VOL. 60 - Nr. 2
SERIA HORTICULTURĂ**

EDITURA "ION IONESCU DE LA BRAD" IAȘI



2017

U.S.A.M.V IAȘI - LUCRĂRI ȘTIINȚIFICE - SERIA HORTICULTURĂ - VOL. 60 Nr.2 (2017)



ISSNL = 1454-7376
(Print)-ISSN 1454-7376
(Online) = ISSN 2069-8275
(CD-ROM) = ISSN 2069 847X

CONTENT

1.	JITĂREANU Carmenica Doina, SLABU Cristina, MARTA Alina Elena - Physiological researches on the influence of salt stress at some local populations of beans (<i>Phaseolus vulgaris</i> L.)	11
2.	COVAȘĂ Mihaela, JITĂREANU Carmen Doina, SLABU Cristina, MARTA Alina Elena - The influence of salt stress on ascorbic acid (vitamin C) in the fruits of some tomato cultivars from N-E Romania .	17
3.	MANOLE Carmen Gabriela, PARASCHIV Maria, CONSTANTIN Mugurași, BĂDULESCU Liliana - The influence of storage period on variation of phenolic content in sweet cherries	23
4.	SMEREA Svetlana, ANDRONIC Larisa, SCHIN Victoria - Callusogenetic and morphogenetic capacity of safflower explants ...	33
5.	DINCĂ L., VASILE Diana, VOICULESCU I. - The characteristics of plants from <i>Hieracium</i> genre present in Alexandru Beldie herbarium from I.N.C.D.S. Bucharest	39
6.	GACHE (LUNGU) Mirabela, MUNTEANU N., STOLERU V. TELIBAN G.C., GALEA (DELEANU) Florina Maria, CABA (INCULEȚ) Simona Carmen, HRIȚCU (MAFTEI) Adriana , GACHE (PĂTLĂGICĂ) M. - Preliminary studies on the culture of vegetable plants in pots and containeres	49
7.	GALEA (DELEANU) Florina-Maria, MUNTEANU N., STOLERU V., TELIBAN G.C., GACHE (LUNGU) Mirabela, HRISCU (MAFTEI) Adriana - Ornamental vegetable gardens in a family system	55
8.	ROȘCA Mihaela, HLIHOR Raluca-Maria, COMĂNIȚĂ Elena-Diana, COZMA Petronela, SIMION Isabela-Maria, GAVRILESCU Maria - The potential of some indigenous microorganisms and plants for the removal of heavy metals from soil	65
9.	HLIHOR Raluca Maria, POGĂCEAN Manuela Olga, ROȘCA Mihaela, COZMA Petronela, GAVRILESCU Maria - Dissipation behavior of pesticides applied in multiple treatments in apples	73
10.	GUȚUL Margareta, ILIEV P. - The importance of the production of grafted tomato seedlings	83
11.	GOCAN Tincuța-Maria, ANDREICA Ileana, POȘTA G, ROZSA Melinda, ROZSA S. - The effects of the industrial processing of the tomato paste and tomatoe juice on the C vitamin content	89
12.	INCULEȚ Simona-Carmen, MUNTEANU N., TELIBAN G.C., STOLERU V. - Preliminary studies regarding the improvement of tomato quality through technological measures	93
13.	MOHAMMED J.M., CIOFU Roxana, HOZA Gheorghita¹, NEAȚĂ Gabriela, BĂDULESCU Liliana - The impact of different n sources on the growth and yield of cucumber varieties under the plastic greenhouse	99

14.	ROZSA Melinda, APAHIDEAN Maria, GONCAN Tincuța-Marta - Study on golden oyster mushroom mycelium <i>Pleurotus citrinopileatus</i> Singer	111
15.	ROZSA Melinda, APAHIDEAN Maria - The influence of temperature and pH on <i>Cordyceps militaris</i> mushroom mycelium growth	117
16.	ROZSA S., LAZĂR V., GONCAN Tincuța Marta, ROZSA Melinda, POȘTA G. - Interaction between growing substrate nitrogen content and <i>Agaricus blazei</i> Murrill mushrooms protein content	123
17.	Rozsa S. - Correlation between soluble dry matter and β -1.3 D-glucan content in <i>Agaricus blazei</i> Murrill mushrooms	131
18.	BALAN V., IVANOV I., ȘARBAN V., BALAN P., VAMAȘESCU S. - Changes in cherries size and quality according to color	139
19.	DICIANU Elena Diana, IVAN Elena Ștefania, JERCA I.O., CICEOI Roxana, STĂNICĂ F. - Morphometric and phytopathological analysis of Romanian jujube fruits during the storage period	145
20.	IUREA Elena, SÎRBU Sorina, CORNEANU Margareta - Research on the behavior of some sweet cherry cultivars in Iasi area	151
21.	KISS I. K., HOZA D., ISTRATE M. - Observations on the frost resistance of the Fernor walnut variety during the rest period (january-april), under the pedoclimatic conditions in Sălcioara area, Dâmbovița county	157
22.	KOTROTSIOS I., SLAV M., HOZA D. - Preliminary study in regards to the culture of blueberry in containers	163
23.	MARIN F.C., CĂLINESCU Mirela, MILITARU Mădălina, SUMEDREA Mihaela, SUMEDREA D. - Behavior of some new apple varieties on the fireblight attack	169
24.	SÎRBU Sorina, IUREA Elena, CORNEANU Margareta - New sweet cherry cultivars for Romanian orchards	177
25.	VERINGĂ Daniela, MOHORA Angela, LĂMUREANU Gh. - Preliminary results regarding maintaining of the quality after harvesting of the apricots	183
26.	COLIBABA Cintia, ROTARU Liliana - Studies regarding some grape varieties in Dealu Bujor vineyard during 2015-2016	191
27.	ZALDEA Gabi, NECHITA Ancuța, DAMIAN Doina, ALEXANDRU L. C. - Dynamics of soil moisture in vineyards under water and thermal stress conditions	197
28.	ANDRIEȘ M. T., ODĂGERIU G., VĂRARU F., ZAMFIR C.I., COTEA V. V. - Experimental aspects regarding the malolactic fermentation using the freeze-dried culture of <i>Oenococcus oeni</i> for red wines	203
29.	ANDRIEȘ M. T., TUDOSE-SANDU-VILLE Ș., ZAMFIR C.I., VARARU F., NICULAU M., COLIBABA Cintia, ODĂGERIU G., COTEA V.V. - Study of volatile aroma compounds of some rosé wines from Iași Copou vineyard	209
30.	CIUBUCĂ A., DONICI Alina, POSTOLACHE Elena, BORA D. F., BÂRLIGA N., DONICI I. - Determination of levurien biomass in bioreactor	215

31. **FOCEA M.C., LUCHIAN Camelia, ZAMFIR C., NICULAU M., MOROȘANU Ana Maria, NISTOR Alina, ANDRIEȘ T., LACUREANU G., COTEA V.V.** - Organoleptic characteristics of experimental sparkling wines 221
32. **TELIBAN I.-V., COLIBABA CINTIA, ZAMFIR C., NICULAU M., ODAGERIU G., TUDOSE SANDU-VILLE S., COSTEA-SAVIN Zenaida, COTEA V.V.** - Studies on some Aligoté wines obtained through different wine-making technologies 227
33. **TUDOSE-SANDU-VILLE Ș., NICULAU M., COLIBABA Cintia, ANDRIEȘ M. T., ZAMFIR C.I., LUCHIAN Camelia Elena, COTEA V. V.** - Studies of the influence of the different selected yeast on the aromatic compounds from cider 231
34. **CĂLIN Maria, CRISTEA Tina Oana, AMBARUS Silvica, BREZEANU Creola, BREZEANU P. M., MUSCALU S. P., PRISECARU Maria, COSTACHE M., ȘOVAREL Gabriela, BRATU Liliana** - The study of biological control of onion thrips in pepper 237
35. **RADHI M.N., CONSTANTINESCU Flori, ANDREI Ana Maria, SHALLAL Hadi Hoobi, ROȘCA I.** - Using of *Trichoderma* spp. (*Trichoderma harzianum* and *Trichoderma koningii*) and its extract to control pathogenic fungi in the soil in vitro 243
36. **SIKAVELIS K., ROȘCA I.** - Researches on the pests evolution in grafted watermelon crops 251
37. **TĂLMACIU M., TĂLMACIU Nela, HEREA Monica, MOCANU Ionela** - Observations on the structure, dynamics and abundance of carabid species (order *Coleoptera*, family *Carabidae*) from fruit tree orchards 257
38. **TĂLMACIU Nela, TĂLMACIU M., HEREA Monica, MOCANU Ionela** - Considerations on the entomofauna in some apple orchards ... 263
39. **BOBOC (OROS) Paula, CANTOR Maria, HITTER Timea, GOCAN Tincuța** - *Passiflora* – source of sanogenic compounds, prospects for medicine and current uses 269
40. **DASCĂLU Doina Mira, DASCĂLU V., COJOCARIU Mirela** - The rescue of Iasi city landscape homage to G. M. Cantacuzino 275
41. **PAȘCU Roxana, ZLATI Cristina , BERNARDIS R.R.** - Research on sustainable methods of maintenance of green roofs 279
42. **ZLATI Cristina, PAȘCU Roxana, BERNARDIS R., VIERU I.** Permaculture concept in 3 dimensional agricultural landscaping 285
43. **CHELARIU Elena Liliana, COJOCARIU Mirela, DRAGHIA Lucia, BRÎNZĂ Maria, AVARVAREI B.V.** - Research regarding the behaviour of some rose from thea group in cropping conditions from Iași county, Romania 291
44. **CHELARIU Elena Liliana** - Studies regarding the behaviour of *Chasmathium latifolium* (Michx.) Yates ornamental specie in cropping conditions from Iași county, Romania 299
45. **COJUHARI Tamara, VRABIE Tatiana, KRIVOV Ludmila, KOTERNEAK Ana-Maria, ANGHEL Liubovi** - The dynamics of biocenotics indices of the soil in the forest ecosystem, "Codrii" reservation 305

46.	STOLERU V., TELIBAN G.C., COJOCARU A., CIURARU M.-C., CIUBOTĂRIȚĂ Anamaria - Influence of cultivation systems on production and content of heavy metals in eggplant	317
47.	HALITCHI Liliana-Gabriela, TOMIȚĂ Daniela Ivona, ILIESCU Codruța - Study regarding the relationship between diet and baby bottle tooth decay	323
48.	TOMIȚĂ Daniela Ivona, VASILIU Mihela Papușa, SACHELARIE Liliana, DELEU G., STADOLEANU Carmen - The role of fruit and vegetable consumption in maintaining normal oral pH	329
49.	VASILIU Mihela Papușa, TOMIȚĂ Daniela Ivona, SACHELARIE Liliana, FUIOAGĂ P.C., SHARDI Manahedji Ardeshir, COSTIN G. - Consumption of fruit and vegetables and quality of life	337
50.	BODALE I., CAZACU Ana, ENEA Elena-Andreea, OANCEA Servilia - Increasing the risk of tornadoes in Romania due to climate change	345
51.	CAZACU Ana, BODALE I., ILCU Florina-Raluca, OANCEA Servilia - Biological effects of cyanides on growth dynamics of corn and wheat plants	351
52.	RITTNER T., ARSENOAIA V., CÂRLESCU P., ȚENU I. - Research on the wear and reliability of machines for combating diseases and pests in vineyards	357
53.	BĂETU M., CÂRLESCU P., ROȘCA R., FILIMON R., RITTNER T., ȚENU I. - CFD simulation of the must flow in a hydrocyclon	363
54.	PATRAȘ Antoanela - Chemical characteristics of some commercial sunflower and corn oils	369
55.	BRÎNZĂ Maria, DRAGHIA Lucia, CHELARIU Elena Liliana, Boz Irina - The influence of some fertilizers on anatomical structure and the assimilating pigments of <i>Gazania splendens</i> 'Big kiss'	375
56.	MORARU Mihaela, CHELARIU Elena Liliana, BRÎNZĂ Maria, DRAGHIA Lucia - Aspects regarding the morphological and decorative characteristics of <i>Echinops ritro</i> plants obtained from seeds exposed to gamma radiation	383
57.	MORARU Mihaela, CHELARIU Elena Liliana, BRÎNZĂ Maria, GOANȚĂ Mirela, DRAGHIA Lucia - Aspects regarding the ornamental value of plants from <i>Eryngium</i> genus	389
58.	BAHRIM Cezar, BRÎNZĂ Maria, CHELARIU Elena Liliana, DRAGHIA Lucia - Characterization of <i>Eremurus</i> plants for ornamental purposes	395
59.	BAHRIM C., DRAGHIA Lucia, BRÎNZĂ Maria, CHELARIU Elena Liliana - Morphological and ornamental study of <i>Eremurus</i> species	401

CUPRINS

1. **JITĂREANU Carmenica Doina, SLABU Cristina, MARTA Alina Elena** - Cercetări fiziologice privind influența stresului salin la unele populații locale de fasole (*Phaseolus vulgaris* L.) 11
2. **COVAȘĂ Mihaela, JITĂREANU Carmen Doina, SLABU Cristina, MARTA Alina Elena** - Influența stresului salin asupra conținutului de acid ascorbic (vitamina C) din fructele unor genotipuri de tomate din Nord-Estul României 17
3. **MANOLE Carmen Gabriela, PARASCHIV Maria, CONSTANTIN Mugurași, BĂDULESCU Liliana** - Influența perioadei de păstrare asupra variației conținutului de fenoli la cireșe 23
4. **SMEREA Svetlana, ANDRONIC Larisa, SCHIN Victoria** - Capacitatea de calusogeneză și morfogeneză a explantelor de sofrănel 33
5. **DINCĂ L., VASILE Diana, VOICULESCU I.** - Caracteristici ale speciilor de plante din genul *Hieracium* existente în herbarul Alexandru Beldie al I.N.C.D.S. București 39
6. **GACHE (LUNGU) Mirabela, MUNTEANU N., STOLERU V. TELIBAN G.C., GALEA (DELEANU) Florina Maria, CABA (INCULEȚ) Simona Carmen, HRIȚCU (MAFTEI) Adriana , GACHE (PĂTLĂGICĂ) M.** - Studii preliminare privind cultura plantelor legumicole în ghivece și containere 49
7. **GALEA (DELEANU) Florina-Maria, MUNTEANU N., STOLERU V., TELIBAN G.C., GACHE (LUNGU) Mirabela, HRISCU (MAFTEI) Adriana** - Grădini legumicole ornamentale în sistem familial 55
8. **ROȘCA Mihaela, HLIHOR Raluca-Maria, COMĂNIȚĂ Elena-Diana, COZMA Petronela, SIMION Isabela-Maria, GAVRILESCU Maria** - Potențialul unor microorganisme și plante indigene de eliminare a metalelor grele din sol 65
9. **HLIHOR Raluca Maria, POGĂCEAN Manuela Olga, ROȘCA Mihaela, COZMA Petronela, GAVRILESCU Maria** - Comportamentul unor pesticide aplicate în tratamente multiple în mere 73
10. **GUȚUL Margareta, ILIEV P.** - Importanța producerii răsadurilor altoite de tomate 83
11. **GOCAN Tincuța-Marta, ANDREICA Ileana, POȘTA G, ROZSA Melinda, ROZSA S.** - Efectele procesării industriale a pastei de tomate și a sucului de roșii asupra conținutului de vitamina C 89
12. **INCULEȚ Simona-Carmen, MUNTEANU N., TELIBAN G.C., STOLERU V.** - Studii preliminare privind îmbunătățirea calității fructelor de tomate prin diferite măsuri tehnologice 93
13. **MOHAMMED J.M., CIOFU Roxana, HOZA Gheorghiza, NEAȚĂ Gabriela, BĂDULESCU Liliana** - Studii asupra influenței diverselor surse de azot asupra creșterii și producției la diverse soiuri de

	castraveți din solarii	99
14.	ROZSA Melinda, APAHIDEAN Maria, GONCAN Tincuța-Marta - Studiu privind miceliul ciupercii aurii <i>Pleurotus citrinopileatus</i> Singer	111
15.	ROZSA Melinda, APAHIDEAN Maria - Influența temperaturii și a pH-ului asupra creșterii miceliului ciupercii <i>Cordyceps militaris</i>	117
16.	ROZSA S., LAZĂR V., GONCAN Tincuța Marta, ROZSA Melinda, POȘTA G. - Interacțiunea dintre conținutul de azot al substratului de cultură și conținutul de proteină al ciupercilor <i>Agaricus blazei</i> Murrill	123
17.	ROZSA S. - Corelație între substanța uscată solubilă și conținutul de β -1,3 D-glucan la ciupercile <i>Agaricus blazei</i> Murrill	131
18.	BALAN V., IVANOV I., ȘARBAN V., BALAN P., VAMAȘESCU S. - Modificări ale dimensiunii și calității cireșelor în funcție de culoare	139
19.	DICIANU Elena Diana, IVAN Elena Ștefania, JERCA I.O., CICEOI Roxana, STĂNICĂ F. - Analiza morfometrică și fitopatologică a fructelor de jujube din România în timpul perioadei de depozitare	145
20.	IUREA Elena, SÎRBU Sorina, CORNEANU Margareta - Cercetări privind comportarea unor soiuri de cireș în zona Iași	151
21.	KISS I. K., HOZA D., ISTRATE M. - Observații asupra rezistenței la îngheț a soiului de nuc Fernor, în timpul perioadei de repaus (ianuarie-aprilie), în condițiile pedoclimatice din zona Sălcioara, jud. Dâmbovița	157
22.	KOTROTSIOS I., SLAV M., HOZA D. - Cercetări preliminare privind cultura afinului în container	163
23.	MARIN F.C., CĂLINESCU Mirela, MILITARU Mădălina, SUMEDREA Mihaela, SUMEDREA D. - Comportarea unor soiuri noi de mar la atacul focului bacterian	169
24.	SÎRBU Sorina, IUREA Elena, CORNEANU Margareta - Noi soiuri de cireș pentru plantațiile pomicele din România	177
25.	VERINGĂ Daniela, MOHORA Angela, LĂMUREANU G. - Rezultate preliminare privind menținerea calității caiselor după recoltare	183
26.	COLIBABA Cintia, ROTARU Liliana - Studii asupra unor soiuri de struguri din podgoria Dealu Bujor în condițiile anilor 2015 și 2016	191
27.	ZALDEA Gabi, NECHITA Ancuța, DAMIAN Doina, ALEXANDRU L. C. - Dinamica umidității solului în plantațiile viticole în condiții de stres hidric și termic	197
28.	ANDRIEȘ M. T., ODĂGERIU G., VĂRARU F., ZAMFIR C.I., COTEA V. V. - Aspecte experimentale privind folosirea unui preparat de <i>Oenococcus oeni</i> la fermentația malolactică a unor vinuri roșii	203
29.	ANDRIEȘ M. T., TUDOSE-SANDU-VILLE Ș., ZAMFIR C.I., VARARU F., NICULAU M., COLIBABA Cintia, ODĂGERIU G., COTEA V.V. - Studii privind compușii volatili de aromă din unele vinuri roze obținute în Podgoria Iași Copou	209
30.	CIUBUCĂ A., DONICI Alina, POSTOLACHE Elena, BORA D. F., BÂRLIGA N., DONICI I. - Determinarea biomasei levuriene în bioreactor	215

31. **FOCEA M.C., LUCHIAN Camelia, ZAMFIR C., NICULAU M., MOROȘANU Ana Maria, NISTOR Alina, ANDRIEȘ T., LACUREANU G., COTEA V.V.** - Caracteristici organoleptice ale unor vinuri spumante experimentale 221
32. **TELIBAN I.-V., COLIBABA CINTIA, ZAMFIR C., NICULAU M., ODAGERIU G., TUDOSE SANDU-VILLE S., COSTEA-SAVIN Zenaida, COTEA V.V.** - Studii asupra unor vinuri de Aligoté obținut prin diferite tehnologii de vinificație 227
33. **TUDOSE-SANDU-VILLE Ș., NICULAU M., COLIBABA Cintia, ANDRIEȘ M. T., ZAMFIR C.I., LUCHIAN Camelia Elena, COTEA V. V.** - Studiu privind influența diferitelor preparate levuriene folosite în tehnologia de producere a cidrului asupra compușilor de aromă 231
34. **CĂLIN Maria, CRISTEA Tina Oana, AMBARUS Silvica, BREZEANU Creola, BREZEANU P.M., MUSCALU S.P., PRISECARU Maria, COSTACHE M., ȘOVAREL Gabriela, BRATU Liliana** - Studiul combaterii biologice a tripsului comun la ardei 237
35. **RADHI M.N., CONSTANTINESCU Flori, ANDREI Ana Maria, SHALLAL Hadi Hoobi, ROȘCA I.** - Utilizarea *Trichoderma* spp. (*Trichoderma harzianum* și *Trichoderma koningii*) și extractul acestora pentru inhibarea ciupercilor patogene din solul in vitro 243
36. **SIKAVELIS K., ROȘCA I.** - Cercetări privind evoluția dăunătorilor în culturile de pepeni verzi altoiți 251
37. **TĂLMACIU M., TĂLMACIU Nela, HEREA Monica, MOCANU Ionela** - Observații privind structura, dinamica și abundența speciilor de carabide (ord. *Coleoptera*, fam. *Carabidae*) din plantațiile pomicole de măr 257
38. **TĂLMACIU Nela, TĂLMACIU M., HEREA Monica, MOCANU Ionela** - Considerații asupra entomofaunei din unele plantații pomicole de măr 263
39. **BOBOC (OROS) Paula, CANTOR Maria, HITTER Timea, GOCAN Tincuța** - *Passiflora* – Sursă de compuși sanogenici, perspective pentru medicină și utilizări curente 269
40. **DASCĂLU Doina Mira, DASCĂLU V., COJOCARIU Mirela** - Salvarea peisajului citadin ieșean, omagiu lui G. M. Cantacuzino 275
41. **PAȘCU Roxana, ZLATI Cristina, BERNARDIS R.R.** - Cercetări privind metode sustenabile de întreținere a acoperișurilor verzi 279
42. **ZLATI Cristina, PAȘCU Roxana, BERNARDIS R., VIERU I.** - Conceptul de permacultură în amenajarea peisagistică 3D 285
43. **CHELARIU Elena Liliana, COJOCARIU Mirela, DRAGHIA Lucia, BRÎNZĂ Maria, AVARVAREI B.V.** - Cercetări privind comportarea unor trandafiri din grupa *thea* în condițiile de cultură din Iași, România 291
44. **CHELARIU Elena Liliana** - Cercetări privind comportarea speciei ornamentale *Chasmathium latifolium* (Michx.) Yates în condițiile de cultură din Iași, România 299
45. **COJUHARI Tamara, VRABIE Tatiana, KRIVOV Ludmila,** 305

	KOTERNEAK Ana-Maria, ANGHEL Liubovi - Dinamica unor indici biocenotici ai solului în ecosistemul forestier, rezervația “Codrii”	
46.	STOLERU V., TELIBAN G. C., COJOCARU A., CIURARU M.-C., CIUBOTĂRIȚĂ Anamaria - Influența sistemelor de cultivare asupra producției și conținutului de metale grele la pătlăgelele vinete	317
47	HALITCHI Liliana-Gabriela, TOMIȚĂ Daniela Ivona, ILIESCU Codruța - Studiu privind interrelația dieta-carie de biberon la copil	323
48	TOMIȚĂ Daniela Ivona, VASILIU Mihela Papușa, SACHELARIE Liliana, DELEU Grigorii, STADOLEANU Carmen - Rolul consumului de fructe și legume în menținerea pH-ului oral normal	329
49	VASILIU Mihela Papușa, TOMIȚĂ Daniela Ivona, SACHELARIE Liliana, FUIOAGĂ P.C., SHARDI Manahedji Ardeshir, COSTIN G. - Consumul de fructe și legume și calitatea vieții	337
50	BODALE I., CAZACU Ana, ENEA Elena-Andreea, OANCEA Servilia - Creșterea riscului de apariție a tornadelor în România datorită schimbărilor climatice	345
51	CAZACU Ana, BODALE I., ILCU Florina-Raluca, OANCEA Servilia - Efecte biologice ale cianurilor în dinamica creșterii plantelor de porumb și de grâu	351
52	RITTNER T., ARSENOAIA V., CÂRLESCU P., ȚENU I. - Cercetări privind uzura și fiabilitatea mașinilor pentru combaterea bolilor și dăunătorilor din plantațiile viticole	357
53	BĂETU M., CÂRLESCU P., ROȘCA R., FILIMON R., RITTNER T., ȚENU I. - Simularea CFD a curgerii mustului într-un hidrociclon	363
54	PATRAȘ Antoanela - Caracteristici chimice ale unor uleiuri comerciale de floarea - soarelui și porumb	369
55.	BRÎNZĂ Maria, DRAGHIA Lucia, CHELARIU Elena Liliana, Boz Irina - Influența unor îngrășăminte asupra structurii anatomomorfologice și a conținutului în pigmenți asimilatori la <i>Gazania splendens</i> ‘Big kiss’	375
56.	MORARU Mihaela, CHELARIU Elena Liliana, BRÎNZĂ Maria, DRAGHIA Lucia - Aspecte privind caracterele morfologice și decorative ale plantelor de <i>Echinops ritro</i> obținute din semințe tratate cu radiații gamma	383
57.	MORARU Mihaela, CHELARIU Elena Liliana, BRÎNZĂ Maria, GOANȚĂ Mirela, DRAGHIA Lucia - Aspecte privind valoarea decorativă a plantelor din genul <i>Eryngium</i>	389
58.	BAHRIM C., BRÎNZĂ Maria, CHELARIU Elena Liliana, DRAGHIA Lucia - Caracterizarea plantelor genului <i>Eremurus</i> pentru utilizare în scop ornamental	395
59.	BAHRIM C., DRAGHIA Lucia, BRÎNZĂ Maria, CHELARIU Elena Liliana - Studii privind caracterele morfologice și ornamentale ale unor specii de <i>Eremurus</i>	401

**PHYSIOLOGICAL RESEARCHES ON THE INFLUENCE
OF SALT STRESS AT SOME LOCAL POPULATIONS
OF BEANS (*PHASEOLUS VULGARIS* L.)**

**CERCETĂRI FIZIOLOGICE PRIVIND INFLUENȚA STRESULUI SALIN
LA UNELE POPULAȚII LOCALE DE FASOLE
(*PHASEOLUS VULGARIS* L.)**

*JITĂREANU Carmenica Doina*¹, *SLABU Cristina*¹,

*MARTA Alina Elena*¹

e-mail: doinaj@uaiasi.ro

Abstract. *Saline stress affects seeds germination, reduces the chlorophyll content in the plant leaves and the photosynthesis activity, changes that have prompted the researchers around the world, also in Romania, to study this abiotic factor with interest. The success of the research could provide the extension of plant cultivation to areas affected by salinisation or as well as the possibility of using sea and ocean water, a vast resource, for irrigation of crops, and as a result, the increase in world biomass production. The present research investigated the influence of saline solutions (100 mM and 200 mM NaCl) on the chlorophyll pigments content in 10 local populations of common beans (*Phaseolus vulgaris* L.) grown in pots, in greenhouse conditions. The main objective of this study was to identify the salinity tolerant genotypes, knowing that this attribute is also conferred by a high chlorophylls concentration. Also tolerant genotypes could be used in plant breeding, as these local populations are adapted to the environmental conditions of the NE of Romania.*

Key words: salt stress, *Phaseolus vulgaris*, chlorophyll content

Rezumat. *Stresul salin afectează germinația semințelor, provoacă diminuarea conținutului de clorofilă din frunzele plantelor și reducerea fotosintezei, modificări ce au determinat pe cercetătorii din România și din întreaga lume să studieze cu interes acest factor abiotic. Reușita cercetărilor ar putea însemna extinderea cultivării plantelor pe suprafețele afectate de salinizare precum și posibilitatea utilizării apei mărilor și oceanelor, o resursă vastă, pentru irigarea culturilor, toate acestea având ca efect creșterea producției mondiale de biomasă. În lucrarea de față s-a urmărit studierea influenței unor soluții salină (100 mM și 200 mM) asupra conținutului de pigmenți clorofilieni, la 10 populații locale de fasole comună (*Phaseolus vulgaris* L.) cultivate în condiții de seră, la ghivece. Scopul principal a fost depistarea genotipurilor tolerante la salinitate, știindu-se faptul că această însușire este conferită și de un nivel ridicat al concentrației de pigmenți clorofilieni. De asemenea, genotipurile tolerante ar putea fi folosite în ameliorare, populațiile locale fiind adaptate condițiilor de mediu din partea de NE a României.*

Cuvinte cheie: stres salin, *Phaseolus vulgaris*, conținut de clorofilă

¹University of Agricultural Sciences and Veterinary Medicine Iasi, Romania

INTRODUCTION

Soil salinity currently represents an important limiting factor of agricultural crops productivity, in many regions of the world, being considered the main cause of desertification, which remains the worst form of soil degradation. Worldwide, the situation is quite worrying because arid or desert areas represent approx. 25% of the Earth's surface and one third of irrigated land is affected by salinity

Following the demographic growth and the pronounced expression of the greenhouse effect, considerable efforts have been made around the world to breeding salinity resistant agricultural plants, but so far only small progress was recorded for this purpose. It is a certainty that the food provision has always constituted a primary goal, which even now, in modern times, brings people to try, to seek, and to discover. For these reasons, the capitalization of genetic variability of the local plants populations, regarding salinity resistance, may be a first step in the works of improving the salinity tolerance of the cultivated species with the aim to increase the living standards and to fully exploit soil resources.

There are many concerns about salt tolerance of plants, their response to high salinity, the various aspects of saline stress, otherwise this being the most intensely studied type of abiotic stress on plants. All salts affect plant growth, but not all inhibit this process. Also, the interaction effect is manifested inside the plant, some of which are simple, while some are complex. Despite numerous published researches on mechanisms of plant adaptation for salinity tolerance, the exact elucidation of these biochemical and physiological mechanisms of metabolic adaptation to saline stress has not been achieved (Petcu, 2008).

The impact of saline excess on the productivity of several cultivated plants is sometimes disastrous, fact which determines the identification and creation of new plants genotypes, with osmotic stress tolerance. *Phaseolus vulgaris* L. is considered very sensitive to saline stress and the decreasing in the chlorophyll content under saline stress conditions is described as a phenomenon which diminishes the plant productivity, inhibits or alters their growth, distribution of dry matter, seed germination, photosynthesis and their yield (Galani, 2014).

MATERIAL AND METHOD

The biological material used in this research was represented by 10 local bean populations collected from saline soils in the Iasi and Botosani counties: Copălău 1, Coropcenii 1, Coropcenii 2, Iezer 4, Iezer 5, Moșna 3, Moșna 4, Săveni 1, Trușești 4 and Trușești 5.

The experiments were carried under greenhouse conditions in the Phytotron of the "Vasile Adamachi" Didactical Center, from University of Agricultural Sciences and Veterinary Medicine Iași. The *Phaseolus vulgaris* seeds were sowed in March 2016 in a 15-liter vegetation pot, in a mixture of garden soil and peat in a 1: 1 ratio.

The research was bifactorial, the first factor being the genotype, and the second the concentration of the saline solution applied to the plants. Thus, there were

3 experimental variants: 1. the control variant (V0) in which the bean plants were irrigated only with drinking water; 2. variant V1 - wherein the plants were watered with 100 mM NaCl solution; 3. Variant V2-irrigation with a 200 mM NaCl solution. Each experimental variant included 6 rehearsals.

RESULTS AND DISCUSSIONS

Influence of saline stress on the foliar pigments content. According to the literature data, it is highlighted that under saline stress conditions, the chloroplasts aggregation occurs in the leaves, and cell membranes become wrinkled and distorted. For many plant species, the photosynthesis is inhibited by NaCl concentration, and the chlorophyll pigments content decreases with increasing of saline concentrations (Khavari-Nejad and Mostofi, 1998).

The chlorophyll pigments analysis is an important tool to assess the effect of saline stress, because they play an important role in plant metabolism. According to Abdel-Kader *et al.*, (2008), the decrease in chlorophyll a and chlorophyll b is due to accelerating tissue and biochemical degradation under saline stress.

In our research, the spectrophotometric analysis performed 15 days after salt application, it resulted that **chlorophyll a 662-663 nm** had the lowest, but close, values in Copălău 1 populations (0.242 a.u., 0.148 a.u.; 0.217 a.u.) and Săveni 1 (0.517 a.u., 0.476 a.u., 0.530 a.u.), that indicated a low but not salty stressed photosynthetic intensity (fig. 1).

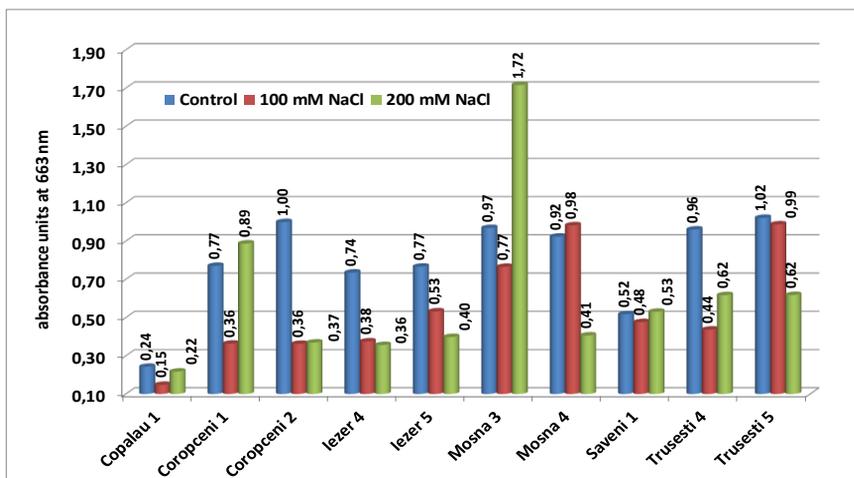


Fig. 1 The saline stress effect on the chlorophyll a 662-663 nm content

In the Coropcenii 2 and Iezer 4 populations, approximately equal values were observed for the 100 and 200 mM NaCl treated variants, up to 1/3 of the control variant, indicating sensitive populations to this type of stress. The highest

values of the chlorophyll content of 662-663 nm in 100 mM NaCl variants were recorded at Moșna 4 (0.982 a.u.) and Trușești 5 (0.987 a.u.), showing resistance to lower salt concentrations and can be taken in consideration for medium or poorly leveled soils. High values of the analyzed parameter at high salt concentrations (200 mM NaCl) were observed in Coropceni 1 (0.887 a.u.) and especially in Moșna 3 (1.716 a.u.), both against the control and 100 mM NaCl, which shows us populations with good resistance to saline stress.

Compared to controls, the other analyzed populations obtained much lower values of chlorophyll a 662-663 nm in the variants subjected to osmotic stress, which proves more sensitivity to the action of NaCl that has multiple negative effects, causing toxic actions on the protoplasm, manifested by deregulation of submicroscopic structure of chloroplasts.

The content of **chlorophyll b 453-454 nm**, the main component of the reaction center in the photosynthetic systems, also had oscillating values from one population to another. The lowest content was recorded in the Copălău 1 populations (0.223 a.u., 0.376 a.u.) and Săveni 1 (0.624 a.u., 0.716 a.u.), but the values were close to the control variant, indicating genotypes with low chlorophyll concentrations and reduced photosynthetic intensity. At Coropceni 2 and Iezer 4 we have noticed much lower levels of chlorophyll b 453-454 in the variants treated with NaCl compared to the control variant, proving a susceptibility to saline stress. The highest content of chlorophyll b in variants treated with 100 mM NaCl have registered Moșna 3 (1.11 a.u.), Moșna 4 (1.516 a.u.) and Trușești 5 (1.360 a.u.) (fig. 2).

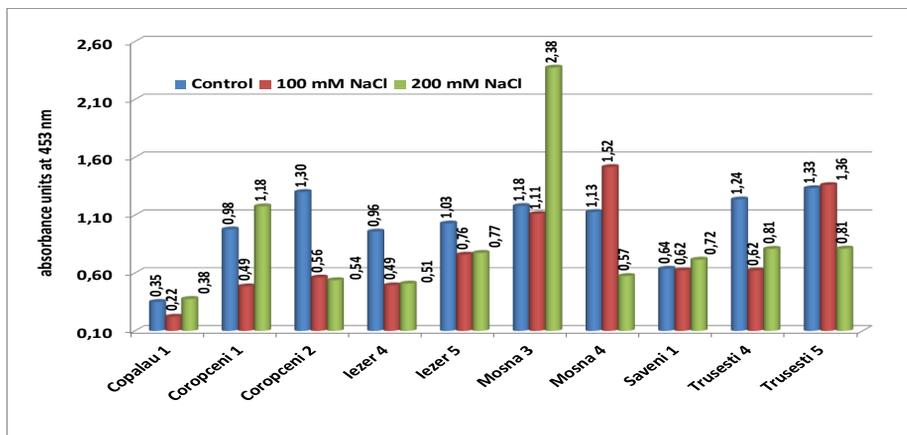


Fig. 2 The saline stress effect on the chlorophyll b 453-454 nm content

In versions treated with 200 mM NaCl, Coropcenii 1 (1.176 a.u.) and Moșna 3 (2,375 a.u.) stood out, even surpassing the control, demonstrating good resistance to osmotic stress.

The other experimental populations recorded significantly lower values than the control variant, with a marked sensitivity to osmotic stress, which had disastrous effects on plants, in addition to reducing the chlorophyll content, causing reduced photosynthesis, decreased production and crop yield.

Analysis of chlorophyll content with maximum absorption at 434 - 435 nm (AIV) reveals similar behaviors to other types of chlorophyll. Thus, among all analyzed variants, the lowest content is noted in the local population Copălău, the minimum values being of 0.299 a.u. to the variant treated with 100 mM NaCl and 0.331 a.u. to the variant treated with 200 mM NaCl (fig. 3)

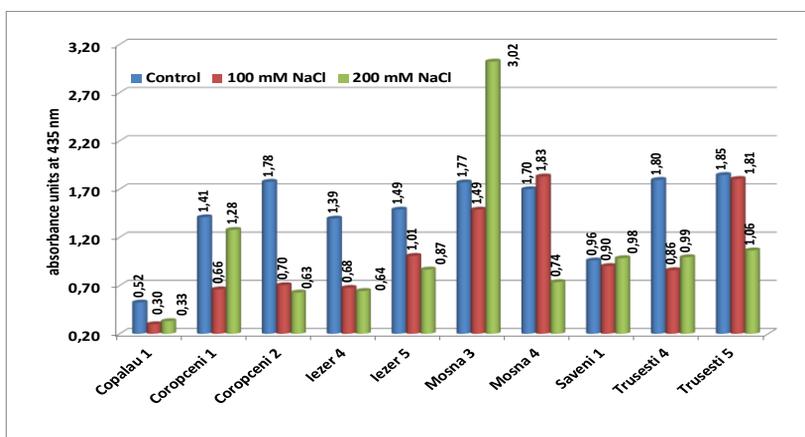


Fig. 3 The saline stress effect on the chlorophyll b 434-435 nm content

At 200 mM, a maximum content is observed at Moșna 3 (3.022 a.u.), followed by Coropcenii 1 (1.277 a.u.), which demonstrated the best resistance to high concentrations of NaCl and could be grown on salt-rich terrains. In the case of osmotic stress sensitive populations, NaCl produced a decrease in chlorophyll a and b, saline stress also producing both a fresh and dry bean weight reduction due to decreased photosynthesis intensity.

The content of **flavonoid pigments** responsible for the protection of plants under stress conditions proved to be particularly great in the control variant.

In particular, the Moșna 3 and Trușești 5 populations, which recorded high values for all analyzed variants: control, 100 mM and 200 mM NaCl (fig. 4).

In 100 mM-treated variants, maximum values were observed for Coropcenii 1, Iezer 5 and Săveni 1 genotypes, while in the 200 mM wet variants only the

Moșna 4 population were found to be high. The lowest values of 100 mM flavonoids are noted in Copălău 1, Coropcenii 2, Iezer 4, Iezer 5 and Trușești 4, which proves a poor protection against their osmotic stress.

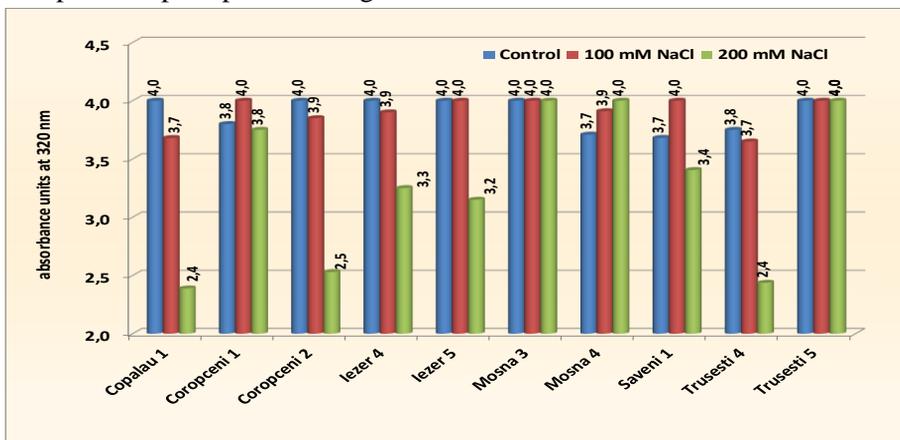


Fig. 4. The saline stress effect on the flavonoid pigments content

CONCLUSIONS

1. The chlorophyll content of 662-663 was found to be higher in the local populations of Moșna 4 and Trușești 5 at saline concentrations of 100 mM NaCl and Coropcenii 1 and Moșna 3 to 200 mM NaCl, which denotes resistance to saline stress.

2. The main component of the reaction center, chlorophyll b 453-454 nm, recorded high values in the 100 mM NaCl variant at Moșna 3, Moșna 4 and Trușești 5 and at 200 mM NaCl at Coropcenii 1 and Moșna 3.

3. The maximum content of chlorophyll pigments at the 200 mM concentration recorded in the local populations of Moșna 3 and Coropcenii 1 demonstrates their better resistance to saline stress and recommends these local populations in culture on saline soils and their use in amelioration.

REFERENCES

1. Abdel Kader A F., Aronsson H., Solymosi K., Bela Boddi, Sundqvist C., 2008 - *Chlorophyll accumulation, protochlorophyllide formation and prolamellar body conversion are held back in wheat leaves exposed to high salt stress*, Photosynthesis. Energy from the Sun, 1133-1136.
2. Galani (Neculai) D., 2014 – Managementul conservării biodiversității. Stresul abiotic la plante. USAMVB. https://www.academia.edu/7728524/Stresul_salin_la_salat_Lactuca_sativa
3. Khavari-Nejad R.A., Mostofi Y., 1998 – *Effects of NaCl on photosynthetic pigments, saccharides and chloroplast ultrastructure in leaves of tomato cultivars*. Photosynetica, 35:151-154.
4. Petcu Elena, Țerbea Maria, Lazăr C., 2007 - *Cercetări în domeniul fiziologiei plantelor de câmp la Fundulea*, An. I.N.C.D.A. Fundulea, vol. LXXV:431-458.

THE INFLUENCE OF SALT STRESS ON ASCORBIC ACID (VITAMIN C) IN THE FRUITS OF SOME TOMATO CULTIVARS FROM N-E ROMANIA

INFLUENȚA STRESULUI SALIN ASUPRA CONȚINUTULUI DE ACID ASCORBIC (VITAMINA C) DIN FRUCTELE UNOR GENOTIPURI DE TOMATE DIN NORD-ESTUL ROMÂNIEI

*COVAȘĂ Mihaela¹, JITĂREANU Carmen Doina¹,
SLABU Cristina¹, MARTA Alina Elena¹*
e-mail: miha_bologa@yahoo.com

Abstract: *Vitamin C or ascorbic acid is an organic acid with antioxidant properties, involved in a number of processes taking place in living cells. Through their efforts to adapt to the saline stress, plants have to increase the antioxidant level by increasing, mainly, the ascorbic acid. The research was conducted under greenhouse condition. The biological material was represented by seven local tomatoes populations collected from areas with saline soils from Moldavia region and compared with commercial type salt-tolerant tomato. Tomato genotypes in the study were subjected to salt stress for a period of 30 days is constantly wetted with saline solution to a concentration of 100 mM and 200 mM. The content of vitamin C in fruit was determined by using the titrimetric method. The research on the vitamin C content from tomatoes fruit showed that, as the concentration saline increases, the concentration of ascorbic acid raises too.*

Key words: salinity, stress, tomatoes, vitamin C, adaptation

Rezumat: *Vitamina C sau acidul ascorbic, este un acid organic cu proprietăți antioxidante, implicat într-o serie de procese care se desfășoară în celulele vii. Plantele, prin eforturile de adaptare la stresul salin, sunt nevoite să-și mărească nivelul de antioxidanți în principal prin creșterea conținutului de acid ascorbic. Au fost luate în studiu șapte genotipuri de tomate colectate din solurile salin ale regiunii Moldovei și un soi comercial rezistent la salinitate. Acestea au fost expuse stresului salin pe o perioadă de 30 de zile, fiind udate constant cu soluții salin de concentrație 100 mM și 200 mM. S-a determinat conținutul de vitamina C din fructe după metoda titrimetrică pentru determinarea acidului L – ascorbic. Cercetările au demonstrat că odată cu creșterea concentrației salin crește și valoarea concentrației acidului ascorbic.*

Cuvinte cheie: salinitate, stres, tomate, vitamina C, adaptare

¹University of Agricultural Science and Veterinary Medicine from Iasi, Romania

INTRODUCTION

Exposure of plants to abiotic stresses such as high salinity, drought, extreme light and temperature leads to major loss in crop productivity worldwide. Among the various abiotic stress factors, salinity is the biggest threat to plant agriculture. Salt stress affects almost every aspect of the physiology and biochemistry of plants and significantly reduces yield. Therefore, a concerted effort to understand the effects of salinity on plants is essential to combat the world's salinity problem (Murshed *et al.*, 2014).

According to the FAO guideline tomato is moderately tolerant to salinity (Munns and Tester, 2008). It has been shown that irrigation with saline water may improve the taste of both round and cherry tomatoes by increasing their sugar and organic acid content. A controlled level of stress, imposed via irrigation with saline water, is also used to improve quality and flavour of processed tomatoes. Tomato fruits are a valuable source of several nutrients such as vitamin C (Pascale *et al.*, 2001).

Vitamin C serves as a cofactor in the synthesis of collagen needed to support cardiovascular function, maintenance of cartilage, bones, and teeth, as well as being required in wound healing. The National Academy of Sciences has recommended 90 mg/day of the vitamin for adult males and 75 mg/day for adult females. Although vitamin C can be obtained from the consumption of fresh meat, it is destroyed by heating and is more typically obtained from plant sources. Ascorbic acid is present in high amounts generally in fruits and leafy vegetables whereas grains typically have much lower levels of the vitamin, particularly in dried grain. Moreover, the diet of a significant portion of the global population consists largely of plant-based foods (Gallie, 2013).

Although post-harvest reductions in ascorbic acid can occur, particularly in leafy vegetables, increasing vitamin C content would help to preserve the nutritional quality of stored foods. As a result, much research has focused on developing strategies to increase vitamin C content in plant foods to improve their nutritional value including strategies to increase the biosynthetic capacity of plants and to increase the recycling of ascorbic acid once it has been used in a reaction (Hancock and Viola, 2005).

MATERIAL AND METHOD

The research was conducted under greenhouse condition from USAMV Iași in the year 2016.

The biological material was represented by six local tomatoes populations collected from areas with saline soils from Moldavia region and compared with commercial type salt-tolerant tomato (*Ursula F₁*) from Israel.

The bifactorial experience was conducted in a pots experiment in randomized blocks with three repetitions. Six tomato genotypes (*Moșna₂*, *Șcheia*, *Copalău₃*, *Copalău₄*,

Copălău₅, *Moșna₃*) studied were subjected to salt stress for a period of 30 days is constantly wetted with saline solution to a concentration of 100 mM and 200 mM.

The extraction of ascorbic acid from the sample, using oxalic acid solution, or solution of metaphosphoric acid and acetic acid and the titration with 2.6 dichlorophenolindophenol, until obtaining a light pink color.

For interpretation of the results was used Anova Two Factor.

RESULTS AND DISCUSSIONS

Vitamin C or ascorbic acid is an organic acid with antioxidant properties, involved in a number of processes taking place in living cells.

Through their efforts to adapt to the saline stress, plants have to increase the antioxidant level (Ehret *et al.*, 2013) by increasing, mainly, the ascorbic acid, this fact being also showed by our determinations.

The researches conducted in this study on the vitamin C content from tomatoes fruit showed that, as the concentration saline increases, the concentration of ascorbic acid raises too. For the control variant, the maximum value was registered in the genotype *Șcheia* - 10.68 mg and the minimum value in the genotype *Copălău₃* - 4.50 mg. For the variant treated with saline solution of 100 mM compared to control variant, all genotypes had higher values, the maximum of 15.56 mg being determined in *Ursula F₁* variety's fruit and the minimum value of 9.15 mg was registered in the genotype *Copălău₃* (fig. 1).

For the variant subjected to a 200 mM saline stress concentration compared to the control variant, all genotypes had higher values, the minimum value being for the genotype *Copălău₃* - 14.63 mg, and the maximum for genotype *Copălău₄* - 18.24 mg.

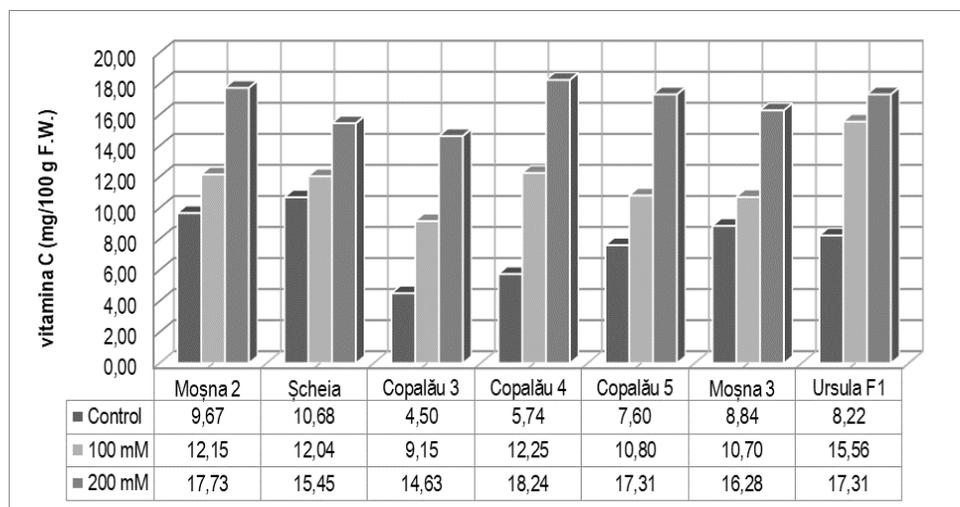


Fig. 1 Vitamin C concentration (mg / 100 mg F.W.) from tomato fruit subjected to saline stress over a period of 30 days

Compared to control cultivar *Ursula*_{F1} used (8.22 mg), three of the genotypes *Moșna*₂, *Șcheia*, *Moșna*₃ have higher values, between 8.84 - 10.68 mg vitamin C / 100 g F.W. For the variant with a saline stress of 100 mM, all studied genotypes present salinity values between 9.15 - 12.25 mg, lower than those of the resistant cultivar (15.56 mg). Compared to *Ursula*_{F1} (17.31 mg.), the variant subjected to a saline solution of 200 mM, 2 genotypes *Moșna*₂ and *Copălău*₄ have higher values, between 17.73 -18.24 mg.

The results on the content of vitamin C in the fruit of some tomatoes genotypes subjected to saline stress of 100 mM showed that this level of salinity has favored the synthesis of ascorbic acid in concentrations of 1.36 - 7.34 times higher compared to the control variant. For the variant treated with a saline solution of 200 mM, the values for the concentration of vitamin C have been 4.77 - 12.50 times higher than for the control variant. However, other studies (Dumas *et al.*, 2003) showed a decrease in the content of ascorbic acid in conjunction with the saline stress. The reason may be either the degree of salinity used, which induces different stress levels, or the genetic differences between the biotypes of cultivated tomatoes, which influences the resistance to saline stress, or other factors, such as the degree of maturation.

After conducting the variance analysis on genotypes of tomatoes subjected to stress saline for 30 days, it was found that the accumulation of ascorbic acid was insignificantly influenced by *a factor – genotype*, there being no significant differences among the genotypes of the same variant, but *b factor - NaCl concentration* has a very significant influence on the concentration of vitamin C (tab. 1).

Table 1.

**The variance analysis of the tomato genotypes under stress salinity
of stomatal conductance**

after 30 days

Source of variance	SP	G L	MS	F	P-value	F crit	Influence
Genotype	33.942	6	5.65705 2	2.40958 8	0.09183	2.996	NS
Concentration	273.054	2	136.527 1	58.1529 2	0.00000 1	3.885	***
Error	28.1727	12	2.34772 6				
Total	335.169	20					

Anova Two- Factor: ^{NS} insignificant statistical differences ($p \geq 0.05$); * significant statistical differences ($p \leq 0.05$); ** distinctly significant statistical differences ($p \leq 0.01$); *** highly significant statistical differences ($p \leq 0.001$), $F > F$ crit null hypothesis rejected

After running *Test T*, it has been found that there are distinctly significant statistical differences between the control variant and the variant subjected to saline stress of concentration of 100 mM. There are highly significant statistical differences between the control variant and the variant subjected to saline stress of concentration of 200 mM, as well as between the variants treated with saline solution (tab.2).

Table 2.

Statistical differences of the content of vitamin C in fruit (mg / 100 mg F.W.) observed between the control variant and the variants treated with saline concentration

Compared variants	t-stat	P two-tail	Meaning
I-II	-4.4616	0.004275	**
I-III	-9.6544	0.000071	***
II-III	-7.6605	0.000258	***

t-Test Paired Two Sample for Means : ^{NS} insignificant statistical differences ($p \geq 0.05$) between variants; *significant statistical differences ($p \leq 0.05$) between variables; ** distinctly significant statistical differences ($p \leq 0.01$) between variants; *** highly significant statistical differences ($p \leq 0.001$) between variants, I-control, II- 100 Mm, III- 200 mM

CONCLUSIONS

The results on the content of vitamin C in the fruit of some tomatoes genotypes subjected to saline stress of 100 mM showed that this level of salinity has favored the synthesis of ascorbic acid in concentrations of 1.36 - 7.34 times higher compared to the control variant. For the variant treated with a saline solution of 200 mM, the values for the concentration of vitamin C have been 4.77 - 12.50 times higher than for the control variant.

Salinity increased the contents of acid ascorbic on the tomato fruits and thus improved the fruit quality.

REFERENCES

1. Dumas Y., Dadomo M., Lucca G.D., Grolier P., Lucca G., 2003 - *Effects of environmental factors and agricultural techniques on antioxidant content of tomatoes*. Journal of the Science of Food and Agriculture, 83(5), p. 369-382.
2. Ehret D.L., Usher K., Helmer T., Block G., Steinke D., Frey B., Kuang T., Diarra M., 2013 - *Tomato fruit antioxidants in relation to salinity and greenhouse climate*. Journal of agricultural and food chemistry, 61 (5), p. 1138-1145.
3. Gallie D.R., 2013 - *Increasing vitamine C content in plant foods to improve their nutritional value - Successes and Challenges*. Journal Nutrients, 5(9), p. 3424-3446.

4. **Hancock R.D., Viola R., 2005** - *Improving the nutritional value of crops through enhancement of l-ascorbic acid (vitamin C) content: Rationale and biotechnological opportunities.* Journal Agriculture Food Chemistry, 53, p. 5248–5257
5. **Munns Ranna, Tester M., 2008** - *Mechanisms of salinity tolerance.* Annu Rev Plant. Biol, 59, p. 651-681.
6. **Murshed R., Lopez Lauri F., Sallanon H., 2014** - *Effect of salt stress on tomato fruit antioxidant systems depends on fruit development stage.* Physiol Mol Biol Plants, 20(1), p. 15–29.
7. **Pascale Stefania, Maggio A., Fogliano V., Ambrosino Patrizia, Ritieni A., 2001** - *Irrigation with saline water improves carotenoids content and antioxidant activity of tomato.* Journal of Horticultural Science and Biotechnology, 76(4), p. 447-453.

THE INFLUENCE OF STORAGE PERIOD ON VARIATION OF PHENOLIC CONTENT IN SWEET CHERRIES

INFLUENȚA PERIOADEI DE PĂSTRARE ASUPRA VARIAȚIEI CONȚINUTULUI DE FENOLI LA CIREȘE

MANOLE Carmen Gabriela ^{1,2}, PARASCHIV M. ^{2,3}, CONSTANTIN M. ⁴,
BĂDULESCU Liliana ¹

e-mails: manolecarmen2000@yahoo.com, lilib_20@yahoo.com

Abstract. *The paper deals with bio-compounds preservation in soft fruits during storage in order to allow their consumption in off-season. The work addresses sweet cherries, the most popular consumed fruits in countries across the temperate regions like Romania, which the consumer can enjoy only in May-July period. Consequently, the aim of the study was to evaluate the influence of storage conditions on the yield of biologically active compounds. In this respect, the content of total phenols and flavonoids, and free radical scavenging activity have been analyzed in order to enable consumers to choose the most efficient storage method. The best characteristics cultivar offering the potential prospects for growers is also highlighted. Sweet cherries provided by 'New Star', 'Celeste' and 'Giant Red' cultivars were stored for 7 days in refrigerated and freezing conditions and then subjected to the extraction method with hydrochloric acid in methanol. Using Folin-Ciocalteu method total phenols content of the extracts was determined. The flavonoid content was identified using an adapted method based on rutin as reference sample. The free radical scavenging activity (EC50) of the extracts was determined using stabile 2,2 diphenyl-1-picrylhydrazyl radical. The results showed that high phenols and flavonoids contents are in 'N Star' cultivar (0.144 g in fresh fruits and 0.129 g refrigerated ones) while the free radical scavenging activity is better conserved in frozen fruits from 'Celeste' cultivar (5.94 mg/mL).*

Key words: cherry varieties, biologically compounds, temperature variation

Rezumat. *Articolul prezintă date referitoare la conservarea bio-compușilor în fructele moi pe parcursul depozitării, pentru a spori consumul lor în afara sezonului. Lucrarea are ca obiect de studiu cireșele dulci, cele mai populare fructe consumate în țări din regiunile temperate precum România, de care consumatorul se poate bucura numai în perioada mai-iulie. În consecință, scopul studiului a fost de a evalua influența condițiilor de depozitare asupra randamentului compușilor biologic activi. În acest sens, a fost analizat conținutul total de fenoli și flavonoide și activitatea antiradicalică pentru a permite consumatorilor să aleagă metoda cea mai eficientă de stocare. De asemenea, în lucrare se evidențiază și cel mai bun cultivar cu caracteristici importante cu perspective potențiale pentru cultivatori. Cireșele dulci furnizate de soiurile 'New Star', 'Celeste' și 'Giant Red' au fost depozitate timp de 7 zile în condiții de refrigerare și congelare și apoi supuse metodei de extracție cu acid clorhidric în metanol. Astfel, a fost determinat conținutul total de fenoli ai extractelor folosind metoda Folin-Ciocalteu. Conținutul de flavonoide a fost identificat utilizând o metodă adaptată bazată pe o curbă de calibrare a*

rutinului. Activitatea antiradicalică (EC50) a extractelor a fost determinată utilizând un radical liber stabil de 2,2 difenil-1-picrilhidrazil. Rezultatele au aratat un conținut ridicat de fenoli și flavonoide în cultivarul 'N Star' (0,144 g în fructe proaspete și 0,129 g refrigerate) în timp ce activitatea antiradicalică este mai bine evidențiată în fructele congelate din soiul 'Celeste' (5,94 mg / mL).

Cuvinte cheie: varietăți de cireșe, compuși biologici, variația temperaturii

INTRODUCTION

In the past years, numerous research studies have been focused on plant micronutrients and their health benefits. These studies showed that a diet rich in fruits and vegetables containing various classes of phenols, which are key compounds in decreasing the risk of premature diseases and aging (Piljac-Zegarac *et al.*, 2009; Patthamakanokporn *et al.*, 2008; Freeman *et al.*, 2011; Rekhy and McConchie, 2014). Therefore, these foods may provide optimal fibres, minerals, vitamins and phytochemicals such as natural antioxidants (Palafox-Carlos *et al.*, 2011; Charanjit and Harish, 2001).

Sweet cherries are one of the most popular consumed fruits across the temperate regions, in several areas being the first fruit of the season (Prvulović *et al.*, 2011). In addition, they are natural sources of antioxidants being part of human diet for several years (Melicháčová *et al.*, 2010).

In Romania, *Prunus avium* L. is cultivated in home gardens, farms and professional orchards, and have a celebration day. According to Food and Agriculture Organization of United Nations, in 2013 Romania has registered a cultivated area of 7078 hectares, and a production of 80477 tones. Local people use sweet cherries both as fresh and frozen fruits, jams, compote or different types of beverages. Amongst other bioactive compounds, sweet cherries are rich in sugars and organic acids, and are considered a major source of phenolic compounds, responsible for the colour and sensory properties (Kelebek and Selli, 2011). Most often, biological properties differ depending on growing conditions, the harvest year, cultivar and phenological phase of fruit maturation (Ferretti *et al.*, 2014).

Considering these aspects, over the years numerous research regarding the identification and exploitation of fruit phenolic compounds were conducted (Gonçalves *et al.*, 2004; Asănică *et al.*, 2004, Jakobek *et al.*, 2007; Liu *et al.*, 2011; Ballistreri *et al.*, 2013; Cao *et al.*, 2015). They found that the storage temperature has a high influence on phenolic content. Thus, this content decreases when the temperature is around 1-2 °C and rises when the storage temperature is around 15 +/- 5 °C. Moreover, analysing different cherry species (*Prunus avium*, *Prunus cerasus*, *Prunus pseudocerasus* and *Prunus tomentosa*) they proved that inter-species variability of phenolic compounds was greater than of intra-species one. Also, the results of their research suggest that climatic conditions have a significant influence on the yield of these compounds, especially in cultivars

‘Burlat’, ‘Saco’, ‘Summit’, and ‘Van’ grown on the mountainsides of the Etna volcano (Sicily, Italy).

Due to the pleasant taste and appearance of the fruit but also for the significant amounts of compounds with free radical scavenging properties, the demand is continuously increasing (Naderiboldaji *et al.*, 2015). As the fruits are perishable and have a short shelf life (up to 10 days in normal conditions), in some cases the consumers are not receiving them in optimal quality. Their shelf life is influenced by several factors (fig. 1), which influences both organoleptic and biochemical properties (Wani *et al.*, 2014).

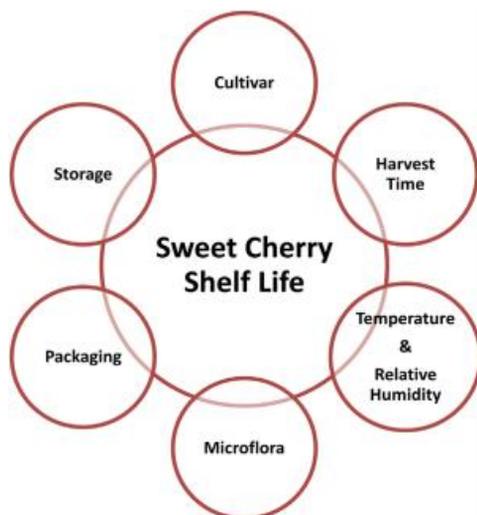


Fig. 1 Factors influencing shelf life of fresh sweet cherry (Wani *et al.*, 2014)

This paper presents quantitative analysis on the phenolic and flavonoid contents, and anti-radical activity of several sweet cherries varieties grown in Romania. The reason of choosing these parameters for analysis is related to the fact that they ensure the quality of soft fruits, which begins to decline after harvesting. For most of fruits (crops), the environmental conditions (i.g. the storage temperature) are critical for ensuring the required level of health-promoting compounds (Karlund *et al.* 2014).

The goal of the study was to assess the influence of storage conditions on the yield of biologically active compounds in sweet cherries and on their anti-radical activity in order to enable consumers to choose the most efficient storage method, depending on the intended use.

MATERIAL AND METHOD

The biological material

The fruits provided from the three cultivars of cherries represented the biological material. Harvested at the end of May, the fruits from the *Prunus avium* L.

cultivars 'New Star' (N. Star), 'Celeste' and 'Giant Red' (G. Red) were kept in three different storage conditions according to table 1.

Table 1.

Storage conditions of sweet cherries

Varieties	Fresh	Refrigerated	Freezer (-85°C)
N. Star			
Celeste	Harvest day	7 days after harvest	7 days after harvest day
G. Red		day	

The fruits were milled and subjected to the extraction method adapted after Cheel *et al.* (2007) with hydrochloric acid (HCl), 1% (v/v) in methanol (MeOH), for 30 minutes on ice bath. The used fruit/solvent extraction ratio was 1/5. The extracts were shaken and left at room temperature for 48 hours. Then, the extracts were filtered through Whatman paper and further subjected to the spectral analyses.

Methods

Using Folin-Ciocalteu method Neményi *et al.* (2015) total phenolic content of the extracts was determined. After 45 minutes, the absorbance was measured at $\lambda = 750$ nm against a control sample, which was obtained by replacing the extract volume with distilled water. The results were quantified based on a calibration curve of gallic acid (Sigma purity) and were expressed as gallic acid equivalents (GAE). The linear regression curve was given by the equation (1):

$$\text{Abs} = 0.00968 + 0.000167857 \times C_{\text{gallic acid}}, R = 0.996, p < 0.05 \quad (1)$$

The results are showed as [g] GAE / 100 [g] fresh weigh (FW).

The flavonoid content was determined using a method adapted after Toker *et al.* (2012) using the rutin as reference sample. The diluted extracts were mixed with sodium nitrite solution (NaNO₂), 5% (w/v) in water. After 5 minutes was added aluminum chloride solution (AlCl₃), 10% (w/v) in water, and after another 6 minutes sodium hydroxide solution, 1M NaOH, has been added, too. After 45 minutes, the sample's absorption was measured at the wavelength of 510 nm. The results were obtained based on the rutin calibration curve, having the equation (2):

$$\text{Abs} = -0.0068 + 0.000627455 \times C_{\text{rutin}}, R = 0.999, p < 0.05 \quad (2)$$

The free radical scavenging activity of the extracts was determined using stabile radical 2,2 diphenyl-1-picrylhydrazyl (DPPH•), using an adapted method (Clarke *et al.*, 2013). The inhibitory effect of DPPH was calculated using to the equation (3):

$$\text{Inhibition} (\%) = \frac{\text{Absorbance control} - \text{Absorbance sample}}{\text{Absorbance control}} \times 100 \quad (3)$$

The results obtained were figured against the sample concentration to determine the amount of antioxidant necessary to decrease the initial DPPH concentration by 50%. IC₅₀ (EC₅₀) represents the level where 50% of the radicals were scavenged by sweet cherries extracts.

Bonferoni and Tukey tests were used for the comparison of means values for the bio-compounds content between groups, using Statistical Package for Social Science (SPSS version 21.0). The statistical significance for the probability value of difference $p < 0.05$ was considered. The obtained results were expressed as mean values \pm standard error. For charts design, Microcal Origin version 6.0 software was used.

RESULTS AND DISCUSSIONS

Several studies on the influence of freezing temperatures on biochemical content of sweet cherries were realized by Kelley et al. (2006), Chaovanalikit and Wrolstad (2004) and Richman et al. (2007). They found that the degradation of phenolic compounds in frozen cherries is related to the presence of native enzymes, particularly polyphenol oxidase that is a temperature-dependent enzyme. Polyphenol oxidase can accelerate the degradation process in presence of chlorogenic acid, the major phenolic compounds in cherries. Considering different cultivars, statistical results show that in fresh stage are not significant differences. Belge et al. (2015) carried out similar studies on postharvest changes of cell wall of sweet cherry from ‘Celeste’ and ‘Somerset’ cultivars after storage at 0 °C.

The total phenolic content for fresh sweet cherries of all three cultivars is shown in Table 2. It can be seen that the maximum value was recorded by ‘N. Star’ cultivar the results being similar to those published by Serrano et al. (2009) for ‘Cristalina’ cultivar.

Table 2

Total phenolic content – fresh sweet cherries

Varieties	Mean g GAE/100g FW	Std. Error (SE)	95% Confidence Interval for Mean		Minimum	Maximum
			Lower Bound	Upper Bound		
N. Star	0.144	0.001	0.138	0.149	0.142	0.146
Celeste	0.126	0.002	0.119	0.133	0.123	0.128
G. Red	0.125	0.006	0.111	0.138	0.093	0.146

Values represent the mean of three replicates \pm SE

In the case of refrigerated sweet cherries (see Table 3), the value of total phenolic content was well preserved only for ‘N. Star’ cultivar, and the value stays close to those found by Gil et al. (2006) for refrigerated strawberries. For the other cultivars, the phenolic content reduces during cold storage, for ‘Celeste’ cultivar the decrease being more significant.

Table 3

Total phenolic content – frozen sweet cherries

Varieties	Mean g GAE/100g FW	Std. Error (SE)	95% Confidence Interval for Mean		Minimum	Maximum
			Lower Bound	Upper Bound		
N. Star	0.114	0.002	0.106	0.122	0.110	0.116
Celeste	0.097	0.005	0.075	0.119	0.087	0.104
G. Red	0.108	0.002	0.101	0.115	0.106	0.111

Values represent the mean of three replicates \pm SE

These results contradict those recorded by Kevers *et al.* (2007), who reported that phenolic content was generally stable during storage. Moreover, several authors reported an increase of phenolic compounds during cold storage and subsequent shelf-life (Bernalte *et al.*, 2003).

The total flavonoid content for fresh sweet cherries of all three cultivars is shown in Table 4. Once again, 'N. Star' cultivar exhibits the maximum value of flavonoid content. The recorded values is in good correlation with data published by Prvulović *et al.* (2011).

Table 4

Total flavonoid content – fresh sweet cherries

Varieties	Mean g RE/100g FW	Std. Error (SE)	95% Confidence Interval for Mean		Minimum	Maximum
			Lower Bound	Upper Bound		
N. Star	0.156	0.002	0.148	0.165	0.153	0.160
Celeste	0.114	0.000	0.113	0.116	0.114	0.115
G. Red	0.110	0.001	0.107	0.114	0.109	0.112

Values represent the mean of three replicates \pm SE

In this work, by refrigerating the sweet cherries, the total amount of flavonoids decreases for all three-tested cultivars. The cultivar influence on total flavonoid accumulation during refrigeration appears to be significant. N Star cultivar is still showing the best performance, while the 'Celeste' registered the highest degree of reduction in total flavonoid content (28.94%) and the 'G. Red' lost the smallest quantity during the refrigeration (7.27%). The obtained results are summarized in Table 5.

Table 5

Total flavonoid content – refrigerated sweet cherries

Varieties	Mean g RE/100g FW	Std. Error (SE)	95% Confidence Interval for Mean		Minimum	Maximum
			Lower Bound	Upper Bound		
N. Star	0.129	0.006	0.103	0.155	0.117	0.135
Celeste	0.081	0.003	0.066	0.095	0.074	0.085
G. Red	0.102	0.001	0.098	0.106	0.101	0.104

Values represent the mean of three replicates \pm SE

Analyzing the flavonoid content in frozen sweet cherries it was proved that, compared to fresh fruits, for all tested cultivars the values decreased. Compared to refrigerated fruits, it can be observed that 'Celeste' cultivar has a slight tendency of increasing the flavonoids content. The values are presented in Table 6.

Total flavonoid content – frozen sweet cherries

Varieties	Mean g RE/100g FW	Std. Error (SE)	95% Confidence Interval for Mean		Minimum	Maximum
			Lower Bound	Upper Bound		
N Star	0.101	0.003	0.090	0.113	0.096	0.104
Celeste	0.083	0.000	0.082	0.085	0.083	0.084
G Red	0.094	0.005	0.072	0.117	0.084	0.101

As shown above, sweet cherries contain several phenolic compounds, important for consumer's health. These results are well correlated to Ferretti *et al.* 2010 investigation on antioxidant properties of fresh fruits, which were demonstrated using different approaches.

With regard to free radical scavenging activity, the obtained results for all three analyzed stages are presented in figure 2. Significant differences in free radical scavenging activity of the tested sweet cherry cultivars during conservation process can be observed, and similar phenomena were reported by Sen *et al.* (2016) analyzing 'Early Burlat', 'Napoleon', and '0900 Ziraat' sweet cherries cultivars.

Concerning storage conditions, the inhibition rate (EC 50) during all three analyzed stages decreased in the following order: fresh > frozen > refrigerated.

The inhibition rate (EC 50) of the sweet cherries extracts during all three analyzed stages was highlighted 'Celeste' cultivar with an average of 7.94 (fresh fruits), 5.94 (frozen fruits), and 4.35 mg/ml (refrigerated fruits). The values are presented in fig. 2.

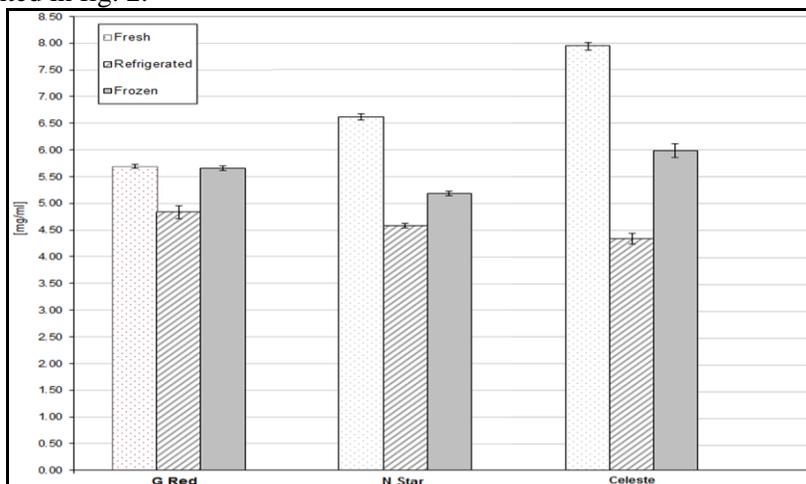


Fig. 2 Free radical scavenging activity during analyzed storage conditions

CONCLUSIONS

In this paper, the influence of storage conditions on the accumulation of biological active compounds in sweet cherries was highlighted.

1. It was found that postharvest factors such as storage could influence biological composition of sweet cherries.

2. For the studied cultivars, it was established that during postharvest storage, the ripening process advances in refrigerated stage, ranging the phenolic and flavonoid content of sweet cherries.

3. Moreover, the free radical scavenging activity of sweet cherries was well maintained during the storage period at -85 °C in frozen stage.

Acknowledgments:

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

REFERENCES

1. **Asănică A., Cepoiu N., Bădulescu L., Hoza D., 2004** - *Studies Regarding the Biochemical Composition of Some Interspecific Cherry Hybrid Rootstocks*, Scientific papers USAMV Bucharest, Series B, Horticulture, XLVII, p. 282-288.
2. **Ballistreri G., Continella A., Gentile A., Amenta M., Fabroni S., Rapisarda P., 2013** - *Fruit quality and bioactive compounds relevant to human health of sweet cherry (Prunus avium L.) cultivars grown in Italy*, Food Chemistry 15, p. 630-6388.
3. **Belge B., Comabella E., Graell J., Lara I., 2015** - *Post-storage cell wall metabolism in two sweet cherry (Prunus avium L.) cultivars displaying different postharvest performance*. Food Science and Technology International 21, p.416-427.
4. **Bernalte M. J., Sabio E., Hernández M. T., Gervasini C., 2003** - *Influence of storage delay on quality of 'Van' sweet cherry*. Postharvest Biology and Technology 28, p. 303-312.
5. **Cao J., Jiang Q., Lin J., Li X., Sun C., Chen K., 2015** - *Physicochemical characterisation of four cherry species (Prunus spp.) grown in China*. Food Chemistry 173, p.855-863.
6. **Chaovanalikit A., Wrolstad R. E., 2004**, *Total anthocyanins and total phenolics of fresh and processed cherries and their antioxidant properties*. Food Chemistry and Technology 69, p. 1-6.
7. **Charanjit K., Kapoor H. C., 2001** - *Antioxidants in fruits and vegetables - the millennium's health*. International Journal of Food Science & Technology 36, p. 703-725.
8. **Cheel J., Theoduloz C., Rodriguez J. A., Caligari P. D. S., Schmeda-Hirschmann G., 2007** - *Free radical scavenging activity and phenolic content in achenes and thalamus from Fragaria chiloensis spp. Chiloensis, F. vesca and F. x ananasa cv. Chandler*. Food Chemistry 102, p. 36-44.
9. **Clarke G., Ting K. N., Wiart C., Fry J., 2013** - *High correlation of 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging, ferric reducing activity potential and total phenolics content indicates redundancy in use of all three assays to screen for*

- antioxidant activity of extracts of plants from the malaysian rainforest. Antioxidants* 2, p. 1-10.
10. **Darshan S. K., Reuven R., Robert A. Jacob, Adel A. Kader, Bruce E. M., 2006** - Consumption of bing sweet cherries lowers circulating concentrations of inflammation markers in healthy men and women. *Journal of Nutrition* 136, p. 981–986.
 11. **Ferretti G., Neri D., Bacchetti T., 2014** - *Effect of Italian sour cherry (Prunus cerasus L.) on the formation of advanced glycation end products and lipid peroxidation.* *Food and Nutrition Sciences* 5, p. 1568-1576.
 12. **Ferretti G., Bacchetti T., Belleggia A., Neri D., 2010** - *Cherry antioxidants: from farm to table.* *Molecules*, 15, p. 6993–7005.
 13. **Gil M. I., Aguayo E., Kader A. A., 2006** - *Quality changes and nutrient retention in fresh-cut versus whole fruits during storage.* *Journal of Agricultural and Food Chemistry* 54, p. 4284–4296.
 14. **Gonçalves B., Landbo A. K., Knudsen D., Silva A. P., Moutinho-Pereira J., Rosa E., Meyer A. S., 2004** - *Effect of ripeness and postharvest storage on the phenolic profiles of cherries (Prunus avium L.).* *Journal of Agricultural and Food Chemistry* 52, p. 523–530.
 15. **Hugo P. C., Ayala-Zavala J. F., González-Aguilar G. A., 2011** - *The role of dietary fiber in the bioaccessibility and bioavailability of fruit and vegetable antioxidants,* *Journal of Food Science* 76, p. R6–R15.
 16. **Jakobek L., Seruga M., Medvidović-Kosanović M., Novak I., 2007** - *Anthocyanin content and antioxidant activity of various red fruit juices.* *Deutsche Lebensmittel Rundschau* 103, p. 58–64.
 17. **Kårlund A., Moor U., Sandell M. O., Karjalainen R., 2014** - *The impact of harvesting, storage and processing factors on health-promoting phytochemicals in berries and fruits.* *Processes* 2, p. 596-624.
 18. **Kelebek H., Sellì S., 2011** - *Evaluation of chemical constituents and antioxidant activity of sweet cherry (Prunus avium L.) cultivars.* *International Journal of Food Science & Technology* 46, p. 2530–2537.
 19. **Kevers C., Falkowski M., Tabart J., Defraigne J. O., Dommes J., Pincemail J., 2007** - *Evolution of antioxidant capacity during storage of selected fruits and vegetables.* *J Agric Food Chem* 55, p. 8596–8603.
 20. **Liu Y., Liu X., Zhong F., Tian R., Zhang K., Zhang X., Li T., 2011** - *Comparative study of phenolic compounds and antioxidant activity in different species of cherries.* *Journal of Food Science* 76, p. C633-8.
 21. **Melicháčová S., Timoracká M., Bystrická J., Vollmannová A., Čéry J., 2010** - *Relation of total antiradical activity and total polyphenol content of sweet cherries (Prunus avium L.) and tart cherries (Prunus cerasus L.).* *Acta Agriculturae Slovenica* 95, p. 21-28.
 22. **Naderiboldaji M., Badeka A. V., Kontakos S. Kontominas M. G., 2015** - *Characterization of four popular sweet cherry cultivars grown in Greece by volatile compound and physicochemical data analysis and sensory evaluation.* *Molecules* 20, p.1922-1940.
 23. **Nemenyi A., Stefanovitsne-Banyai E., Pek Z., Hegedus A., Gyuricza C., Barocsi Z., Helydes L., 2015** - *Total antioxidant capacity and total phenolics content of*

- phyllostachys taxa shoots*. Notulae Botanicae Horti Agrobotanici Cluj-Napoca 43, p. 64-69.
24. **Patthamakanokporn O., Puwastien P., Nitithamyong A., Sirichakwal P. P., 2008** - *Changes of antioxidant activity and total phenolic compounds during storage of selected fruits*. Journal of Food Composition and Analysis 21, p. 241–248.
25. **Piljac-Zegarac J., Valek L., Martinez S., Belščak A., 2009** - *Fluctuations in the phenolic content and antioxidant capacity of dark fruit juices in refrigerated storage*. Food Chemistry 113, p. 394–400.
26. **Prvulović D., Malenčić D., Popović M., Ljubojević M., Ognjanov V., 2011** - *Antioxidant properties of sweet cherries (*Prunus avium* L.) - role of phenolic compounds*. World Academy of Science, Engineering and Technology 5, p. 676-679.
27. **Prvulović D., Popović M., Malenčić Đ., Ljubojević M., Ognjanov V., 2011** - *Phenolic compounds in sweet cherry (*Prunus Avium* L.) petioles and their antioxidant properties*. Research Journal of Agricultural Science, 43, p. 1-5.
28. **Rickman J. C., Barrett D. M., Bruhn C. M., 2007** - *Nutritional comparison of fresh, frozen and canned fruits and vegetables. Part 1. Vitamins C and B and phenolic compounds*. Journal of the Science of Food and Agriculture 87, p. 930–944.
29. **Rekhy R., McConchie R., 2014** - *Promoting consumption of fruit and vegetables for better health. Have campaigns delivered on the goals?*. Appetite 79, p. 113-123.
30. **Sen Fatih, Oksar RE, Golkarian M, Yaldiz S, 2014** - *Quality changes of different sweet cherry cultivars at various stages of the supply chain*. Notulae Botanicae Horti Agrobotanici Cluj-Napoca 42, p. 501-506.
31. **Serrano M., Diaz-Mula H. M., Zapata P. J., Castillo S., Guillén F., (...), Valero D., 2009** - *Maturity stage at harvest determines the fruit quality and antioxidant potential after storage of sweet cherry cultivars*. J Agric Food Chem 57, p. 3240-3246.
32. **Turker G., Kizilkaya B., Cevik N., Gonuz A., 2012** - *Free radical scavenging activity and phenolic content of edible wild fruits from Kazdagi (Ida Mountains), Turkey*. Journal of Medicinal Plants Research 6, p. 4989-4994.
33. **Wani A. A., Singh P., Gul K., Wani M. H., Langowski H. C., 2014** - *Sweet cherry (*Prunus avium*): critical factors affecting the composition and shelf life*. Food Packaging and Shelf Life - Journal 1, p. 86–99.

**CALLUSOGENETIC AND MORPHOGENETIC CAPACITY OF
SAFFLOWER EXPLANTS**

**CAPACITATEA DE CALUSOGENEZĂ ȘI MORFOGENEZĂ A
EXPLANTELOR DE ȘOFRĂNEL**

SMEREA Svetlana¹, ANDRONIC Larisa, SCHIN Victoria

e-mail: andronic.larisa@yahoo.com

Abstract. For *in vitro* culture were optimized the conditions of sterilization (concentration of sterilization solution and the duration of treatment), the composition of nutritive media for direct embryogenesis of seeds and callusogenesis. Two types of explants, fragments of leaves cotyledons and hypocotyls, were used for inducing *in vitro* callusogenesis. As callus-inducing medium served Murashige & Skoog mineral base (1962) with 4 variants of additions of growth regulators (6-Benzylaminopurine and 2,4-Dichlorophenoxyacetic acid). The higher frequency of callusogenesis was found for both types of explants on medium with 2,4-D 0,25mg/L + BAP 0,5 mg/L and 2,4-D 0,25mg/L + casein hydrolysates 500 mg/L. Based on the ANOVA test it was established that the positive response is determined significantly only by the culture medium (hormonal balance) at 99.9%.

Key words: safflower, callus, callusogenesis, morphogenesis, explant

Rezumat. Pentru inducerea culturii *in vitro* au fost optimizate condițiile de sterilizare: stabilită concentrația soluției de sterilizare și durata tratamentului, compoziția mediilor nutritive pentru embriogeneza directă a semințelor și calusogenezei. În calitate de explant au fost utilizate fragmente de frunze cotiledonate și hipocotil de șofrănel. Ca mediu de inducere a calusurilor a fost utilizată baza minerală conform Murashige & Skoog (1962) cu 4 variante de adăugare a regulatorilor de creștere (6-benzilaminopurină și acid 2,4-diclorfenoxiacetic). Frecvența mai majoră a calusogenezei a fost stabilită pentru ambele tipuri de explante pe mediile suplimentate cu 2,4-D 0,25mg/L + BA 0,5 mg/L și 2,4-D 0,25mg/L + hidrolizat de cazeină 500 mg/l. În baza testului ANOVA a fost stabilit că, mediul nutritiv (balanța hormonală) influențează semnificativ la nivel de 99,9 % răspunsul pozitiv al explantelor de șofrănel.

Cuvinte cheie: șofrănel, calus, calusogeneză, morfogeneză, explant

INTRODUCTION

Safflower (*Carthamus tinctorius* L.) is a very ancient crop that has origin of domestication from approximately 4000 years ago in the Fertile Crescent region, ranged from southern Israel to Western Iraq (Chapman *et al.*, 2010). Safflower has multiple use. Until this century, before cheaper aniline dyes became available, safflower was mainly grown for dye. Cultivated varieties are applied as source of

¹Institute of Genetics, Plant Physiology and Protection, Academy of Sciences of Moldova, Chisinau, Republic of Moldova

quality oil (rich in linoleic acid). From safflower petals are extracted carthamidin (yellow dye, water-sol) and carthamin (red dye, water-insoluble) which are very important as a source of medicinal preparations, natural food colour and dyes for colouring fabrics.

Safflower is cultivated in 800 000 ha in the world with a yield of 650 000 tones (Emongor, 2010). The main producers are India, USA, Mexico, Ethiopia, Argentina, China, Kenia, Canada, Spain, Italy, Turkey, Iran and Russia.

Safflower plants are tolerant to severe drought and salinity, grow in dry hot climates, and can be cultivated, under poor environmental conditions (Kizil *et al.*, 2008).

Domestication of safflower has resulted in traits such as reduced shattering, smooth seeds, reduced duration of early vegetative growth stage, restriction of branching to the upper part of the stem, and reduced seed dormancy (Berville *et al.*, 2005). Breeding programs have resulted in the release of cultivars with high oil content and/or increased disease resistance. But breeding works were increasingly restricted by lack of germplasm (McGuire *et al.*, 2012). On average, the collections created 99.3% were spiny and 98.9% were orange flowered. There is strong selection pressure against spineless types by birds and livestock, bushy types would bene favored. It is considered that orange flowers are a hold-over from a period over 150 years ago when orange and red flowers were a source of carthamin, an important dye of commerce. So, red-flowered types should have been more frequent.

In vitro technology has been known to be effective procedure for diversification of crop plants. The genetic variability may be achieved by means of somaclonal variation or combination of *in vitro* culture with experimental mutagenesis. Safflower regeneration through tissue culture has been limited by low frequency and lack of an efficient protocol that suitable for most safflower cultivars (Fan and Guo, 2013). The somaclonal regeneration processes had the many factors, namely genotype, age of seedling and callus (Fan and Guo, 2013); type and orientation of explants (Chawla, 2000); medium components, plant growth regulators and other additives (Rao *et al.*, 2008; Fan and Guo, 2013; Xue *et al.*, 2015).

The aim of present work involved the study of the reaction of safflower explant to *in vitro* culture in order to induced somaclonal morphogenesis.

MATERIAL AND METHOD

For inducing *in vitro* callusogenesis and morphogenesis were used the two types of explants (fragments of cotyledon leaves and hypocotyls) obtained from aseptic plantlets. Firstly, the seeds were rinsed in water with drops of Tween-80 (0.1%) and under running tap water for 15 min. Following, the seeds were surface sterilized for 1 min in 70% ethanol and then were disinfected with sodium hypochlorite solution (5.2%, as a commercial bleach, in dilution 1:1) for 17 min. After that, the seeds were rinses for three times 3 min each, in sterilized water to remove all traces of Clorox. The sterilization procedure and the incubation had been conducted in culture cabinet (laminar airflow hood).

According to the purpose objectives, the sterile seeds were inoculated in Magenta jars with Murashige&Skoog (MS) medium without hormones for inducing direct embryogenesis (fig. 1). Culture medium was solidified with 0.8% agar and adjusted to pH 5.7 and incubated at $25\pm 2^{\circ}\text{C}$ under illuminated conditions (16h photoperiod).

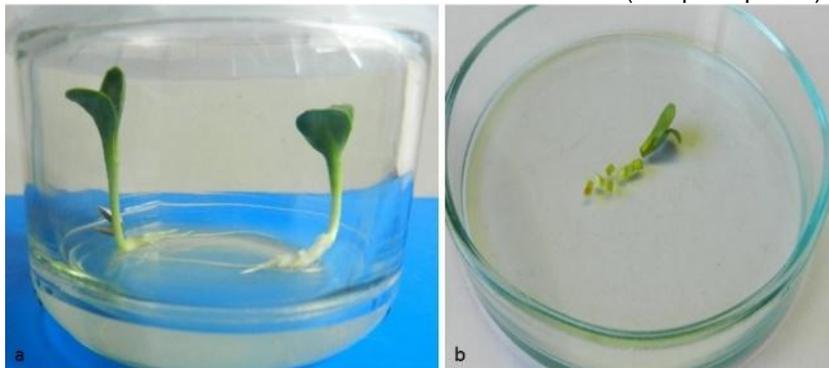


Fig. 1 Plantlets induction in sterile condition (a) and applied of aseptic fragments as explant for *in vitro* culture (b).

Leaves cotyledons and hypocotyls of 21 day old plantlets were sliced into 4-6 mm sections and used as explants in *in vitro* inoculation (fig. 1b). For callus induction was used MS medium (pH 5.8) supplemented with 6-benzylaminopurine (BAP), thidiazuron (TDZ), alpha-naphthaleneacetic acid (NAA) and 2,4-dichlorophenoxyacetic (2,4-D) in different combination and concentration added before autoclaving. It was tested 4 variants: NAA 1,5mg/L + BAP 0,5 mg/L (No 1), 2,4-D 0,25mg/L + BAP 0,5 mg/L (No 2), 2,4-D 0,25mg/L + casein hydrolysates 500 mg/L (No 3) and NAA 0,5mg/L + TDZ 1 mg/L (No 4). pH of the medium was adjusted to 5.7 before sterilization by autoclaving for 20 minutes under the pressure of $P=1$ atm, $T=120^{\circ}\text{C}$. Every 25 pieces per type of explant were inoculated on nutrient media in three repetitions. The explants were incubated in dark and temperature-controlled conditions ($25 \pm 2^{\circ}\text{C}$) for 2-3 weeks. After initiating callus vessels with explants were passed under 16-hour light and 8 hours dark for initiating morphogenesis. Serial passages were conducted every 2-3 weeks on initial and intermediate mediums.

As parameter it was assessed the frequency of explants (fragments of cotyledons leaves and hypocotyls) with positive response. The software package Statgraphics Plus 2.1 was used for statistical analysis. ANOVA test it was applied for variance analysis of callusogenesis frequency, and Student test in assessment of statistically significant differences between treatments.

RESULTS AND DISCUSSIONS

At second day after seeds inoculation has been established the first germination. According to the observations made during the first 3-4 days it was revealed the mass contamination of culture in treatment with sterilization of explants in sodium hypochlorite (5.2%), dilution 1:1 (sodium hypochlorite: sterile water). No contamination was identified in case of applied of standard concentration of commercial bleach. The best results were obtained for *in vitro* cultivation of the fragments collected during the first 7-8 days of cotyledons

leaves (rate of callusogenesis 67.34%) comparative to response explant collected after 21 days (35%) (fig. 2).

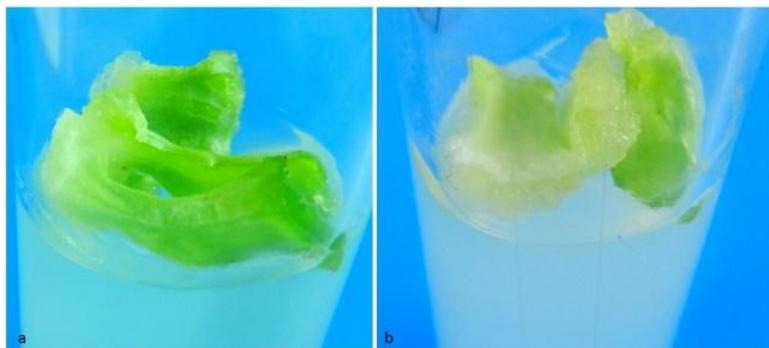


Fig. 2 The reaction of safflower explants to *in vitro* cultivation. Positive response of fragments of cotyledon leaves (a) and hypocotyls (b).

The evaluation of response of explants (cotyledon leaves and hypocotyls) to *in vitro* culture was carried out after the first 4-5 days of incubation in the dark. So, it was confirmed the extension in volume of the majority of explants as a result of active cell proliferation. At 7-8 days of culture it was established the callus initiations at the fragment margins. Meanwhile, 3.8% of hypocotyl explants presented somatic regeneration on media No. 1 and No. 4 (with the addition of NAA) (tab. 1).

After of 18-19 days of culture in dark, were visualized colorless, yellow-green or brown calluses. The intensity of callusogenesis was assessed as high, medium or low in dependence of the nutritive medium. Sporadic were certified browning and necrotizing of tissue callus, especially at the margins of explants, which imposed the necessity for passage of explants on initial or intermediate media (fig. 2).



Fig. 3 *In vitro* cultivation of safflower explants. Morphological aspect of different types of calluses (A) and subcultivation of morphological calluses (B).

The obtained results highlight the increasing capacity of tissue proliferation, regardless of colour and structure of induced callus. The increased frequency was found for medium No. 2 (92.86%) and No.3 (87.22%), followed by the No.1 (72.62%). The lowest level of positive response of explants has been recorded for medium No. 4 (16.67%), caused by the lack of positive response for hypocotyls and low rate for cotyledon leaves (33.33%) (tab. 1).

Table 1

Average values of callusogenesis frequency in dependence of the nutrient medium and types of explant callus

Nutritive medium	Explant	Callusogenesis frequency, %	Average values
1	hypocotyl	66.67	72.62
	cotyledon leaves	78.57	
2	hypocotyl	85.71	92.86
	cotyledon leaves	100	
3	hypocotyl	80.00	87.22
	cotyledon leaves	94.44	
4	hypocotyl	0.00	16.67
	cotyledon leaves	33.33	
Average values			67.34

The interaction of sources of variation nutritive medium-explants demonstrate that the cultivation of cotyledon leaves on medium No. 2 induced maximal effect - 100%, on medium No.3 - 94.44%, and on the No.1 - 78.57%, while the positive response of hypocotyl fragments on same media have 85.71%, 80.0% and 66.67% respectively.

In order to evaluate the impact of culture media on callus frequency was established the rate of explant with positive response comparative to total number of inoculated explants. Based on the ANOVA test it was determined that the positive response is determined significantly by the culture medium (hormonal balance) at 99.9%, while the type explants do not show statistically significant differences (tab. 2).

Table 2

Analysis of variance for rate of callusogenesis (ANOVA test)

Source of variance	Sum of Squares	Degrees of freedom	Mean Square	F-ratio
Explant (E)	4494.03	1	4494.03	3.44
Nutritive medium (M)	47556.1	3	15852.0	12.13 ^{***}
Interaction E-M	962.63	3	320.87	0.25
Total	112455.0	54		

*** - significant at $P \leq 0.001$.

The subcultivation of calluses from both types of explants on initial media revealed that, yellow and brown calluses has fluid structure, while green are mixed calluses had compact areas.

In vitro morphogenesis involves obtaining of plantlets regeneration in results of organogenesis or somatic embryogenesis and is greatly influenced by exogenous and endogenous content of growth regulators, despite the initiation of morphogenetic zones in all types of histogenes. Further subcultivation of the calli was performed on the intermediate medium. This medium increases the *in vitro* activation of regenerative processes due to the grow of the content of cytokinins in the culture medium.

CONCLUSIONS

1. Evaluation of callusogenesis and morphogenesis frequency initiated from safflower explant, proved the positive influence of hormonal balance on reaction of fragments of leaves cotyledons and hypocotyls to *in vitro* cultivation.

2. The derived calluses established morphogenetic capacity not dependent of external aspects (colour - white or green; consistence - compact or fluid).

Acknowledgments: These investigations were supported by the project 6097 STCU/ASM.

REFERENCES

1. Berville A., Breton C., Cinliffe K., Darmency H., Good A.G., Gressel J., Hall L.M., McPherson M.A., Medail F., Pinatel C., Vaughan D.A., Warwick S.I., 2005 - *Issues of fertility or potential for fertility in oats, olives, the Vigna group, ryegrass species, safflower and sugarcane*. In: Crop Fertility and Volunteerism. CRC Press, p.231255.
2. Chapmen M.A., Hvala J., Strever J., Burke J.M., 2010 – *Population genetic analysis of safflower (Carthamus tinctorius; Asteraceae) reveals a Near Eastern origin and five centers of diversity*. American Journal of Botany, 97: p.831-40.
3. Chawla H.S., 2000 - *Introduction to plant biotechnology*. 2nd edn, Inc. Enfield, New Hampshire, USA, Science publisher, p. 39–56.
4. Emongor V., 2010 - *Safflower (Carthamus tinctorius L.) the underutilized and neglected crop: a review*. Asian Journal of Plant Sciences, 9 (6), p. 299-306.
5. Fan L., Guo M., 2013 - *Progress of safflower (Carthamus tinctorius L.) regeneration through tissue culture*. J. Med. Coll. PLA, 28(5), p. 289-301.
6. Kizil S., Çakmak Ö., Kirici S., İnan M.A., 2008 - *Comprehensive study on safflower (Carthamus tinctorius L.) in semi-arid conditions*. Biotechnol. & Biotechnol. Eq. 22(4), p.947-953.
7. McGuire P.E., A.B. Damania, and C.O. Qualset (eds.), 2012 - *Safflower in California. The Paulden F. Knowles personal history of plant exploration and research on evolution, genetics, and breeding*. Agronomy Progress Report No. 313, Dept. of Plant Sciences. University of California. Davis CA USA.
8. Rao N.N., Sujatha M., Narasu L., Kumar D.V., 2008 - *Establishment of regeneration and transformation protocols in safflower (Carthamus tinctorius L.)*. Proceeding of 7th International safflower conference, Wagga, Australia.
9. Singh V., Nimbkar N., 2006 - *Safflower (Carthamus tinctorius L.)*. Chapter 6, p.168-194, In: Genetic Resources, Chromosome Engineering, and Crop Improvement: Oilseed Crops. Vol. 4, CRC Press.
10. Xue Y., Li D., Gao Y., Guo M., 2015 - *Optimization of Carthamus tinctorius L. tissue culture system based on the combination of 1-naphthylacetic acid and 6-benzyl aminopurine*. Pharmaceutical Care and Research, 15(2), p. 91-94.

**THE CHARACTERISTICS OF PLANTS FROM *HIERACIUM*
GENRE PRESENT IN ALEXANDRU BELDIE HERBARIUM
FROM I.N.C.D.S. BUCHAREST**

**CARACTERISTICI ALE SPECILOR DE PLANTE DIN GENUL
HIERACIUM EXISTENTE ÎN HERBARUL ALEXANDRU BELDIE AL
I.N.C.D.S. BUCUREȘTI**

DINCĂ L.¹, VASILE Diana¹, VOICULESCU I.¹

e-mail: dinka.lucian@gmail.com

Abstract. *The Alexandru Beldie Herbarium from I.N.C.D.S. Bucharest comprises approximately 60.000 plates of some herbaceous plants, trees and shrubs. Amongst them, the present article analyses the 273 plates dedicated to the plants from the Hieracium genre. After a short description of the genre, some of the 112 species present in this herbarium are described. The plants were gathered between 1858 and 1954, with a larger incidence in the periods 1890-1899 and 1940-1949. Their origin ranges from different areas of our country (Bucegi, Ciucas, Retezat, Turda, Bufta, Pojorata) as well as from abroad (Pyrenees, Tirol, Silesia) and were gathered by Romanian specialists (Beldie, Morariu, Georgescu, Cretzoiu) and foreign ones (Stefanoff, Baenitz, Richter, Weisenbeck, Sagorski, Weisenbach, Wolff).*

Key words: *Hieracium*, herbarium, inventory, botany specialists

Rezumat. *Herbarul Alexandru Beldie al I.N.C.D.S. București este alcătuit din aproximativ 60.000 de planșe ale unor plante, arbori și arbuști. Articolul de față analizează 273 de astfel de planșe aparținând genului Hieracium. După o scurtă descriere a genului, câteva dintre cele 112 specii prezente în herbar sunt descrise. Plantele au fost recoltate între anii 1854-1954, majoritatea datând din perioada 1890-1899 și 1940-1949. Originea lor aparține diferitelor regiuni din țara noastră (Bucegi, Ciucaș, Retezat, Turda, Bufta, Pojorâta) precum și din străinătate (Munții Pirinei, Tirol, Silesia), fiind recoltate de specialiști români (Beldie, Morariu, Georgescu, Cretzoiu) și străini (Stefanoff, Baenitz, Richter, Weisenbeck, Sagorski, Weisenbach, Wolff).*

Cuvinte cheie: *Hieracium*, ierbar, inventar, botaniști

INTRODUCTION

After H. Zahn's monographic studies (Zahn, 1922-1938), the *Hieracium* genre has been investigated by E. I. Nyárády who also presented a detailed account of this genus in the "Flora R. P. Romîne" (Nyárády, 1965). In recent times, the genre was revised by other authors for various identification books (Beldie, 1979; Ciocîrlan, 1990, 2000).

¹National Institute for Research and Development in Forestry "Marin Drăcea", Romania

”Flora Europaea” (Sell and West, 1976) mentioned 134 *Hieracium* species for Romania (and additionally 72 hybrid species). However, the most recent checklist for the Romanian flora (Popescu and Sanda, 1998, accepted as ”Standard flora” by the Euro+Med Plant Base Editorial Committee 2001) mentions *Hieracium* with 139 species and 60 hybrids.

Numerous *Hieracium* species are collected in the Herbarium Al. Beldie from ”Marin Drăcea” National Institute of Research and Development in Forestry Bucharest. They are kept in their original portfolio in the drawers of 30 modules (Vasile *et al.*, 2017).

This collection is enrolled INDEX HERBARIUM and all the species are gathered by known personalities in the field of systematic botany, one of the Romanian botanists, being Al. Beldie himself who dealt especially with this herbarium.

The aim of this article is to present the state of this collection, describe the species, the total number of *Hieracium* specimens (112 species), the date when they were collected, and their location together with the botanist who collected each exemplary and their conservation degree.

MATERIAL AND METHOD

The study material was composed of the 273 plates present in the above mentioned herbarium that belong to the *Hieracium* genre. They were further organized based on species, year of harvest, origin place and the specialists who has gathered them. An excerpt of the *Hieracium* genre inventory is rendered in Table number 1.

RESULTS AND DISCUSSIONS

Hieracium or *hawkweeds* is a plant from *Asterales* Order, *Asteraceae* family (tab. 1) (considered one of the largest flower family, even the second according to Niehaus, 1976). As a total, *Hieracium* has recorded until now over 10.000 species and subspecies (IOPI, 2007). The majority of specialists and botanists agree that there are two subgenres: *Hieracium* and *Pilosella* although there are many controversies with regard to the accepted number of species (ranging between 800 and thousands of species).

The controversies arise from the reproduction of this plant. The asexual reproduction (through seeds that are identical to the mother plant) generates populations or clones that are formed of genetically identical plants. As such, some botanists decide to accept these clones as a species (in Russia, UK or Scandinavia), while others decide to be more selective and not include the clones (this is the case for USA and Central Europe).

Regardless of their number and categorization, the plant is recognizable through some characteristic features: *Hieracium* has a straight, single stem, that can be sometimes hairy or even branched. This characteristic varies a lot and can range from straight or curly surfaces to ”stellar-pubescent” (surfaces that have scattered branched hairs) and ”stipitate-glandular” (surfaces that have gland-tipped hairs). The flowers are usually yellow and packed around a single floret. Furthermore, the plant contains milky latex. The flowering period ranges from May to June, although it can also continue during late summer and up to September.

The inventory of *Hieracium* genre from Al. Beldie INCDS Bucharest Herbarium (excerpt)

The drawer	The sheet nr.	Herbarium/ Botanical collection/ Institution	The name of the species	Date of collection	Place of collection	Collected/ Determined by:	Degree of conserv ation (1..4)
34	1	Museum Botanicum Universitatis Cluj	<i>Hieracium pocuticum</i> Wot.ssp.pocuti cum	1928.08.09	Distr.Hunedoa ra Muntii Retezat	E.I. Nyarady	2
34	5	Dr.C.Baenitz Herbarium Europaeum	<i>Hieracium hostianum</i> Wiesb.f. stenophyllum	1883.08.25	Breiten Furt	J. Wiesbaur S.J.	1
34	8	Joseph Hervier,Saint- Etienne (Loire)	<i>Hieracium pseudo- hybridum</i> Arv.Touv.	1894.07	Spania Sierra del Pinar d'Albarracin	E. Reverchon	2
34	18	Herbarul Politehnicei Bucuresti Facultatea de Silvicultura	<i>Hieracium piloselloides</i>	1947.06.09	Ilfov Buftea	I. Morariu	1
34	35	Herbarium Al.Beldie	<i>Hieracium pilosella</i> L.	1948.05.21	Distr.Muscel Radesti	I. Morariu / M. Ciuca	1
34	50	Herbariul N.Al.Iacobescu	<i>Hieracium pavichii</i>	1903.08.08	Calimanesti	N.Al. Iacobescu	1
34	67	Societe Helvetique	<i>Hieracium piliferum</i>	1888.07.27	St. Bernard	F.Tripet	1
34	72	Horto Botanico Universitatis lassiensis	<i>Hieracium pojoritense</i>	1964.08.08	Distr.Suceava Pojorata	E.Topa	1
34	126	Museum Botanicum Universitatis Cluj	<i>Hieracium pseudocaesium</i>	1927.07.20	Muntii Retezat	E.I. Nyarady / K.H.Zahn	1
37	1	Herbarul Institutului de Cercatari Silvice	<i>Hieracium nigrescens</i>	1905.03.09	Bucegi: Jepii Mici	Al. Beldie	1
37	18	Labor.Botanic Scoala Politehnica "Regele Carol"	<i>Hieracium nipholasium</i>	1891.08.18	Silezia	Callier	1
37	23	Herbarul Politehnicei Bucuresti Facultatea de Silvicultura	<i>Hieracium murorum</i>	1946.08.17	Dej (Somes)	I. Morar	1
37	35	Fl.Raverica	<i>Hieracium monanthum</i>	1904.12.27	Frölingell	Weisenbac h	1
37	84	Flora Austrice inferioris	<i>Hieracium humile</i>	1888.07	in valle Atlitzgraben	Dr. Karl Richter	1
37	145	Societe Helvetica	<i>Hieracium glaciale</i>	1888.08.01	Grana Saint- Bernan	F. Tripet	1
37	147	Museum Botanicus Universitatis Cluj, Flora Romanae Exsiccata	<i>Hieracium fritzeiforme</i> Zahn	1928.08.10	Muntii Retezat distr.Hunedoa ra	E.I. Nyarady	1

The plant prefers the mountain areas and usually grows near roadsides, meadows and pastures. It can also grow in forest openings as it is resistant to shade. The plant usually grows in well-drained soils that are low in organic matter and coarse.

Specialists differentiate two genres of *Hieracium*: *Hieracium* and *Pilosella*, differentiated by specific features. As such, the *Hieracium* plant produces only one kind of seed and reproduces through them, while *Pilosella* is renowned for producing both sexual and asexual seeds and can reproduce by seeds as well as by stolons. The plants can also be differentiated visually: *Hieracium* has a dentate and divided type of leaves, while the *Pilosella* leaves are smooth and full.

Regarding their role, the *Hieracium* genre is classified as an invasive species that poses an important threat in alpine ecosystems. In New Zealand the plant is prohibited from distribution or propagation (www.weedbusters.co.nz). This is caused by the fact that the plant reproduces massively and as such crowds native species, lowering the biodiversity.

The collection gathers **112 species** of this genre:

Hieracium bifidum Kitaibel: the stem is almost always divided in two parts from the basis, while the bracts are green, the leaves are oval-elongated and the fruits brown-reddish (<http://christian000.free.fr/pages/191-hieracium.htm>).

Hieracium carneum Greene (Figure 1): can be found on rocky areas from North America, especially at altitudes of 2000-3000m from Arizona, Texas or New Mexico. The plant can be recognized by its white-pink flowers and long, linear or lanceolate leaves that can reach 12 cm. The plant can grow up to 60cm. (https://en.wikipedia.org/wiki/Hieracium_carneum).



Fig. 1 *Hieracium carneum*

Hieracium floribundum Nägeli & Peter, considered for a long time a mixture of *Hieracium cespitosum* and *Hieracium latucella*, the plant is native of Europe (France),

Canada and the US. With a shaped spatula, hairy leaves and clustered flowers, the plant can grow up to 25-91 cm (https://en.wikipedia.org/wiki/Hieracium_floribundum).

Hieracium glaciale Lachenal: has involucre of 8-10 mm length, sharp bracts, yellow-gold flowers, 1-7 flower-heads, and a stem with stellar shinleaf. It prefers granite or schist fields. (<http://christian000.free.fr/pages/191-hieracium.htm>).

Hieracium glaucum All.: has a height of 10-50 cm, unhairy stem, glaucous elongated leaves, whole or slightly dented. The pale yellow flowers appear in July-August, the involucre is of 9-13mm, with unequal bracts, which cover one another, red-brownish fruits of 4 mm length. It generally prefers siliceous fields, but is also spread on limestone fields. It can reach up to 2500 m, but it rarely lowers to altitudes of 400 m altitude. It is spread out in France, Switzerland, Italy and the South part of Central Europe. (<http://christian000.free.fr/pages/191-hieracium.htm>).

Hieracium hoppeanum Schultes: has involucre with obtuse bracts at the top, of oval or elliptical shape, membranous on the sides, more or less provided with shin leaves on their external side. It is usually found at altitudes between 1200 and 2600 m (<http://christian000.free.fr/pages/191-hieracium.htm>).

Hieracium humile Vill.: grows on rocks from the mountain area and prefers limestone areas that do not reach a higher altitude of 2000 m. It can reach a height of 6-30 cm, with glandular stem and leaves. The inferior leaves have petiole, while the superior ones lack it. The yellow flowers bloom between June and August. 1-4 flower-heads with grey involucre of 12-17 mm, red fruits of 3-4 mm (<http://christian000.free.fr/pages/191-hieracium.htm>).

Hieracium lanceolatum Vill.: firm leaves (robust and solid), almost glaucous, with connected veins slightly prominent on the inferior side, ovoid or semi-spheric involucre that is larger than 10 mm with red or brown fruits (<http://christian000.free.fr/pages/191-hieracium.htm>).

Hieracium laevigatum Willd.: 30-120 cm height, springs in autumn and is pollinated by insects. It has a ramified stem and generally lacks basal leaves. It is a species of semi-shade or light spread on poor, acid soils that have a moderate type of humus, under quercus stands, peat bogs and outskirts (Rameau *et al.*, 1989).

Hieracium murorum L.: is a plant with a height that varies between 6 cm and up to 1 m, whose yellow flowers appear from May until September. The involucre has irregular bracts, the exterior ones being shorter and unequal. The inferior leaves are without shin leaves. The shin leaves of the superior leaves are simple and denticulate. The black fruits have a length of 2-4 mm. Variations of the species (especially the ones with speckled leaves) are cultivated for decorating old walls, ruins or rocks. The flowers are producing a nectar highly appreciated by bees. The entire plant was used against lung diseases, while its subterranean parts contain a significant quantity of inulin. The plant is spread through the entire Europe, Asia, Arctic America and Labrador (<http://christian000.free.fr/pages/191-hieracium.htm>).

H. paniculatum L.: is recognizable through its yellow flowers grouped on stalks, long jagged leaves that are mostly grouped on the stem. The plant can grow up to 90 cm (https://en.wikipedia.org/wiki/Hieracium_paniculatum).

Hieracium pilosella L. (fig. 2): spread out on sandy, arid areas, on meadows and pastures, the plant has 7-30 cm and yellow flowers from May up to September. The flower stem that rises above the basal leaves rosette does not have leaves and is almost always ending with a single capitol. The leaves, grouped in a rosette are oval elongated and obtuse. The involucre, more or less cylindrical, has unequal bracts, with the exterior ones obtuse at the top. The fruits can reach 1-2 mm. The plant can produce a type of natural lawn that covers a large area and which can derive from a single initial germination. During droughts, the leaves are re-bending downside towards the lateral margins in order to diminish the perspiration. As such, the plants has a whitish aspect. The plant is rarely cultivated as ornamental plant, but it was used against lung diseases, intermittent fevers and the trots (<http://christian000.free.fr/pages/191-hieracium.htm>).

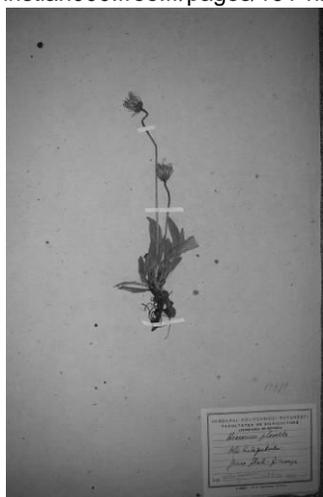


Fig. 2 *Hieracium pilosella*

Hieracium umbellatum L.: 10-120 cm height, springs between July and October, being pollinated by insects and dispersed by the wind. It does not have basal green leaves during bloom, but has a glabrous stem, alternate sessile lanceolate leaves and ovoid involucre. It is a species of semi-shade or heliophile, being spread out on the outskirts of oak or beech forests or on meadows and dunes (Rameau *et al.*, 1989).

Hieracium vulgatum Fr.: with a height of 30-60 cm, it flowers between June-July. The stem is ramified at the top, while the basal leaves rosette is persistent during blooming. The yellow flowers are grouped in panicles. It is mainly a semi-shade species that is widespread on siliceous substrates (Rameau *et al.*, 1989).

Hieracium pojoritense Wol. (fig. 3): an endemic, rare and endangered species (Nyarady, 1965; Oltean *et al.*, 1994; Sanda *et al.*, 2004; Sârbu and Ștefan, 2000) and it is also mentioned in the Carpathian List of Endangered Species (2003). It grows in calcareous crevices in the Eastern Carpathians. Morphology suggests some influence of *H. umbellatum*. Zahn (Zahn, 1938) considered it as an 'intermediate' species and

placed it between *H. sparsum* and *H. racemosum* and are characteristic for certain vegetation types in Romania, respectively *Vaccinio-Piceetea*, thus showing a strong correlation between features of the vegetation and the ecological requirement of this species (Ștefan *et al.*, 2002). It is considered that *H. pojoritense* is an old taxon that either for some reason does not resemble *H. alpinum* morphologically, or that it has originated from an extinct species closely related to, but morphologically different from recent *H. alpinum* (Krač, 2012).



Fig. 3 *Hieracium pojoritense*

Other species of this genre that are present in the herbarium are: *H. alatum*, *H. albidulum*, *H. arnedianum*, *H. arolae*, *H. baenitzianum*, *H. brevifolium*, *H. breviscapum* DC., *H. canum*, *H. cavillieri*, *H. collinum* Gochn., *H. comosum*, *H. cyaneum* Arv.-Touv., *H. cymosum* subs. *uplandiae* Nägeli & Peter, *H. dubium*, *H. echioides* Lumn., *H. epimedium* Fries., *H. epinephum*, *H. erianthum*, *H. eriophyllum* Schl., *H. fallax* Willd., *H. favratii* Muret, *H. flagellare* W., *H. flocciferum* Arum., *H. flomense*, *H. floribundum* ssp. *suecium* Fr., *H. fritzei*, *H. fritzeiforme* Zahn, *H. furculatum*, *H. fuscum* Vill., *H. gaudryi*, *H. glabratum*, *H. glanduliferum* Hoppe., *H. glandulosoventatum* Uechtv., *H. gronovii*, *H. horridum*, *H. Hostianum* Wiesb. f. *stenophyllum*, *H. intybaceum* All., *H. inuloides*. Tanfids., *H. jablonicense*, *H. jankae*, *H. kochianum* Jord., *H. krašanii*, *H. lacerum* Reut., *H. lachenalii* Gmel., *H. lanatum* Seeds., *H. laniferum* Cav., *H. laurinum* Arv.-Touv., *H. lawsonii* Vill., *H. leptopholis*, *H. levicaule* Jord., *H. lomnicense*, *H. longifolium*, *H. longiscapum* Boiss. & Kotschy, *H. lucidum* Guss, *H. lycopifolicum*, *H. macrocephalum* Huter, *H. maculatum* Sm., *H. marmoratum*, *H. mattfeldianum*, *H. mixtum*, *H. monanthum*, *H. morisianum* Rchb, *H. naegelianum*, *H. napaeum*, *H. nigrescens*, *H. nillyvenonñ* Monier, *H. nipholasium*, *H. norvegicum*, *H. occidentale* Eastw., *H. oxyodon*, *H. paltinae*, *H. pamphili*, *H. pannonicum* Nägeli & Peter, *H. pannosum*, *H. pavichii*, *H. peleterianum* Mérat, *H. picroides*, *H. pietroszense*, *H. piliferum*, *H. piloselliflorum* Nägeli & Peter, *H. piloselloides* Vill., *H. plumbeum*, *H. pocuticum* Wot., *H. porrifolium*, *H. praecox* Sch. Bip, *H. praecurrens*, *H. prediliense*, *H. prenanthoides* Vill, *H. procurrens* Norrl., *H.*

pseudobifidum, *H. pseudocaesium*, *H. Pyrenaicum* Jord., *H. ramosum*, *H. rotundatum*, *H. sparsum* subs. *pisaturense* Nyar., *H. valesiacum* Fr., *Hieracium wolffii*.

Most plants present in the herbarium belong to the *Hieracium pilosella* (28), *Hieracium pseudobifidum* (19), *Hieracium murorum* (13), *Hieracium pavichii* (8), *Hieracium praecurrens* (11), *Hieracium levicaule* (5), *Hieracium fritzei* (4) and *Hieracium nipholasium* (4) species.

Plant's harvesting year. The plants were harvested in a time period ranging from 1858 until 1954. The oldest plants from this genre are *Hieracium glaucum*, harvested in 1829 and 1831, followed by *Hieracium pilosella*, harvested in 1850. Most plants were harvested between 1890-1899 and 1940-1949 (fig. 4).

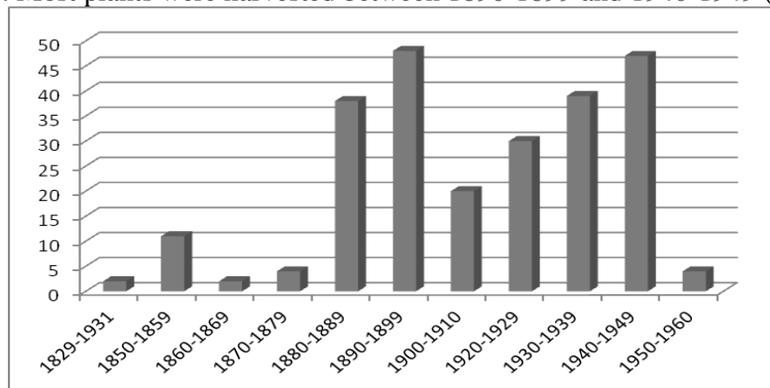


Fig. 4 Harvesting periods for *Hieracium* plants from INCDs Herbarium

Harvesting place from Romania: the majority of species (*Hieracium fritzei*, *Hieracium murorum*, *Hieracium napaeum*, *Hieracium nigrescens*, *Hieracium pilosella*, *Hieracium praecurrens*, *Hieracium prenanthoides*, *Hieracium pseudobifidum*) were harvested from Bucegi (Coștila, Zănoaga, Poarta, Peștera, Furnica, Poiana Kalinderu, Valea Jepilor, Valea Albă, Valea Cerbului, Valea Horoabei, Clincea, Plaiul Fânului) and from other mountain areas (Munții Ciucaș, Munții Harghitei, Munții Retezat, Piatra Craiului, Sinaia). *Hieracium pilosella* plants were gathered from Vișeu de Jos, *Hieracium procurrans* from Albac, *Hieracium murorum* from Dej, *Hieracium pilosella* from Cluj, *Hieracium pseudobifidum* from Turda, *Hieracium praecurrens* from Păltiniș, *Hieracium vubelum* from Sibiu, *Hieracium umbellatum* and *Hieracium pseudobifidum* from Băile Herculane, *Hieracium Pavichii* from Svinița, *Hieracium pilosella* from Brănești, *Hieracium piloselloides* from Buftea and *Hieracium pojoritense* from Pojorâta (fig. 5).

The harvesting place from Europe: contains mountain areas from the Alps, Pyrenees, Tirol, as well as areas from USA (Sierra Nevada, Long Island-Brooklyn), Russia (previous Könisberg), Macedonia, Moravia, Switzerland (Lausanne, Simplon valley), Italy (Piemont, Palermo), Germany (Freiburg, Bavaria), Hungary, Austria (Carinthia), Spain (Sierra del Pinar), France (Loire) (fig. 6).

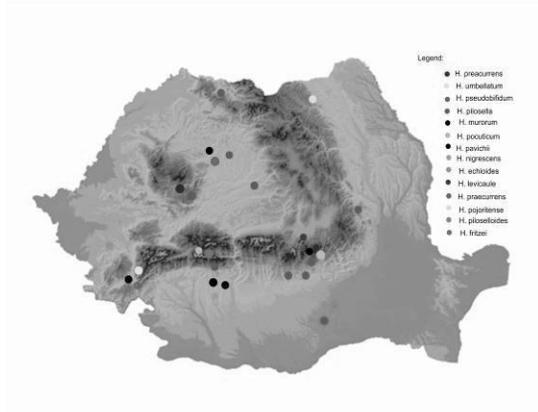


Fig. 5 Place of harvest for *Hieracium* plants in Romania

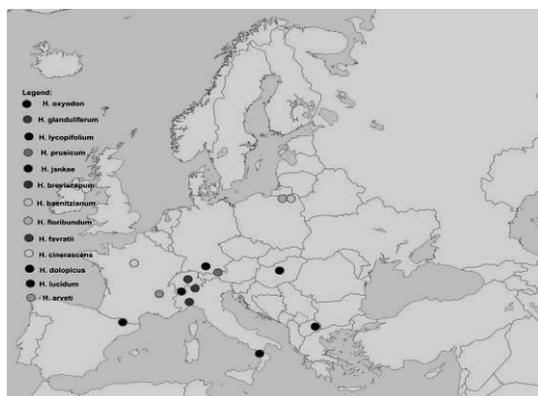


Fig. 6 Harvesting places of *Hieracium* plants from Europe

The persons that have gathered the plants are represented by Romanian specialists (Al. Beldie, C.C. Georgescu, E.I. Nyarady, I. Morariu, N. Al. Iacobescu, P. Cretzoiu) or foreign ones (B. Stefanoff, C. Baenitz, dr. Karl Richter, F.O. Wolf, Georg Weisenbeck, Sagorski, Weisenbach, Wolff).

CONCLUSIONS

1. The Al Beldie Herbarium from INCDS "Marin Drăcea" has a rich collection of plants.

2. As such, from the 60.000 herbaceous plants, 112 are *Hieracium* species. *H. pojoritense* is present amongst them, being a local endemism from Pojorâta, Câmpulung Moldovenesc, a species that can only be found in Romania.

3. This important plant collection is remarkable through the beauty of its exemplars, but especially because of their scientific value. Almost all of the species have kept their original labels and were identified and harvested by Romanian and foreign specialists.

REFERENCES

1. **Beldie A., 1979** - *Flora României - determinant ilustrat al plantelor vasculare*. Editura Academiei RSR. p. 407.
2. **Chapman H., Pearson M.L., Robson B., 2003** - *Genetic diversity in tussok hawkweed (*Hieracium lepidulum*) and use of allele frequencies for identifying patterns of spread*. Department of Conservation, Wellington, New Zealand, 19 pag.
3. **Ciocârlan V., 1990** - *Flora ilustrată a României*, I, II. Ed. Ceres București.
4. **Ciocârlan V., 2000** - *Flora ilustrată a României. Pteridophyta et Spermatophyta*, Edit. Ceres, București, 1138 p.
5. **Grieve M., 1933** - *Hawkweed, Wood*. A modern Herbal. botanicum.com.
5. **International Organization for Plant Information (IOPI) - Plant Name Search Results**. International Plant Names Index.
6. **Krak K., 2012** - *Molecular phylogeny and evolutionary trends in *Hieracium* (Asteraceae, Lactuceae)*. Ph.D. thesis. Prague.
7. **Niehaus T.F., 1976** - *Pacific States Wildflowers. The Peterson Field Guide Series. Illustrations by Charles L. Ripper*. New York, New York 100003: Houghton Mifflin Company. pp.102.
8. **Nyarady E.I., 1965** - *Subfamilia Liguliflorae DC (Fam. Compositae)*. In: Savulescu T. (ed.) *Flora României*, vol X (Compositae). Editura Academiei Romane, Bucuresti, Romania.
9. **Oltean M., Negrean G., Popescu A., Roman N., Dihoru GH., Sanda V., Mihăilescu S., 1994**- *Lista roșie a plantelor superioare din România*, București, Studii, Sinteză, Doc. de Ecologie, 1: 52 P.
10. **Popescu A. & Sanda V. 1998** - *Conspectul florei cormofitelor spontane din România*. 336 S. Editura Universității din București.
11. **Sanda V., Bită D.C., Barabas N., 2004** - *Flora cormofitelor spontane și cultivate din România*, Edit. Ion Borcea, Bacău.
12. **Sârbu I., Stefan N., 2000** - *Considerations on endemic species of *Hieracium* in the flora of Romania*. In: *Proceedings of the 4th Hieracium Workshop*, 31.05-05.06.2000, Niederspree, Oberlausitz, Germany: Abhandlungen und Berichte de Naturkundemuseums Görlitz, Band 72 Supplement S.13.
13. **Sell P.O. and West C. 1976** - *Flora Europaea* 4: 395.
14. **Ștefan N., Oprea A., Mânzu C., 2002** - *Phytocenological characterisation of Romanian *Andryala* and *Hieracium* species*. 6th Hieracium Workshop. Hirscheegg (Austria).
15. **Rameau J.C., Mansion D., Dumé G., Timbal J., Lecoite A., Dupont P., Keller R., 1989** - *Flore forestière Française*. Institute pour le Développement Forestier, 1783 pag.
16. **Strother J.L.** - *Hieracium in Flora of North America.*_FNA Vol. 19, 20 and 21. *efloras.org*. pp. Page 219, 278, 279.
17. **Vasile D., Dincă L., Indreica A., Voiculescu I., 2017** - *Herbarul Al. Beldie - o colecție de plante și o importantă bază de date pentru specialiști*. Revista de Silvicultură și Cinegetică, nr.39, 2017, pag. 114-119.
18. **Zahn K. H. 1922** - *Hieracium L.* In: A. ENGLER (ed.), *Das Pflanzenreich Regni Vegetabilis Conspectus* 82: 865–1146. Wilhelm Engelmann, Leipzig.
19. **Zahn K. H. 1938** - *Hieracium L.* In: P. GRAEBNER FIL. (ed.), *Synopsis der mitteleuropäischen Flora*. 12(3): 1–708. Borntraeger, Berlin.
- 20.***, www.weedbusters.co.nz
- 21.***, <http://invasives.org.au/blog/hawkweeds-a-recent-discovery-in-victorias-alps-and-a-taxonomic-name-change>
- 22.***, https://en.wikipedia.org/wiki/Hieracium_carneum
- 23.***, https://en.wikipedia.org/wiki/Hieracium_floribundum
- 24.***, https://en.wikipedia.org/wiki/Hieracium_paniculatum
- 25.***, <https://plants.usda.gov/core/profile?symbol=HIERA>
- 26.***, <http://christian000.free.fr/pages/191-hieracium.htm>

PRELIMINARY STUDIES ON THE CULTURE OF VEGETABLE PLANTS IN POTS AND CONTAINERS

STUDII PRELIMINARE PRIVIND CULTURA PLANTELOR LEGUMICOLE ÎN GHIVECE ȘI CONTAINERE

GACHE (LUNGU) Mirabela¹, MUNTEANU N.¹, STOLERU V.¹, TELIBAN
G.C¹, GALEA (DELEANU) Florina Maria¹, CABA (INCULEȚ) Simona
Carmen¹, HRIȚCU (MAFTEI) Adriana¹, GACHE (PĂTLĂGICĂ) M.²

e-mail: mirabelagache@yahoo.com

Abstract. This paper presents a literature review of the vegetable growing in pots and containers. Growing vegetables in this system it is known for a long time in the countries of Western Europe and in some areas of our country. Adopting this system in Romania requires in-depth studies regarding: the suitable species, the type of pots and soil recipes needed, crop establishment and maintenance (fertilizers application, irrigation) and, in some cases, optimization of the certain referring to light and placement of pots and containers. This cultivation system is spread mainly in peri-urban areas where the interest among gardeners to grow their own crops and secure their vegetable needs is high and has a favorable environment. Vegetable plants cultivated in pots and containers present a large diversity worldwide but, within this diversity, the climatic conditions from our country must be appropriate for an efficient activity.

Key words: vegetable crop, irrigation, substrate, fertilizers

Rezumat: Lucrarea prezintă o sinteză a literaturii de specialitate referitoare la cultura plantelor legumicole în ghivece și containere. Cultivarea legumelor în acest sistem este cunoscută de foarte mult timp în țările din Vestul Europei și uneori chiar și la noi. Adoptarea acestui sistem în România necesită studii aprofundate referitoare la: speciile potrivite, tipul de ghiveci, substraturile folosite, modul de înființare a culturilor, lucrările de îngrijire (fertilizare, irigare) și eventual reglarea unor factori referitori la lumina și amplasament. Acest tip de cultură este răspândit mai ales în zonele periurbane unde există dorința cultivatorilor de a-și asigura necesarul de legume precum și un mediu favorabil. Plantele legumicole cultivate în ghivece și containere prezintă o largă diversitate la nivel mondial, dar în cadrul acestei diversități, trebuie alese condiții care sunt adecvate de la noi din țară. Prin studiile și cercetările pe care mi le-am propus se dorește găsirea soluțiilor posibile de aplicat de la noi din țară.

Cuvinte cheie: culturi de legume, irigare, substrat, fertilizări

INTRODUCTION

The development of the cultivation of vegetables from the last decades can be observed from the continuous growth of the crop surfaces and quantities. At the same time, the technologies have constantly assured the growth of the crop

¹University of Agricultural Sciences and Veterinary Medicine Iași, Romania

²Gropnița Professional School, Iași, România

quantity and quality, thus appearing the so called systems of cultivation (Ciofu *et al.*, 2003). Therefore, we can distinguish between open space systems and protected space systems, the system on natural soil and that on artificial soil, conventional and nonconventional systems (ecological) etc. The industrial and the domestic systems (family type) are also of major interest. Within the last one, it has recently become more obvious that there is the possibility of a system of crops in pots and containers (Pipa, 2008).

A major attention has been given to improving the methods of cultivation in pots and containers and also to the development of an appropriate type of technology, able to assure the good use of family yards and gardens, in a pleasant way, through the aesthetics of the plants, and the utility of this system, through the quantity and quality of the vegetable plants. Pot gardening gives the opportunity to assure plant growing throughout the year, and thus it becomes an easy and pleasant activity. Besides this, for many people this is the only way of gardening when the outside space is relatively small or it does not exist at all (as it is for many people living in blocks of flats) (Wilson, 2007).

The vegetables that are cultivated in pots and containers can be placed in different parts of the garden, where there are the best conditions for growth and development, giving also a pleasant aspect to the garden, the sense of harmony, balance and elegance, enhanced by the organization and placement of the pots. Also, the pots and the containers can be placed on terraces or in the garden as design elements. Within the present work, we are trying to generally describe the steps that need to be followed in order to achieve the cultivation of vegetable plants in pots and containers.

MATERIAL AND METHOD

The study presented in this work was done on the basis of the existing information in literature, and of the experience of the Romanian cultivators. Taking into account the purpose and objectives of the work, the study is structured so that it achieves each one of the objectives. A special attention has been given to the following elements that contribute to the success of this system: the appropriate species, the type of pot, the soil, the method of cultivation, maintenance (fertilizers, irrigation), and the adjustment of some factors, such as the placement of the pots.

The appropriate species. The existing information will be analyzed and compared, according to the plant species: annual and perennial plants, short and tall plants, etc.

The type of pot or container: there are countless 'pots' that can be used; they may be specially designed for cultivation or improvised. They also differ according to size, shape, the material they are made of, price, ornamental value, etc.

The substrate. In the world literature there are many different formulas for organic substrates. Recent research has determined scientists to investigate the possibilities. The soil may have many components. Generally, substrate is made by mixing different proportions of materials together, such as peat, garden soil, organic compost, sand, perlite, vermiculite, some pharmaceutical products, etc.

Crop establishment. The establishment of vegetables in pots and containers can be done by direct sowing (cucumbers, beans) or by seedling (tomatoes, peppers, eggplants,

etc.). The appropriate time to plant is different for every specie, according to its needs referring to heat, period of vegetation, and the time needed before harvesting, but it also depends on the possibilities of the cultivator to establish such cultures.

RESULTS AND DISCUSSIONS

Results about the species of plants able to be grown in pots and containers

The vegetable plants that are cultivated in pots and containers are chosen according to the conditions of vegetation (light, water, nutrition) that the placement can offer, but also according to the design of the place where they would grow (Hudak, 2003).

The majority of the vegetable plants that can be cultivated in pots and containers are aromatic plants, like: oregano, savory, basil, tarragon, mint, lovage, dill. In bigger pots or containers one can grow cucumbers, onions, peppers, beans, lettuce, spinach, parsley, etc. When choosing the plants to be established in pots or containers, one should take into account the size that the plant might reach. One must also pay special attention to the design of the mini-garden in order to maintain a pleasant appearance and to assure that the plants can be taken care of appropriately.

The tomatoes (*Lycopersicon esculentum* L.) can be successfully cultivated in pots or containers. Many breeds of tomatoes can be grown, but the most suitable ones are cherry tomatoes. They are a lot smaller than normal tomatoes and they are highly appreciated for their distinct flavor and sweet taste (fig.1).

The sweet -pepper (*Capsicum annuum*) is a vegetable plant that can easily adapt to the cultivation in pots and containers, as it can be seen in fig. 2. The cultivation of the sweet -pepper can be established either by sowing or by seedling. The development of the seeds starts at 14-15 °C and takes up to 20-25 days for the seed to sprout. At temperatures of 20-25 °C, it lasts for 6-9 days (Chaux and Foury, 1994).

The beans (*Phaseolus vulgaris*) can be grown in a pot or a container because it does not require a lot of care, it easily adapts to the shortage of space of a balcony. The bean is cultivated for its culinary qualities, can be consumed in its state of string bean or when it reaches maturity. There are different types of beans, some cultivated especially to be consumed as string beans, others that are used as mature plants. Along with the common beans, in our country there is also a specie called *Phaseolus coccineus* L. (sin. *P. multiflorus* Lam.), also known as “the giant beans, or large bean, etc. (Munteanu, 1987). *P. coccineus* resembles *P. vulgaris*, but there are some differences: the root is thicker, even cylindrical; the stalk (both of determined and undetermined growth) is much more vigorous and more branched; the flowers, grouped in big axillary clusters (7-15 flowers) are French red, white or a mix of the two colours, as it can be seen in fig. 3; the pods are bigger (long, wide, thick); the seeds are very big (MMB = 900-1300 g), oblong wide, purple with black spots, beige with brown spots or white (Munteanu, 1985).

Among the greens, a good choice for planting in pots and containers is the lettuce, especially the one grown for leaves, which can be harvested by installment, and which is there to decorate the space for a long period of time, especially the types that have a design purpose and have different colours, from green-yellow to red. Other greens that are suitable for planting in pots and containers are: spinach, ramp, rocket salad, cress, savory, dill, etc. The perennial species are also a good choice for planting in pots and containers because they can be acquired and planted in a more advanced stage of development, thus having an ornamental impact immediately after they are planted (Sima, 2017).

Results of the different types of substrate used for pot and container planting

The nutritious substrate plays an important part in the success of the cultivation in pots and containers. The substrate has to be appropriate in terms of fertilization, texture, structure, pH, nutritious elements and their accessibility for the plant, and the right amount of organic substance. Generally, this kind of substrate is obtained by mixing together different proportions of specific materials, such as peat, garden soil, organic compost, sand, perlite, vermiculite, some pharmaceutical products, etc., as it can be observed in figure 4. Many cultivators choose to make their own organic substrate. This kind of substrate is made of different components, such as peat, coconut shell, perlite or vermiculite (Treadwell *et al.*, 2007).

Results concerning the types of pots and containers

Choosing the right type of pot or container is essential for the vegetable plants. There are no rules on their design, except for the one about the efficiency of the biological processes. The vegetable plants that are chosen have to be suitable for the size of the pot, the plants shouldn't grow more the twice the height of the pot and more the one and a half the width of the pot. The appropriate size of the pots depends on the size and the degree of development of the roots of the cultivated plant. The pots or containers may be made out of different types of material (plastic, ceramics, fiber glass, clay). The plastic, ceramics, fiber glass and wooden pots are the most used for planting vegetables and flowers. According to this system of cultivation, the term 'container' includes all types of pots and also, household recycled containers such as: plastic buckets, canisters, tiers, plastic trays, plastic or wooden crates, etc. Plastic bags or polyethylene bags may also be used. Plastic containers are light, cheap, but they are not resistant. Clay containers are cheap and resistant if they are kept away from frost, but they are heavy and allow the water to evaporate too fast. Vitrified ceramic containers have a very high ornamental value. The ones made of fiber glass are light and durable. In the case of wooden containers, those made of sturdy wood (cedar and oak) must be avoided. Generally, void materials containers (clay, concrete or wood) allow the water to evaporate more quickly than those made of plastic or metal. Suspended baskets and boxes can also be used, especially for running plants (Gessert, 1978). The durability of the containers may vary from a few months to a few years,

according to the vegetal production cycle (Camberato *et. al*, 2010). A few examples of pots are presented in fig. 5.

Results of the establishment of the crops

The establishment of vegetable plants in pots and containers can be done by sowing or seedling, same as field crops. The vegetable species that adapt easily when transplanted are those recommended for planting in pots and containers. The sowing with the purpose of obtaining the seedling is done in plug cell tray and the transplanting of the seedling into pots and containers for most plants should be done when the plant has 3-4 real leaves. In the case of species that have adventive roots (tomatoes, cabbage, etc.), they must be more deeply planted in order to assure the forming of a well developed radicular system. The sowing or seedling distances for pots and containers are different for every specie. Planting too close to each other may trigger problems referring to the amount of light they receive, the elongation and etiolation of the vegetable plants, and it may lead to diseases due to the bad circulation of the air (Sima, 2017).



Fig. 1 Cherry tomatoes in a container (<https://www.google.ro/plante/legumicole/in/ghivece>)



Fig.2 Sweet -pepper in a container (original photo)



Fig. 3 Bean flowers (original photo)



Fig. 4 Pot soil (<https://www.google.ro/search.substrat/mixt/pentru/ghiveci>)



Fig. 5 Types of pots and containers (<https://www.rodaliesorganiclife.com/garden/container-gardening>)

CONCLUSIONS

1. The cultivation of vegetable plants in pots and containers is appropriate for many known Romanian species of plants.

2. The pots and containers may differ in size, shape and materials that they are made of.

3. The substrate needs to provide the proper fertility conditions for good looking and useful plants.

The establishment of vegetable plants in pots and containers can be done by sowing (cucumbers, beans) or by seedling (tomatoes, peppers, eggplants, etc.).

REFERENCES

1. **Camberato D., Lopez, R., 2010** - *Biocontainers For Long-Term Crops. Greenhouse Grower.*
2. **Chaux Cl., Foury Cl., 1994** - *Production legumieres. Tehnique et Documentation* – Lavoiser, Londres – Paris – New York.
3. **Ciofu R. et. al, 2003** – *Tratat de legumicultură.* Editura Ceres București.
4. **Hessayon D. G., 2005** – *Expert în amenajarea propriei grădini.* Ed. București
5. **Fălțiceanu M., Munteanu N. 2006** - *Plante utile pentru grădina dumneavoastră.* Editura Moldova Iași
6. **Gessert K., 1897** - *The beautiful food garden: Creative Landscaping with Vegetables, Herbs, Fruits and Flowers.* Garden Way Publishing Co.
7. **Munteanu N., 2003** - *Tomatele, ardeii și pătlăgelele vinete.* Editura Ion Ionescu de la Brad, Iași.
8. **Munteanu N., 1987** – ‘*Aurie de Bacău*’ – un nou soi de fasole de grădină. Producția vegetală – Horticultură, nr. 1/ 1987, București.
9. **Munteanu N., 1985** - *Phaseolus coccineus – o specie legumicolă care merită mai multă atenție.* Producția vegetală – Horticultura, nr. 4/1985, București.
10. **Pipa G., 2008** - *1001 de idei pentru grădina ta.* Editura ALLFA București.
11. **Sima R., 2017** - *Legumicultură ornamentală,* Editura Acad. Pres, Cluj-Napoca.
12. **Teliban G.C. et. al, 2014** - *The study of the influence of the planting distance on the early production of certain runner bean cultivars (Phaseolus coccineus L.) for pods, in the environment of the polytunnel.* Lucrări științifice, seria Horticultură, vol. 57, nr. 1, pp. 105-110, USAMV Iași.
13. **Treadwell D. et. al, 2011** - *Organic fertilization programs for greenhouse fresh-cut basil and spearmint in a soilless media trough system.*

ORNAMENTAL VEGETABLE GARDENS IN A FAMILY SYSTEM

GRĂDINI LEGUMICOLE ORNAMENTALE IN SISTEM FAMILIAL

GALEA (DELEANU) Florina-Maria¹, MUNTEANU N.¹, STOLERU V.¹, TELIBAN G.C.¹, GACHE (LUNGU) Mirabela¹, HRISCU (MAFTEI) Adriana¹
e-mail: florinagalea@gmail.com

Abstract. Ornamental vegetable gardens have a long history on the European continent. The design of the gardens is different due to influences originated from customs and traditions, which represent important elements in their composition and are reflected in the vegetable growing methods and species used. The purpose of this paper is to analyse the opportunities that these gardens have and to satisfy the nutritional and aesthetic needs of a family. To reach the aim and proposed objectives a series of experiments and case studies were conducted. By combining the owners underlined nutritional needs from our previous studies and the obtained results from our experiments, applicable solutions were created for family vegetable gardens. From a therapeutic point of view this type of landscape design helps maintain cultural identity, encouraging communication and socialization between members of a community. The obtained results show that the studied family gardens situated in urban areas have a positive influence on the sustainability of the community maintaining a "heathy life style" for its inhabitants.

Key words: vegetable gardens, sustainability, community, aesthetics.

Rezumat. Grădinile legumicole ornamentale prezintă o lungă istorie pe continentul European. Influențele datorate diferitelor tradiții și obiceiuri sunt elemente distincte în cadrul acestora, reflectându-se prin modalitatea de cultivarea a legumelor și prin speciile utilizate. Scopul acestei lucrări științifice este de a analiza oportunitățile pe care astfel de grădini le oferă și de a satisface nevoile estetice și nutriționale ale unei familii. Pentru îndeplinirea scopului și a obiectivelor propuse au fost realizate o serie de experimente și studii de caz. Prin combinarea nevoilor nutriționale evidențiate de către proprietari în cadrul studiilor anterioare și a rezultatelor obținute în cadrul experiențelor au fost create soluții ce pot fi aplicate cu ușurință în cadrul grădinilor familiale. Terapeutic vorbind, astfel de amenajări peisagere contribuie la menținerea identității culturale încurajând comunicarea și socializarea între membrii unei comunități. Rezultatele obținute în cadrul acestui studiu arată că grădinile familiale situate în zone urbane contribuie activ la menținerea unui „stil de viață sănătos”, având o influență pozitivă asupra sustenabilității comunității.

Cuvinte cheie: grădini legumicole, sustenabilitate, comunitate, estetic

¹University of Agricultural Sciences and Veterinary Medicine Iasi, Romania

INTRODUCTION

Vegetable gardens in an allotment system have a long history in Europe, ever since the industrial revolution, when people migrated to cities, in the 19th century, this type of gardens were called “workers gardens” or “poor’s’ gardens”. During the two world wars, this type of gardens were known as “victory gardens” and supplied fresh vegetable for city inhabitants who were isolated from the country side. In time, allotment gardens became gardens for hobby, for recreation or education, with more functions (Tei and Gianquinto, 2010).

In some cities, such as Paris and Montreal, allotment gardens have in their composition four types: vegetable gardens, community gardens, collective gardens, shared gardens and family gardens. Based on the study done by Pourias (2014), the surface of the garden varies from 2 m² to 500 m² for a shared garden. The size of the plots for individual gardens (family gardens) was between 25-200 m².

In the United Kingdom of Great Brittan and Ireland the allotment gardens were created for residents and were called “pleasure gardens”. This type of gardens were not opened for the large public, but only for residence who paid a monthly sum (<http://www.ladbrokeassociation.info.html>).

In Romania, vegetable gardens in allotment systems (family gardens) have large plots from 90 m² to 500 m² or more depending if the garden is situated in a peri-urban area. Community gardens or collective gardens are small, about 10 m², situated near the residential building and are mainly used for flowers and decorative shrubs.

Because of the fact that vegetable gardens in allotment systems have evolved from their initial functions, as food providers, in our days the impact that this type of gardens has on human health, on society and the environment are very important. The process of sustainability is taken into consideration worldwide. The increase of agro-biodiversity, food safety and the benefits that family gardens have are underlined by many studies (Taylor and Lovell, 2014; Pawlikowska-Piechotka, 2012; Gosh, 2014).

To increase sustainability of vegetable gardens in allotment systems, we have to take into consideration the agricultural systems used. Because of the fact that an intercropping system has multiple advantages and contributes to increase sustainability of the vegetable gardens, it also gives the possibility to cultivate more crops on the same plot size (Mousavi and Eskardari, 2011).

The purpose of this study is to analyze the necessities and opportunities regarding vegetable cultivation in home gardens in the N and NE of Romania, and to increase their ornamental value by using an intercropping system. By applying correct crop technology and landscape design rules, elements of the sustainability process, such as cultural identity, life style and education it can be increased, as it was revealed in similar studies regarding the benefits of vegetable gardens in allotment systems.

Besides the ornamental value, one of the main objectives of this study was to give a multi-functionality to the proposed vegetable gardens by taking into consideration results from our previous studies.

MATERIAL AND METHOD

To reach the aim and objectives of this research a series of case study were analyzed and some experimental trials were carried out. The studied home family vegetable gardens are situated in different areas of the country, presented in detail by Galea (2016), represented a starting point, giving essential information about the type of vegetables used in Romanian family gardens. Based on these results, three experimental ornamental vegetable gardens were done in the experimental field of Thevegetable growing Department from the farm of the Agronomy University of Iasi, in 2015 and 2016.

The proposed vegetable gardens had o area between 20 m² and 100 m², designed in a geometrical style, using design and aesthetic rules. The three family gardens were evaluated by a panel of 20 experts. Using a survey with 17 questions, with a scale from 1 to 5, in which 1 represented highly disagree, 2 represented disagree, 3 represented neutral, 4 represented agree and 5 highly agree.

In the composition of the survey the following were taken into consideration: the proposed species; the combining method; the succession of plants; plant ornamental layout; garden functions: educational, ecological, cultural and ornamental; the influence of the intercropping system regarding the degree of weeds, pest and disease attack.

The achieved results from evaluating the three ornamental vegetable gardens by the panel of experts was then assessed using SWOT analysis to determine the degree of general agronomical and ornamental value of the proposed family gardens. Due to the SWOT analysis, the strengths and opportunities of the gardens were underlined.

By combining people experiences on their own home gardens and the experimental results we got some solutions to enhance the interest of urban and peri-urban people for family gardens.

RESULTS AND DISCUSSIONS

Based on the results of our previous studies regarding landscaping design in family vegetable gardens we were able to determine the needs of a family when it comes to vegetables, which species are used and how people interact with each other when it comes to exchange of products or seed (Galea *et al.*, 2016). Also, by underling the weaknesses on the studied gardens we were able to propose solutions to transform them into strengths or opportunities and apply them in the three proposed ornamental vegetable gardens.

a. Case study 1.

The first experimental family vegetable garden studied has an area of 20 m² and is designed in a geometrical style, respecting crop technology and landscape design principles for the proposed species. Based on compositional elements such as rhythm, symmetry and prime axis the vegetable garden

decorates trough the flower created using May King and Lollo Rosa lettuce (fig.1).

Using an intercropping system, the garden gives to opportunity to decorate for a longer period due to the combining method and plant succession. The vegetable garden has combined lettuce+ spinach+ onion+ lavender+ red orach in the first part of the year and runner bean + celery+ autumn carrot+ lavender in the second part of the year.



Fig. 1 Detail of the vegetable garden in the first part of the year-vegetable carpet

After the evaluation of the vegetable garden (fig. 2.) the respondents considered that the chosen species were well adapted to the pedo-climatic conditions of the area and were easy to care of. Also, they found the garden to be ornamental and economic.

As it is presented in the second figure, the last question regarding the educational role of the garden in forming the young generation with the necessary skills to grow their own vegetables, the garden obtained the highest number of positive responses (highly agree).

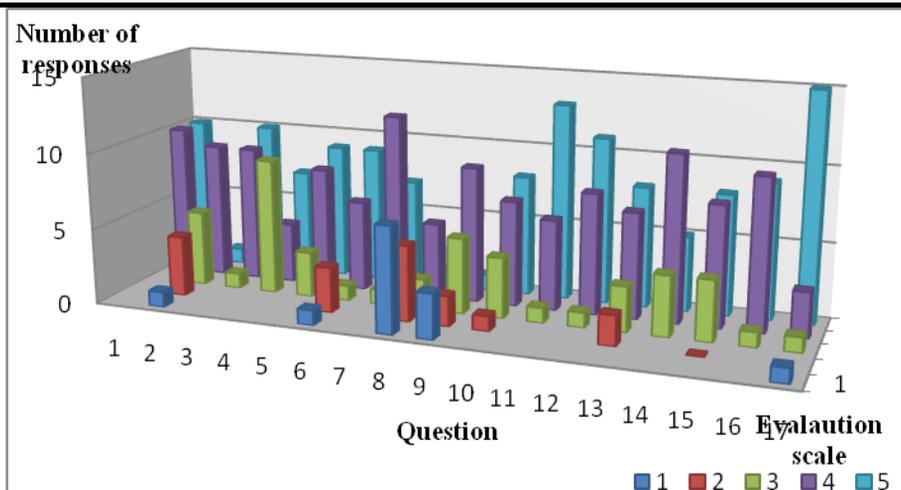


Fig. 2 Survey response analysis

Using SWOT analysis for the evaluation of the survey the strong points, the weak point, the opportunities and threats were revealed (tab. 1).

Table 1.

SWOT Analysis- First study case

Strengths	Weaknesses
<ul style="list-style-type: none"> the proposed species were well adapted to the area and were easy to care for; the ornamental vegetable garden was economical; the garden has a high ornamental and recreational value; the degree of weeds was low due to the intercropping system; a lower risk for diseases attack due to the combing method; the garden assures fresh vegetables for a long period. 	<ul style="list-style-type: none"> medium productivity; a low number of species used;
Opportunities	Threats
<ul style="list-style-type: none"> educational function for the young generation. 	<ul style="list-style-type: none"> moderated plant needs regarding soil nutrients for the combined species; the possibility of incompatibility side-effects due to plant combination

Based on the results obtained from the Swot analysis, the vegetable garden has many functions from recreational to aesthetic, combining the fulfilled need for fresh vegetables with sport activities in nature.

b. Case study 2.

The second vegetable garden was conceived as part of a community garden, it is an ornamental element, from where people can harvest their own fresh vegetables. It has a surface of 100 m² and its design is based on combining 20 horticultural plants with the purpose of multiple functions. The main axes divide the garden into 4 squares underlining its geometrical design (fig. 3).

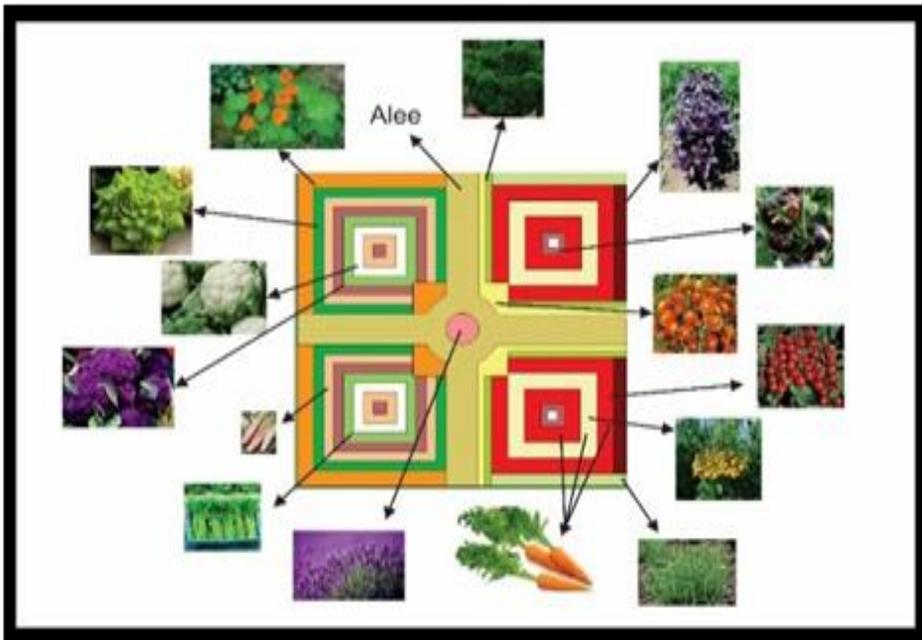


Fig. 3 2D Detail of the vegetable garden plan

In its composition the vegetable garden had 3 combinations of plants:

1. Lollo Rosa lettuce+ cherry tomatoes (yellow, red and striped purple) + French marigold+ leaf parsley + basil (green and purple);
2. cauliflower (green, white, purple) + celery+ tropeolum;
3. lettuce+ beans+ tropeolum;
4. cherry tomato + carrots (in the second part of the year);

The results of the survey revealed that the majority of answers were situated between 4 and 5 on the evaluation scale. The only question that had significantly different answers was number 8, which is a control question and presents that the combination of species can increase the competition for nutrients (fig. 4).

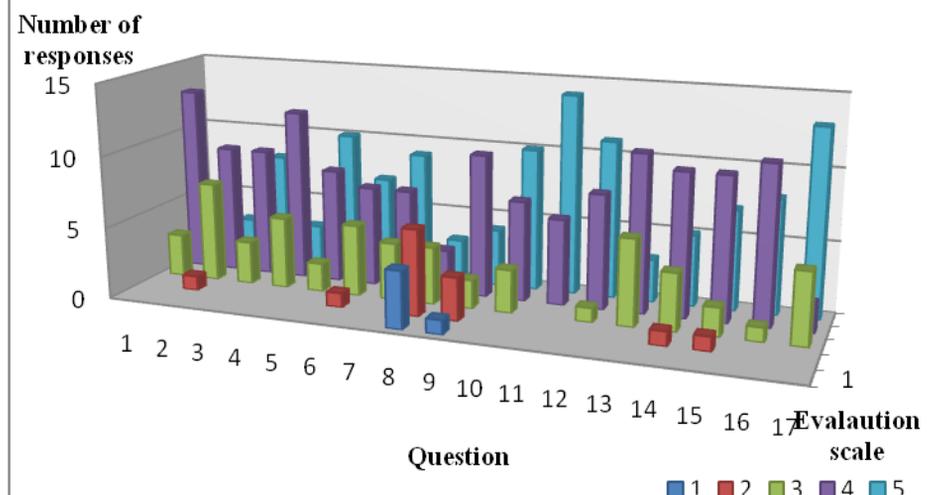


Fig. 4 Survey response analysis

The responses from the survey done by the 20 specialists were then analysed using SWOT analysis and the strong points and opportunities were unlined (tab. 2).

Table 2

SWOT Analysis- Second study case

Strengths	Weaknesses
<ul style="list-style-type: none"> the chosen species are well adapted to the area and easy to care for; high ornamental and recreational value; a lower risk for diseases attack due to plant combination; a relatively large number of species used in the garden; cultural function; favourable conditions for useful entomofauna; alternative methods of plant protection. 	<ul style="list-style-type: none"> side-effects due to plant combination; the degree of weeds in the garden if proper care is not done in time.
Opportunities	Threats
<ul style="list-style-type: none"> horticultural education for the young generation; fresh vegetables for a long time; incourages comucation in the community. 	<ul style="list-style-type: none"> economical rentability.

Due to the use of vegetables and companion plants with important roles in plant protection favourable conditions were created for useful insects in the garden.

c. Case study 3.

The third vegetable garden is designed in a mirror style, with a surface of 48 m². The main alee separates the garden in two equal rectangles. Combining landscape instruments with plant technology and by respecting plant nutrients conditions, the proposed design creates coloured perspectives, symmetry and equilibrium in the garden (fig. 5).



Fig. 5 Garden detail

For the design there were used 16 plants (lettuce, spinach, runner bean, pepper, tomato, carrot, celery, egg plants, leaf parsley, lavender etc.) in 10 different combinations.

The survey underlined the interest that the participants showed regarding the multitude of species used and the large number of function that the garden possess (fig.6).

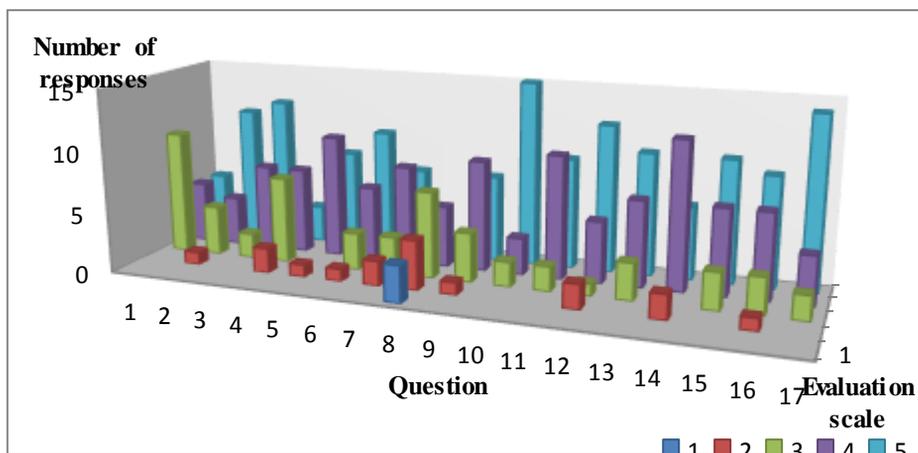


Fig. 6 Survey response analysis

The highest response rate was at question number 10 which underlined the high number of species used in an intercropping system in the garden compared to other systems.

Based on the response of the survey using SWOT analysis we determined the high point of the garden and the opportunities that it brings us (tab. 3).

Table 3

SWOT Analysis- Third study case

Strengths	Weaknesses
<ul style="list-style-type: none"> • the chosen species are well adapted to the area; • high ornamental and recreational value; • a lower risk for diseases attack due to plant combination; • a relatively large number of species used in the garden; • alternative methods of plant protection; • economical rentability; • high biodiversity. 	<ul style="list-style-type: none"> • care practices for the used plants; • plant nutrient uptake.
Opportunities	Threats
<ul style="list-style-type: none"> • horticultural education for the young generation; • encourages communication in the community. 	<ul style="list-style-type: none"> • side-effects due to plant combination; • the degree of weeds in the garden if proper care is not done in time.

The analysis revealed that the third garden was the most appreciated one due to its many strengths.

CONCLUSIONS

The results of the study revealed that family vegetable gardens in the urban and peri-urban area in an intercropping system help the general sustainability of the community, contribute to a “healthy life style” uniting communities and preserving cultural identity.

By using an intercropping system, the gardens had a low risk of disease attack, assuring fresh vegetables for a long time.

The gardens have ornamental value and encourage recreation and spending time in nature and also help teach the young generation about horticultural practices.

REFERENCES

1. **Galea (Deleanu) Florina Maria, Munteanu N., Teliban G.C, Hamburda Silvia Brândușa, Onofrei Vasilica, 2016** - *Study cases regarding landscaping design in family vegetable gardens*. Scientific papers, Vol. 59, No. 2, Horticultural series, 65-70.
2. **Gosh S., 2014** - *Measuring sustainability performance of local food production in home gardens*. Local Environment, Vol 19, No. 1, 33-55.
3. **Mousavi S. R., Eskandari H., 2011** - *A General Overview on Intercropping and Its Advantages in Sustainable Agriculture*, J. Appl. Environ. Biol. Sci., Vol. 1, No.11, 482-486.
4. **Pawlikowska-Piechotka A., 2011** - *Active recreation space "for all": family gardens in Poland*. Studies and Physical Culture and Tourism. Vol. 18. No.4, 351-360.
5. **Pourias J., 2014** - *Growing food for self-consumption inside cities: lessons learnt from urban allotment gardens in Paris and Montreal*. Presentation at 11th European IFSA Symposium, Humbolt Universitat (Berlin, Allemagne).
6. **Taylor J.R., Lovell S.H., 2014** - *Urban home food gardens in the Global North: research traditions and future directions*. Agriculture and Human Values, Vol. 31, No. 2, 285-305.
7. **Tei F., Gianquinto G., 2010** - *Origin, spread and multifunctional role of the urban horticulture*. Italus Hortus, Vol. 17, No.1, 59-73.
8. *** http://www.ladbrokeassociation.info/CommunalgardensoftheLadbrokeestate_000.html

THE POTENTIAL OF SOME INDIGENOUS MICROORGANISMS AND PLANTS FOR THE REMOVAL OF HEAVY METALS FROM SOIL

POTENȚIALUL UNOR MICROORGANISME ȘI PLANTE INDIGENE DE ELIMINARE A METALELOR GRELE DIN SOL

ROȘCA Mihaela¹, HLIHOR Raluca-Maria^{1,2}, COMĂNIȚĂ Elena-Diana¹, COZMA Petronela¹, SIMION Isabela-Maria^{1,2}, GAVRILESCU Maria^{1,3},
e-mail: raluca.hlihor@uaiasi.ro; mgav@ch.tuiasi.ro

Abstract. Heavy metals found in soils from different industrial sources or mining activities are persistent inorganic pollutants able to bioaccumulate along the food chain and cause negative effects in the environment and for human health. Different physical, chemical and biological processes are applied for their removal from soil environments. Biological processes become more and more preferred, since bioremediation strategies have often proved to be more advantageous than the conventional remediation tools, mainly because these processes can be implemented directly onto the contaminated sites (in situ). In this context, the present paper examines the ability of microorganisms and plants to remove heavy metals from soil, in terms of tolerance and bioaccumulation. A particular interest is given to the bioaccumulation processes of metals by proteobacteria, bacilli and actinobacteria, alone or in synergism with indigenous plants. Also, some advances in the biosorption of highly toxic heavy metal ions as Cr(VI) and Cd(II) are just discussed, together with various strategies and practices to explore the synergism between microorganisms and plants as valuable biological resource for increasing tolerance against heavy metals and strengthening the bioremediation processes. **Key words:** bioaccumulation, microorganisms, plants, soil pollution, synergism, tolerance

Rezumat. Metalele grele provenite din diferite surse industriale sau din activitățile miniere sunt poluanți anorganici persistenti ai solurilor, capabili să se bioacumuleze de-a lungul lanțului trofic și să genereze efecte negative pentru mediu și sănătatea umană. Pentru îndepărtarea metalelor grele din sol se pot aplica procese fizice, chimice și biologice. Procesele biologice sunt preferate din ce în ce mai mult, deoarece strategiile de bioremediere s-au dovedit adesea mai avantajoase decât instrumentele de remediere convenționale și pot fi implementate direct pe siturile contaminate (in situ). În acest context, lucrarea analizează capacitatea unor microorganisme și plante indigene de a elimina metalele grele din sol, în relație cu aspecte ce privesc toleranța și bioacumularea metalelor grele. O atenție aparte se acordă proceselor de bioacumulare a metalelor în proteobacterii, bacili și actinobacterii, singure sau

¹“Gheorghe Asachi” Technical University of Iași, Romania

²University of Agricultural Sciences and Veterinary Medicine Iași, Romania

³Academy of Romanian Scientists, Bucharest, Romania

în sinergism cu unele plante indigene. De asemenea sunt evidențiate progresele în biosorbția ionilor unor metale grele foarte toxice, precum Cr(VI) și Cd(II) și sunt discutate pe scurt diferite strategii și practici destinate explorării sinergismului dintre microorganismele și plante ca o resursă biologică valoroasă pentru creșterea toleranței la metale grele și progresului în cunoașterea proceselor de bioremediere.

Cuvinte cheie: bioacumulare, microorganismele, plante, poluarea solului, sinergism, toleranță

INTRODUCTION

Nowadays numerous sites worldwide are contaminated with various organic and inorganic pollutants having different toxic and persistence characteristics. The presence of inorganic toxic pollutants in soils is especially given by heavy metals ions (Gavrilescu, 2014; Pavel *et al.*, 2012; Sobariu *et al.*, 2017; Tóth *et al.*, 2016a). This type of pollution can cause negative impacts in the environment and for ecological systems (e.g. inhibition of cytoplasmic enzymes, damage to cell structures, inhibition of protein synthesis, negative effects in animals by disturbing the central and peripheral nervous and circulatory systems, decrease of plants growth, performance and crop yield etc.) (Cozma and Gavrilescu, 2014; Hlihor *et al.*, 2017; Siminciuc *et al.*, 2015; Sobariu *et al.*, 2017). As a consequence, human health can suffer numerous injuries (e.g. on the functions of brain, lungs, kidney, liver, blood composition; physical, muscular, and neurological degenerative diseases; immune deficiency disorders, heart complications, digestion problems, cancer etc.) (Hlihor *et al.*, 2017; lordache *et al.*, 2016; Rosca *et al.*, 2015; Sobariu *et al.*, 2017).

Based on the information provided by LUCAS database, Tóth *et al.* (2016a) found that about 1.2 million km² (28.3%) of the total surface area of the European Union are affected by pollution with one or more heavy metals ions (e.g. As, Cd, Cr, Cu, Pb, Zn, Sb, Co, Ni), whose concentration exceeds the maximum admissible limits. The largest areas affected by this type of pollution are situated in the West and Central of Europe, center of Italy, Greece and South-East of Ireland. The highest concentrations of Pb in soils were found in the center of Italy, France, Germany, and United Kingdom. Ni is mostly abundant in Mediterranean region of Europe, especially in Greece, while pollution with chromium affects largest areas of Piemonte, Lorraine-Alsace, Western-Macedonia and center of Greece. High concentrations of cadmium can be found in Ireland and Greece, whereas the concentration of Hg ions exceeds the legal limits especially in the center of Italy, North-West of England and East of Slovakia (Tóth *et al.*, 2016a, 2016b). In Romania, approximately 6,639 ha are affected by heavy metals pollution, noting that for 5,773 ha the concentration of some heavy metals found in soil exceeds the maximum admissible limits. The most affected areas are in the West of Romania (23.2%), North - East (20.5%), North - West (19.7%), Center (12.3%) and South - West Oltenia (2%) (Dumitru *et al.*, 2011).

Various physical, chemical and biological processes can be applied for the decontamination of soils polluted with heavy metals, but a special importance is given today to bioremediation techniques (fig. 1). Biological processes become more and more preferred, since the bioremediation strategies have often proved to be more advantageous than the conventional remediation tools, mainly because they are economic and ecological friendly and can be implemented directly onto the contaminated sites (*in situ*). Heavy metals can be eliminated by their bioaccumulation in specific microorganisms and plants. In this context, the present paper examines the abilities of some microorganisms and plants to eliminate heavy metals from polluted soils, considering also their tolerance and bioaccumulation capacity for heavy metals.

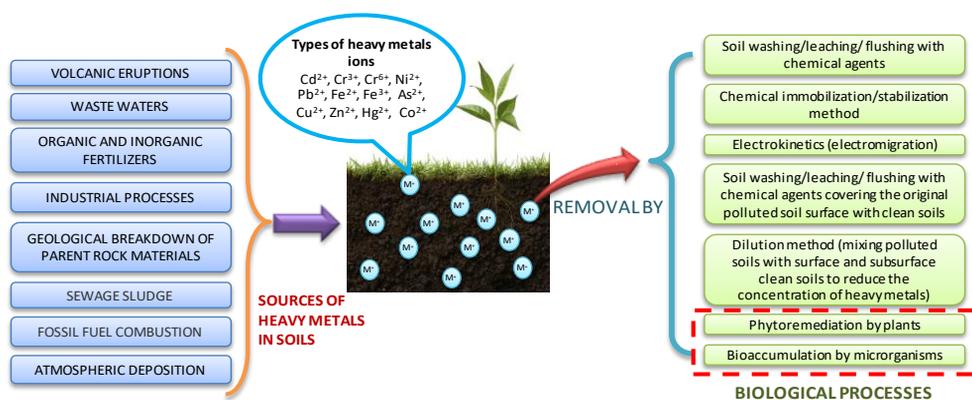


Fig. 1 Sources of heavy metals in soils and the processes used for remediation

BIOREMEDIATION OF SOILS

Recent studies have shown that biological methods based on phytoremediation and bioaccumulation are two *in situ* eco-friendly and economically feasible methods applied for an efficient soil remediation. These processes are based on the potential of plants (native, woody, herbaceous, ornamental, perennial, flowering, wild etc.) or microorganisms (bacteria, fungi, yeasts) to remove heavy metal ions from soil by extracting, transferring and accumulating them in biomass (Colin *et al.*, 2012; Kumari *et al.*, 2016; Rosca *et al.*, 2015; Sobariu *et al.*, 2017). The results of some studies on the potential of plants (tab. 1) and microorganisms (tab. 2) to eliminate heavy metals from soils by their bioaccumulation have demonstrated that various plants and microorganisms possess a high capacity to tolerate and absorb heavy metal ions, playing also an important role in reducing the contamination risk of food with toxic metals (Hlihor *et al.*, 2017; Sobariu *et al.*, 2017).

Removal of heavy metals ions by plants (phytoremediation)

Species of plants	Removal capacity of heavy metals ions (mg/kg d.w*.)								References
	Fe ²⁺	Pb ²⁺	Ni ²⁺	Cu ²⁺	Zn ²⁺	Cd ²⁺	Cr _{tot}	Co ²⁺	
<i>Brassica napus</i>	-	472	45.7	414	5983	23.5	82.5	-	Marchiol et al. (2004)
<i>Raphanus sativus</i>	-	407	51.6	563	4029	59.5	62	-	
<i>Cardaria draba</i>	1452	827	9.5	34.4	1850	2.2	-	-	Chehregani et al. (2009)
<i>Amaranthus retroflexus</i>	6230	371.5	7	57.5	233	5.5	-	-	
<i>Boromus sp</i>	520	210	6.5	26	85	10	-	-	
<i>Noea mucronata</i>	1230	1485	18.5	84	1984	14.6	-	-	
<i>Marrubium vulgare</i>	540	78	4	34	58	9	-	-	
<i>Lactuca serriola</i>	-	3	8	18	1030	21	4	-	Porebska and Ostrowska (1999)
<i>Artemisia vulgaris</i>	-	17	6.8	81	398	36	4	-	
<i>Rheum rhabarbarum</i> L.	-	0.015	-	0.03	0.17	-	-	-	Ipătioaie et al. (2014)
<i>Herniaria hirsuta</i>	-	34	808	22	29	8	275	63	Shallari et al. (1998)
<i>Inula germanica</i>	-	24	211	20	24	5	89	31	
<i>Dittrichia graveolens</i>	-	28	94	1110	849	9	69	34	
<i>Lotus ornithopodioides</i>	-	43	232	14	75	5	63	21	
<i>Alyssum murale</i>	-	23	8463	23	108	3	12	86	
<i>Convolvulus arvensis</i> L.	-	-	-	560	-	1500	800	-	Gardea-Torresdey et al. (2004)
<i>Euphorbia cheiradenia</i>	1040	1138	14.2	65	1873	2.35	-	-	Chehregani and Malayeri (2007)
<i>Biebers teiniamultifida</i>	480	23	4	20	-	7	-	-	
<i>Reseda lutea</i>	5490	371	7	57.5	233	5.5	-	-	
<i>Euphorbia macroclada</i>	2261	81.67	13	26	327	3	-	-	
<i>Ceratophyllum demersum</i>	-	20	-	22.7	104	3.52	-	-	Matache et al. (2013)
<i>Potamogeton pectinatus</i>	-	6.63	-	6.24	16.4	0.64	-	-	
<i>Potamogeton lucens</i>	-	1.51	-	9.8	15.6	0.97	-	-	

*d.w. – dry weight

Phytoremediation and bioaccumulation processes applied in contaminated areas can be influenced by several operational parameters (soil pH, temperature variations, soil morphology, initial concentration of heavy metals etc.) (Pavel et al., 2013). Taking into account these aspects, the selection of the most suitable plants and microorganisms for bioremediation depends on their ability to adapt to the climatic and soil conditions in the polluted area.

Removal of heavy metals ions by microorganisms through bioaccumulation process

Microorganisms species	Initial conditions	Ions	Removal efficiency (%) or uptake (mg/g)	References
<i>Arthrobacter phenanthrenivorans</i>	$C_{Pb(II)}=180$ mg/L, $C_{Cd(II)}=178$ mg/L, $C_{Ni(II)}=85$ mg/L, 72 hours contact time	Pb ²⁺	79.9 %	Banerjee et al. (2016)
		Ni ²⁺	47.62%	
		Cd ²⁺	34.05%	
<i>Pseudomonas putida</i>	$C_{Pb(II)}=1.53$ mg/L, $C_{Co(II)}=8.82$ mg/L, $C_{Ni(II)}=11.48$ mg/L, $C_{Cu(II)}=5.9$ mg/L, $C_{Cd(II)}=50$ mg/L, 5 days contact time	Pb ²⁺	96%	Nanganuru and Korrapati (2012)
		Ni ²⁺	57%	
		Cu ²⁺	49 %	
		Co ²⁺	71%	
		Cd ²⁺	93%	
<i>Enterobacter</i> sp. J1	$C_{heavy\ metal}=100$ mg/L, 24 hours contact time	Pb ²⁺	50.9 mg/g	Lu et al. (2006)
		Cu ²⁺	32.5 mg/g	
		Cd ²⁺	46.6 mg/g	
<i>Bacillus cereus</i>	$C_{heavy\ metal}=0.2-0.6$ mmol/mL, 24 hours contact time	Pb ²⁺	36 mg/g	Banerjee et al. (2015)
		Ni ²⁺	28 mg/g	
		Cu ²⁺	33 mg/g	
		Mn ²⁺	38 mg/g	
		Hg ²⁺	35 mg/g	
		Co ²⁺	31 mg/g	
<i>Saccharomyces cerevisiae</i>	$C_{Hg(II), Co(II)}=500$ mg/L, 21 days contact time $C_{Pb(II)}=100$ mg/L $C_{Cd(II)}=300$ mg/L 30 days contact time	Hg ²⁺	90.48 %	Imam et al. (2016)
		Cd ²⁺	92.68 %	Damodaran et al. (2011)
		Pb ²⁺	67 %	
		Cd ²⁺	73 %	
<i>Bacillus subtilis</i> B38	$C_{heavy\ metal}=0.1-1.25$ mmol/L 24 hours contact time	Pb ²⁺	2.48 mmol/g	Wang et al. (2014)
		Hg ²⁺	4.09 mmol/g	
		Cd ²⁺	3.04 mmol/g	
		Cr _{total}	1.83 mmol/g	
Mix of proteobacteria: <i>O. intermedium</i> , <i>A. ebreus</i> , <i>A. caviae</i> , <i>B. diminuta</i> , <i>B. vietnamiensis</i> , <i>P. mendocina</i> , <i>P. alcaligenes</i> , <i>S. marcescens</i> , <i>S. acidaminiphilia</i> , <i>D. tsuruhatensis</i>	$C_{As(II)}=141$ mg/kg soil, 20 min contact time $C_{Zn(II)}=49$ mg/kg soil $C_{Ni(II)}=21$ mg/kg soil 10 min contact time	As ²⁺	71%	Fauziah et al. (2017)
		Ni ²⁺	50.8%	
		Zn ²⁺	47.6%	
<i>Thiobacillus ferrooxidans</i>	$C_i=2199$ mg/kg soil $C_f=27660$ mg/kg soil $C_r=132$ mg/kg soil $C_i=99500$ mg/kg soil $C_i=7520$ mg/kg soil $C_i=11.68$ mg/kg soil $C_i=7360$ mg/kg soil 72 hours contact time	Zn ²⁺	90 %	Sur et al. (2012)
		Pb ²⁺	0.53 %	
		Cr _{total}	25 %	
		Fe ²⁺	100 %	
		Cu ²⁺	100 %	
		Cd ²⁺	60 %	
		Mn ²⁺	65 %	

In this case, the best choices for soil bioremediation is through plants that normally grow in the contaminated area, as well as indigenous microorganisms. Plants and microorganisms age and the synergistic or antagonistic effects of elements/compounds on going in soil against plants and microorganisms are also important factors that can influence process efficiency (Elekes, 2014). Barbeș and

Bărbulescu (2017) analyzed the accumulation of Cu, Zn, Ni, Pb, Cr, Cd and Co in the leaves and bark of *Populus nigra* L., a species of plant grown in Navodari area, in the region of Romanian Black Sea Littoral. The results have shown that the plant possesses a high potential in the removal of heavy metals ions from polluted area (the effectiveness of the process was higher than 70%). Elekes (2014) studied the potential of some plants, which normally grow on the industrial platform of Targoviste city (*Lolium perenne*, *Festuca pratensis*, *Stipa capillata*, *Agrostis alba*, *Cynodon dactylon*, *Agrostis tenuis* and *Luzula campestris*). The samples taken were analyzed and the results have shown that the plants studied are able to remove the heavy metals (Cu, Zn, Sn, Pb, Co, Ni, Mn, Cr) (e.g. *Lolium perenne* has removed 921.67 mg/kg Zn, 201.23 mg/kg Pb, 114.19 mg/kg Cr, 61.95 mg/kg Cu).

CONCLUSIONS

When comparing the data available from literature, we can notice that biological *in situ* processes can be applied with high potential for the removal of heavy metals from polluted soils, considering different plants and microorganisms. Some species of plants such as: *Amaranthus retroflexus*, *Noea mucronata*, *Alyssum murale*, *Convolvulus arvensis* L., *Brassica napus*, *Raphanus sativus* and *Cardaria draba* can be considered as hyperaccumulators for some heavy metals ions. Also, it has been observed that a wide variety of indigenous microorganisms from proteobacteria, actinobacteria and bacilli class can be used with high effectiveness for the bioremediation of soils polluted with heavy metals (e.g.: *S. cerevisiae*, *Streptomyces*, *A. phenanthrenivorans*, *Pseudomonas putida*, *Enterobacter* sp. etc.). In Romania, the use of these processes for the remediation of soils polluted with various heavy metal ions can be successfully applied, as confirmed by the studies carried out in Navadori and Targoviste regions, as well as in other areas of the country. In order to increase the efficiency of the process, it is necessary to select plants and microorganisms adapted or easily adaptable to climatic conditions in the area, structure and parameters of the polluted soil.

Acknowledgments: This work was supported by a grant of the Romanian National Authority for Scientific Research, CNCS – UEFISCDI, project number PN-III-P4-ID-PCE-2016-0683, Contract no. 65/2017.

REFERENCES

1. Banerjee S., Gothalwal R., Sahu P.K., Sao S., 2015 - *Microbial Observation in Bioaccumulation of Heavy Metals from the Ash Dyke of Thermal Power Plants of Chhattisgarh, India*. Advances in Bioscience and Biotechnology, 2015, 6, 131-138.
2. Banerjee G., Ray A.K., Pandey S., Kumar R., 2016 - *An Alternative Approach of Toxic Heavy Metal Removal by Arthrobacter phenanthrenivorans: Assessment of Surfactant Production and Oxidative Stress*. Current Science, 110, p. 2124-2128.

3. **Barbeș L., Bărbulescu A., 2017** -*Monitoring and Statistical Assessment of Heavy Metals in Soil and Leaves of Populus nigra L.* Environmental Engineering and Management Journal, 16, p. 187-196.
4. **Chehregani A., Malayeri B.E., 2007** - *Removal of Heavy Metals by Native Accumulator Plants.* International Journal of Agriculture & Biology, 9, p. 462-465.
5. **Chehregani A., Noori M., Yazdi H.L., 2009** - *Phytoremediation of Heavy-Metal-Polluted Soils: Screening for New Accumulator Plants in Angouran Mine (Iran) and Evaluation of Removalability.* Ecotoxicology and Environmental Safety, 72, p. 1349-1353.
6. **Colin V.L., Villegas L.B., Abate C.M., 2012** - *Review: Indigenous Microorganisms as Potential Bioremediators for Environments Contaminated with Heavy Metals.* International Biodeterioration & Biodegradation, 69, 28-37.
7. **Cozma P., Gavrilescu M., 2014** - *Key Features of Contaminated Soils, In: Contaminated Soils: a Guide to Sampling and Analysis.* Gavrilescu M., Bulgariu L. (Eds), Future Science, London, p. 7-17.
5. **Damodaran D., Suresh G., Mohan R.B., 2011** -*Bioremediation of Soil by Removing Heavy Metals Using Saccharomyces cerevisiae.* 2nd International Conference on Environmental Science and Technology IPCBEE, 6, p. V2-22-V2-27.
6. **Dumitru M., Manea A., Ciobanu C., Dumitru S., Vrinceanu N., Rișnoveanu I., Calciu I., Tănase V., Preda M., Mocanu V., Eftene M., 2011** - *Soil Quality Monitoring In Romania.* Editura SITECH, Craiova, Romania.
7. **Elekes C.C., 2014** - *Chapter 10: Eco-Technological Solutions for the Remediation of Polluted Soil and Heavy Metal Recovery, In: Environmental Risk Assessment of Soil Contamination.* InTechEditure, p. 309-335.
8. **Fauziah S.H., Jayanthi B., Emenike C.U., Agamuthu, 2017** -*Remediation of Heavy Metal Contaminated Soil Using Potential Microbes Isolated from a Closed Disposal Site,* International Journal of Bioscience, Biochemistry and Bioinformatics, 7, p. 230-237.
9. **Gardea-Torresdey J.L., Peralta-Videa J.R., Montes M., de la Rosa G., Corral-Diaz B., 2004** - *Bioaccumulation of Cadmium, Chromium and Copper by Convolvulus arvensis L.: Impact on Plant Growth and Uptake of Nutritional Elements.* Bioresource Technology, 92, p. 229-235.
10. **Gavrilescu M., 2014** - *Colloid-Mediated Transport and the Fate of Contaminants in Soils, In: The Role of Colloidal Systems in Environmental Protection.* Elsevier, Amstredam, p.397-451.
11. **Hlihor R.-M., Apostol L.C., Gavrilescu M., 2017** - Environmental Bioremediation by Biosorption and Bioaccumulation: Principles and Applications, In: Enhancing Cleanup of Environmental Pollutants, Volume 1: Biological Approaches. Anjum N., Gill S., Tuteja N., (Ed.), Springer Science+Business Media, New York, p. 289-315.
12. **Imam A.S.S., Rajpoot I.K., Gajjar B., Sachdeva A., 2016** - *Comparative Study of Heavy Metal Bioremediation in Soil by Bacillus Subtilis and Saccharomyces erevisiae.* Indian Journal of Science and Technology, 9, p. 1-7.
13. **Iordache M., Branzoi I.V., Popescu L.R., Iordache I., 2016** - *Evaluation of Heavy Metal Pollution into a Complex Industrial Area From Romania.* Environmental Engineering and Management Journal, 15, 389-394.
14. **Ipățioaie D.C., Munteanu N., Stoleru V., Sellitto V.M., Cojocaru A, 2014** – *The accumulation of heavy metals in rhubarb (Rheum rhabarbarum L.).* Lucrări științifice, seria Horticultură, 57, p. 277-282.
15. **Kumari A., Lal B., Rai U.N., 2016** - *Assessment of Native Plant Species for Phytoremediation of Heavy Metals Growing in the Vicinity of NTPC Sites, Kahalgaon, India.* International Journal of Phytoremediation, 18, 592-597.

16. Lu W.B., Shi J.J., Wang C.H., Chang J.S., 2006 - *Biosorption of Lead, Copper and Cadmium by an Indigenous Isolate Enterobacter sp. J1 Possessing High Heavy-Metal Resistance*. Journal of Hazardous Materials, 134, 80-86.
17. Marchiol L., Assolari S., Sacco P., Zerbi G., 2004 - *Phytoextraction of Heavy Metals by Canola (Brassica napus) and Radish (Raphanussativus) Grown on Multicontaminated Soil*. Environmental Pollution, 132, p. 21-27.
18. Matache M.L., Marin C., Rozyłowicz L., Tudorache A., 2013 - *Plants accumulating heavy metals in the Danube River wetlands*. Journal of Environmental Health Science and Engineering, 11, p. 1-7.
19. Nanganuru H.Y., Korrapati N., 2012 - *Studies on Biosorption of Cadmium by Pseudomonasputida*. International Journal of Engineering Research and Applications, 2, p. 2217-2219.
20. Pavel V.L., Stătescu F., Gavrilescu M., 2012 - *Aspects Concerning the Behaviour of Heavy Metals in Soil*, In: *Current topics, Concepts and Research Priorities in Environmental Chemistry*. Zaharia C. (Ed.), Editura Universității „Alexandru Ioan Cuza” din Iași, pp. 341-358.
21. Pavel V.L., Sobariu D.-L., TudoracheFertu I.D., Stătescu F., Gavrilescu M., 2013 - *Symbiosis in the Environment: Biomangementof Soils Contaminated with Heavy Metals*. European Journal of Science and Theology, 9, 211-224.
22. Rosca M., Hlihor R.-M., Cozma P., Comăniță E.-D., Simion I.M., Gavrilescu M., 2015 - *Potential of biosorption and bioaccumulation processes for heavy metals removal in bioreactors*. E-Health and Bioengineering Conference (EHB), DOI: 10.1109/EHB.2015.7391487.
23. Shallari S., Schwartz C., Haskoba A., MorelaJ.L., 1998 - *Heavy Metals in Soils and Plants of Serpentine and Industrial Sites of Albania*. The Science of the Total Environment, 209, p. 133-142.
24. Siminciuc C.G., Munteanu N., Teliban G., Stoleru V., 2015 - *Assement of heavy metals content on tomatoes under organic system*. Lucrări științifice, seria Horticultură, USAMV Iași, 58, 279-284.
25. Sobariu D.L., TudoracheFertu D.I., Diaconu M., Pavel L.V., Hlihor R.-M., Drăgoi E.N., Curteanu S., Lenzde M., Corvini P.F.X., Gavrilescu M., 2017 - *Rhizobacteria and Plant Symbiosis in Heavy Metal Uptake and Its Implications for Soil Bioremediation*. New Biotechnology, 39, p. 125-134.
26. Sur I.M.B., Micle V., Avram S., Șenilă M., Oros V., 2012 - *Bioremediation of Some Heavy Metals from Polluted Soils*. Environmental Engineering and Management Journal, 11, p. 1389-1393.
27. Tóth G., Hermann T., Szatmári G., Pásztor L., 2016a - *Maps of Heavy Metals in the Soils of the European Union and Proposed Priority Areas for Detailed Assessment*. Science of the Total Environment, 565, p. 1054-1062.
28. Tóth G., Hermann T., Da Silva M.R., Montanarella L., 2016b - *Heavy Metals in Agricultural Soils of the European Union with Implications for Food Safety*. Environment International, 88, p. 299-309.
29. Wang T., Sun H., Mao H., Zhang Y., Wang C., Zhang Z., Wang B., Sun L., 2014 - *The Immobilization of Heavy metals in Soil by Bioaugmentation of aUV-mutant Bacillus subtilis 38 Assisted by NovoGroBiostimulation and Changes of Soil Microbial Community*. Journal of Hazardous Materials, 278, p. 483-490.

DISSIPATION BEHAVIOR OF PESTICIDES APPLIED IN MULTIPLE TREATMENTS IN APPLES

COMPORTAMENTUL UNOR PESTICIDE APLICATE ÎN TRATAMENTE MULTIPLE ÎN MERE

HLIHOR Raluca Maria^{1,2}, POGĂCEAN Manuela Olga³, ROȘCA Mihaela², COZMA Petronela², GAVRILESCU Maria^{2,4}

e-mail: raluca.hlihor@uaiasi.ro, raluca.hlihor@ch.tuiasi.ro, mgav@tuiasi.ro

Abstract. *The main objective of this work addresses kinetic studies on the dissipation of 12 pesticides applied in single recommended dose and double dose treatments in apples, considering 6 kinetic models which determine the statistical parameters describing pesticide behavior, including their half-lives. The half-lives of pesticides in apples at BBCH (Biologische Bundesanstalt, Bundessortenamt and CHEMICAL industry) scale 76-79 resulted from the linear regression equations considering single dose treatments were between 0.01 days (for λ -cyhalothrin) and 74.90 days (for myclobutanil). Data on the rate of dissipation and half-lives of pesticides in various plant compartments are particularly significant for pesticide monitoring and human health impacts and risk assessment.*

Key words: active substances, half-life, modeling, plant protection products, monitoring

Rezumat. *Obiectivul principal al acestei lucrări are în vedere studii cinetice ce vizează disiparea a 12 pesticide aplicate în tratamente pentru mere, cu doze recomandate și doze duble, considerând 6 modele cinetice care determină parametrii statistici ce descriu comportamentul pesticidelor, inclusiv timpul de înjumătățire. Timpul de înjumătățire al pesticidelor în mere pentru scara fenologică BBCH (Biologische Bundesanstalt, Bundessortenamt and CHEMICAL industry) 76-79, rezultat din ecuațiile de regresie liniară, este cuprins între 0,01 zile (pentru λ -cihalotrin) și 74,90 zile (pentru miclobutanil). Datele privind viteza de degradare sau timpul de înjumătățire a pesticidelor în diferite compartimente ale plantelor sunt deosebit de importante pentru monitorizarea pesticidelor și pentru evaluarea impacturilor și riscurilor asupra sănătății umane.*

Cuvinte cheie: substanțe active, timp de înjumătățire, modelare, produse pentru protecția plantelor, monitorizare

¹University of Agricultural Sciences and Veterinary Medicine Iasi, Romania

²“Gheorghe Asachi” Technical University of Iasi, Romania

³Phytosanitary Office Mureș, Târgu Mureș, Romania

⁴Academy of Romanian Scientists, Bucharest, Romania

INTRODUCTION

The apple tree is a crop plant affected by a large number of diseases and pests. Fruit trees species health and productivity are strongly influenced by a number of pathogens (e.g. viruses, fungi, bacteria, mycoplasma) and pests (e.g. insects, birds, rodents). Throughout the vegetative cycle, it is therefore necessary to ensure a permanent protection of the plants. According to the information provided by farmers, apple trees are mainly affected by 4-6 pathogens (e.g. apple scab - *Venturia inaequalis*, apple powdery mildew - *Podosphaera leucotricha*, fire blight - *Erwinia amylovora*, brown rot - *Monilinia fructigena*, Apple mosaic virus (ApMV), etc.) and 12-15 pests (e.g. codling moth - *Cydia (Lasperesya) pomonella*, mites (red spider - *Panonychus ulmi*), aphids (San-José scale - *Quadraspidotus perniciosus*, green apple aphid - *Aphis pomi*), apple blossom weevil (*Anthonomus pomorum*) etc.). If no action is taken against these pests, the production of susceptible varieties is compromised to around 80-100% (Tomșa and Tomșa, 2003). Fruit trees can also be affected by other factors, such as climatic, soil and agro-industrial factors. Considering these aspects, the number of treatments with pesticides can reach, in an apple orchard, even 14 per season. The Jonathan apples with smooth bark, a sweet-sour taste and yellowish, juicy and sweet pulp, have a very intense flavor, a high content of vitamin C, along with other vitamins and mineral salts, all being substantial for the human body. A high consumption of fruit and vegetables, generally five or more servings per day, can prevent vitamins deficiency and can reduce the incidence of major diseases such as cancer, cardiovascular disease and obesity (Dietary Guidelines, 2005; Lewis *et al.*, 2005; Pogăcean *et al.*, 2014).

Due to potential risks to human health, pesticide residues in food are carefully regulated and monitored by the authorized agencies and institutions (Hill and Reynolds, 2002; Hlihor *et al.*, 2016; Stoleru *et al.*, 2015). In the last decade, increasing demand for food has stimulated the research concerning the risks associated with fruit and vegetables consumption. Therefore, the food security is a major public concern in the world. As the main route of exposure is ingestion, dietary exposure to pesticides is considered to be five orders of magnitude greater than other exposure routes, such as drinking water ingestion or air inhalation (Cozma *et al.*, 2017; Fantke *et al.*, 2014; Juraske *et al.*, 2009). Increased doses of pesticides may have undesirable effects, including the accumulation of large amounts of residues in products (Van Klaveren and Boon, 2009). Understanding pesticides degradation mechanisms in plants in relation with other factors and the determination of pesticide residues in samples based on the phenological growth stages and at harvest are very important, not only for the proper assessment of food risks, but also for the optimization of pesticide application techniques, so as to create an efficient management (Fantke and Juraske, 2013; Stoleru *et al.*, 2016).

This paper focuses on the dissipation rates of the most common pesticides applied in Jonathan apples, considering their phenological growth stages, as well

as estimating their half-lives when single recommended dose or double dose (overdoses) treatments at different stages of fruit development are applied.

MATERIAL AND METHOD

Chemicals and analysis

Solvents used for extraction (e.g. acetone, petroleum ether and dichloromethane) were of analytical grade and were purchased from Chem Service (West Chester, SUA) and Sigma Aldrich Laborchemikalien GmbH (Seelze, Germany). The list of pesticide products applied for apple treatments along with their commercial name, doses, and Maximum Residue Levels (MRLs) are described in the work of Pogacean *et al.* (2014). The residual concentrations of pesticides in apples were analyzed by a gas chromatograph (Agilent 7890 type with 2 ovens) coupled with a mass spectrometer with flight time, CG*GC-TOFMS Pegasus 4.21 (LECO, SUA). Details regarding the experimental protocol of gas chromatography analysis described by Pogacean *et al.* (2014).

Experimental field trials

Field experiments were performed in an apple orchard, within the Phytosanitary Office Mures, Tg. Mures, Romania. Five treatments with 6 fungicides (captan, folpet, chlorothalonil, myclobutanil, tebuconazole, triadimenol), 5 insecticides (bifenthrin, deltamethrin, α -cypermethrin, λ -cyhalothrin, chlorpyrifos-methyl) and 1 acaricide (propargite) were applied during the growth of Jonathan apples according to BBCH scale (Biologische Bundesanstalt, Bundessortenamt and Chemical industry). Temperature, precipitations and humidity were monitored using a weather station available in the Technical Department, located within the Phytosanitary Office Mures. The entire treatment procedure is discussed in detail by Pogacean *et al.* (2014).

Kinetic modeling of pesticide dissipation

Kinetic modeling of pesticide residues behavior in apples was performed considering single recommended dose and double dose treatments with pesticides for BBCH scale 76-79 (2/3 of normal size) and measuring their concentration in time (t) from 2 days (d) to 2 months after harvesting as indicated in the work of Pogacean *et al.* (2014). In order to evaluate the dissipation behaviour of pesticides in time and to determine the statistical parameters that describe the processes leading to dissipation, we used 6 kinetic models: 1st-order, 1.5th-order, 2nd-order, RF-1st-order, RF-1.5th-order, RF-2nd-order. Time and pesticide residues values were converted by the kinetic models described in tab. 1. The linear regression equation is described in the form of $y = a + b x$, where a is the intersection point of the straight line with the x-axis at $t = 0$ and b represents the slope of the straight line. An important parameter consistent with the persistence of pesticide residues is the decline time (T/X), which denotes the time after which the residue concentration decreased to $1/X$ of the initial concentration. According to this definition, $t_{1/2}$ represents the time required to reduce by half the initial concentration of the pesticide residue. A particular case is the 1st-order model, where the relative declining rate remains constant throughout the process, being independent of the initial concentration (in analogy to the 1st-order reaction). Therefore, $t_{1/2}$ corresponds to the half-life of pesticides. In the case of the other models described, the declining rate, T/X , decreases progressively over time, and the half-life is not proper to be used in this context (Timme and Frehse, 1980; Timme *et al.*, 1986).

Table 1

Calculation formulas for regression equations in the linearized system and for the decline time

Model	Linear regression	T/X
1 st -order kinetics	$\log C = a + bt$	$\frac{\log X}{-b}$
1.5 th -order kinetics	$\frac{1}{\sqrt{C}} = a + bt$	$\frac{a}{b}(\sqrt{X} - 1)$
2 nd -order kinetics	$\frac{1}{C} = a + bt$	$\frac{a}{b}(X - 1)$
RF-1 st -order kinetics	$\log C = a + b\sqrt{t}$	$\left(\frac{\log X}{-b}\right)^2$
RF-1.5 th -order kinetics	$\frac{1}{\sqrt{C}} = a + b\sqrt{t}$	$\left(\frac{a}{b}(\sqrt{X} - 1)\right)^2$
RF-2 nd -order kinetics	$\frac{1}{C} = a + b\sqrt{t}$	$\left(\frac{a}{b}(X - 1)\right)^2$

RF, Root Function; T/X, decline time

RESULTS AND DISCUSSIONS

Climatic conditions

The behavior of pesticides analyzed in various phenological phases of apples growth is strongly influenced by climatic conditions (e.g. temperature, humidity and precipitations) as seen in figs. 1-2. Physical properties of pesticides play an important role in the dynamics of pesticide concentrations, and are included in tab. 2.

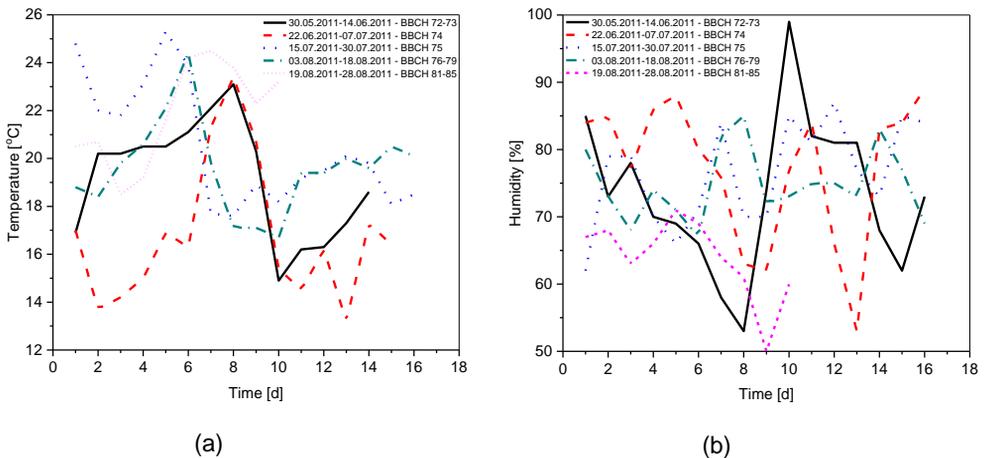


Fig. 1 Temperature (a) and humidity (b) variation during phenological growth phases of apples

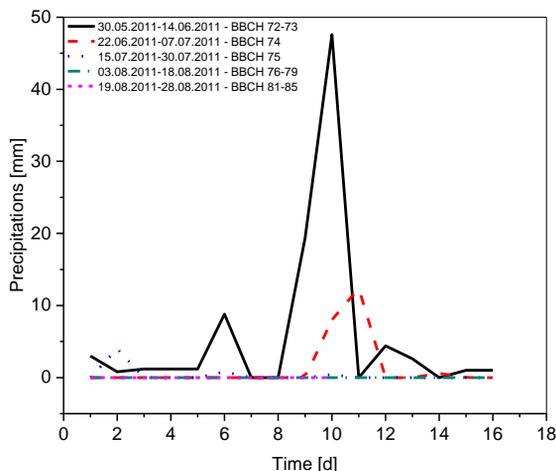


Fig. 2 Precipitations variation during phenological growth phases of apples

Table 2

Basic properties of pesticides applied in the treatment of apple trees

Pesticide	Formula	Molecular mass [g/mol]	Solubility in water [mg/L]	Vaporization pressure [mPa]	Henry constant	log P /octanol-water
Captan	$C_9H_8Cl_3NO_2S$	300.6	3.3	<1.3	$3 \cdot 10^{-4}$ Pa \cdot m 3 /mol at 20°C	2.8 at 25°C pH 7
Folpet	$C_9H_4Cl_3NO_2S$	296.6	0.8	$2.1 \cdot 10^{-2}$ mPa at 25°C	$7.8 \cdot 10^{-3}$ Pa \cdot m 3 /moli	3.11
Triadimenol	$C_{14}H_{18}ClN_3O_2$	295.8	95	A: $6 \cdot 10^{-4}$ mPa at 20°C B: $4 \cdot 10^{-4}$ mPa at 20°C	A: $3 \cdot 10^{-6}$ Pa \cdot m 3 /mol at 20°C B: $4 \cdot 10^{-6}$ Pa \cdot m 3 /mol 20°C	A: 3.08 at 25°C B: 3.28 at 25°C
Myclobutanil	$C_{15}H_{17}ClN_4$	288.8	142	0.213 mPa at 25°C	$4.33 \cdot 10^{-4}$ Pa \cdot m 3 /mol	2.94 at 25°C pH 7-8
Chlorothalonil	$C_8Cl_4N_2$	265.9	0.81	0.076	$2.5 \cdot 10^{-2}$ Pa \cdot m 3 /mol at 25°C	2.92 at 25°C
Tebuconazole	$C_{16}H_{22}ClN_3O$	307.8	36	$1.7 \cdot 10^{-3}$ mPa at 20°C (OECD 104)	$1 \cdot 10^{-5}$ Pa \cdot m 3 /mol at 20°C	3.7 at 20°C
Chlorpyrifos-methyl	$C_7H_7Cl_3NO_3PS$	322.5	3	3.35 mPa at 25°C	0.372 Pa \cdot m 3 /mol	4.24
Bifenthrin	$C_{23}H_{22}ClF_3O_2$	422.9	<1 μg/L	0.024 mPa at 25°C	$1.02 \cdot 10^2$ Pa \cdot m 3 /mol	>6
α-cypermethrin	$C_{22}H_{19}Cl_2NO_3$	416.3	0.67 μg/L pH 4 3.97 μg/L pH 7	$2.3 \cdot 10^{-2}$ mPa at 20°C	$6.9 \cdot 10^{-2}$ Pa \cdot m 3 /mol	6.94 pH 7

			4.54 µg/L pH 9 all at 20°C			
λ-cyhalothrin	C ₂₃ H ₁₉ ClF ₃ NO ₃	449.9	5*10 ⁻³	0.2 µPa at 20°C	0.02 Pa*m ³ /mol la 20°C	7 la 20°C
Deltamethrin	C ₂₂ H ₁₉ Br ₂ NO ₃	505.2	0.0002 mg/L at pH 7.5	1.24*10 ⁻⁵ mPa	3.13 *10 ⁻² Pa*m ³ /mol at 25°C	4.6 at 25°C pH 7.6
Propargite	C ₁₉ H ₂₆ O ₄ S	350.5	0.215	0.04 la 25°C	6.4*10 ⁻² Pa*m ³ /mol	5.70

Dissipation behavior of pesticides in apples

After application of treatments, it is considered that pesticides suffer degradation in environmental compartments (e.g. soil above ground, soil layer, root-soil layer) and vegetation compartments (e.g. land and fruit deposits, leaves, fruits, stem and root thickness) (Fantke *et al.*, 2011). Photochemical oxidation, photolysis, hydrolysis and metabolism driven processes could contribute to the overall pesticides degradation. The rate of degradation of pesticides increases with temperature, soil organic matter content and pH; a higher temperature may favor both microbial decomposition and chemical decomposition. According to literature, the kinetics of pesticide degradation is a first-order reaction (Vanclouster *et al.*, 2000). In this paper, the influences of the aforementioned factors on the rate of degradation of pesticides in apples were not considered separately being incorporated into the kinetic parameters calculated according to the specificity of the kinetic model considered. In the case of most pesticides, the dissipation behavior didn't follow the 1st-order kinetics as is often highlighted in the literature. The correlation coefficients which indicate the best fit, from the six kinetic models applied, are included in tab. 3 for single recommended dose treatments and in tab. 4 for double dose treatments. The half-lives are included in tab. 5 and tab. 6.

Considering the single recommended dose treatments, deltamethrin is the only pesticide which follows the 1st-order kinetic model having a correlation coefficient of 0.96 (tab. 3). From the regression equation, the half-life of deltamethrin in apples for BBCH 76-79 stage is of 0.21 d. Pesticides α-cypermethrin, chlorpyrifos-methyl and bifenthrin follow the 1.5th-order kinetic model with correlation coefficients between 0.97 and 0.99. The corresponding $t_{1/2}$ of these pesticides are 5.25 d, 2.57 d and 10.54 d, respectively (tab. 5). The dissipation of chlorotalonil, folpet, captan and triadimenol applied in recommended doses is best described by the 2nd-order kinetic model ($R^2 > 0.97$), while the corresponding $t_{1/2}$ values are 0.21 d, 20.76 d, 5.41 d and 0.76 d, respectively. The dissipation of miclobutanil follows the RF-1st-order kinetic model ($R^2 > 0.81$) and its half-life in apples is of 74.9 d. For tebuconazole, the concentration variation is best described by RF-1.5th-order kinetic model ($R^2 > 0.98$), while its resulted $t_{1/2}$ in apples is of 5.61 d. Propargite and λ-

cyhalothrin behaviour in apples is best fitted by RF-2nd-order kinetic model ($R^2 > 0.98$). The corresponding half-lives are 0.01 d for propargite and 1.36 d for λ -cyhalothrin.

Table 3

The correlation coefficients determined from kinetic modeling applied for dissipation of pesticides applied in single recommended dose treatments in apples

Pesticide	R^2					
	1 st -order	1.5 th -order	2 nd -order	RF-1 st -order	RF-1.5 th -order	RF-2 nd -order
Chlorothalonil	0.79	0.92	0.97	0.93	0.95	0.90
Propargite	0.75	0.82	0.88	0.89	0.92	0.93
Folpet	0.82	0.95	0.98	0.95	0.96	0.90
Tebuconazole	0.83	0.91	0.96	0.96	0.98	0.98
Captan	0.83	0.98	0.99	0.97	0.97	0.88
Triadimenol	0.81	0.98	0.98	0.95	0.95	0.84
Deltamethrin	0.96	0.75	0.57	0.87	0.58	0.39
α -cypermethrin	0.83	1.00	0.97	0.97	0.96	0.83
λ -cyhalothrin	0.40	0.59	0.74	0.66	0.82	0.91
Chlorpyrifos-methyl	0.79	0.97	0.97	0.90	0.92	0.82
Bifenthrin	0.83	1.00	0.97	0.97	0.96	0.83
Myclobutanil	0.68	0.74	0.80	0.81	0.81	0.81

Table 4

The correlation coefficients determined from kinetic modeling applied for dissipation of pesticides applied in double dose treatments in apples

Pesticide	R^2					
	1 st -order	1.5 th -order	2 nd -order	RF-1 st -order	RF-1.5 th -order	RF-2 nd -order
Chlorothalonil	0.84	0.98	0.99	0.98	0.98	0.89
Propargite	0.65	0.73	0.79	0.85	0.89	0.91
Folpet	0.82	0.93	0.98	0.94	0.95	0.91
Tebuconazole	0.87	0.94	0.98	0.98	0.99	0.98
Captan	0.82	0.96	0.99	0.96	0.98	0.92
Triadimenol	0.80	0.95	0.98	0.93	0.95	0.88
Deltamethrin	0.86	0.99	0.95	0.95	0.90	0.77
α -cypermethrin	0.63	0.78	0.88	0.84	0.92	0.94
λ -cyhalothrin	0.66	0.79	0.88	0.85	0.90	0.91
Chlorpyrifos-methyl	0.65	0.81	0.91	0.84	0.90	0.90
Bifenthrin	0.88	0.99	0.98	0.98	0.96	0.86
Myclobutanil	0.87	0.94	0.96	0.85	0.85	0.82

In the case of double dose treatments with pesticides applied in apples, the kinetic models applied accurately describe the dissipation behaviour of pesticide residues. Thus, the 1.5th-order kinetic model describes the dissipation of deltamethrin and bifenthrin with correlation coefficients, $R^2 > 0.98$. The 2nd-order

kinetic model describes the dissipation of chlorothalonil ($R^2 > 0.99$), folpet ($R^2 > 0.97$), captan ($R^2 > 0.99$), triadimenol ($R^2 > 0.98$), chlorpyrifos-methyl ($R^2 > 0.90$) and myclobutanil ($R^2 > 0.95$), while the RF-1.5th-order model accurately fits the dissipation of tebuconazole in apples ($R^2 > 0.99$). The dissipation of propargite, α -cypermethrin and λ -cyhalothrin pesticides is very well described by the RF-2nd-order kinetic model with correlation coefficients higher than 0.91 in both cases (tab. 4). The corresponding half-lives of pesticides applied in double dose treatments in apples range from 1.51 d to 17.91 d (tab. 6).

Table 5

Linear regression equations and half-lives of pesticides determined from the best fitting model considering single recommended doses treatments of pesticides in apples

Pesticide	Linear regression system	$t_{1/2}$ [d]	$k_{deg} = \ln 2/t_{1/2}$ [d ⁻¹]
Chlorothalonil	$y = 0.0048 + 0.0228 x$	0.21	3.30
Propargite	$y = 0.0623 + 0.0533 x$	1.36	0.50
Folpet*	$y = 0.8156 - 0.0145 x$	20.76	0.03
Tebuconazole	$y = 0.4770 + 0.0834 x$	5.61	0.12
Captan*	$y = -0.0556 + 0.0426 x$	5.41	0.12
Triadimenol*	$y = -0.3953 - 0.0197 x$	0.76	0.91
Deltamethrin	$y = -0.0446 + 0.1181 x$	6.74	0.10
α -cypermethrin	$y = 1.2489 + 0.0984 x$	5.25	0.13
λ -cyhalothrin	$y = 0.2206 + 1.8725 x$	0.01	69.32
Chlorpyrifos-methyl	$y = 0.6541 + 0.1054 x$	2.57	0.26
Bifenthrin	$y = -0.4709 - 0.0185 x$	10.54	0.06
Myclobutanil	$y = 0.2838 - 0.1634 x$	74.90	0.01

*calculated from the 1st-order kinetic model

Table 6

Linear regression equations and half-lives of pesticides determined from the best fitting model considering single recommended doses treatments of pesticides in apples

Pesticide	Linear regression system	$t_{1/2}$ [d]	$k_{deg} = \ln 2/t_{1/2}$ [d ⁻¹]
Chlorothalonil*	$y = 1.1931 - 0.0140 x$	21.50	0.03
Propargite	$y = 0.0860 + 0.0293 x$	8.61	0.08
Folpet	$y = 0.0617 + 0.0109 x$	5.66	0.12
Tebuconazole	$y = 0.4269 + 0.0535 x$	10.92	0.06
Captan	$y = 0.0556 + 0.0170 x$	3.27	0.21
Triadimenol*	$y = -0.1547 - 0.0168 x$	17.91	0.03
Deltamethrin	$y = 0.5459 + 0.1044 x$	2.16	0.32
α -cypermethrin	$y = -2.1523 + 1.7470 x$	1.51	0.45
λ -cyhalothrin	$y = -2.6001 + 1.7828 x$	2.12	0.32
Chlorpyrifos-methyl	$y = 0.2618 + 0.2289 x$	1.14	0.60
Bifenthrin	$y = 0.9076 + 0.0310 x$	12.12	0.05
Myclobutanil*	$y = 0.1153 - 0.0134 x$	2.61	0.26

*calculated from the 1st-order kinetic model

CONCLUSIONS

Modeling pesticide residues in apples was performed considering six well-known kinetic models. For most pesticides, the dissipation didn't follow the 1st-order kinetic model, as is otherwise often emphasized in literature. Taking into account this result, we considered applying other kinetic models and we found that these models fit well the experimental data, with adequate values of correlation coefficients, R^2 .

The half-lives, $t_{1/2}$ resulted from the linear regression equations considering single recommended dose treatments are between 0.01 days (for λ -cyhalothrin) and 74.90 days (for myclobutanil). Regarding double dose treatments, the half-life values of pesticides ranged between 1.51 days and 17.91 days. Understanding the degradation of pesticides in relation to other factors and evaluation of pesticide residues is very important not only for a correct estimation of food risks, but also to optimize pesticide application techniques in order to improve pesticides monitoring programs.

***Acknowledgments:** This work was supported by a grant of the Romanian National Authority for Scientific Research and Innovation, CNCS/CCCDI - UEFISCDI, project number PN-III-P2-2.1-PED-2016-1662, within PNCDI III.*

REFERENCES

1. Cozma P., Apostol L.C., Hlihor R.M., Simion I.M., Gavrilescu M., 2017 -Overview of human health hazards posed by pesticides in plant products. E-Health and Bioengineering Conference (EHB), p. 293-296.
2. Dietary Guidelines, 2005 -Dietary Guidelines for Americans 2005. U.S. Department of Health and Human Services, U.S. Department of Agriculture, On line at: <http://www.health.gov/dietaryguidelines/dga2005/document/pdf/dga2005.pdf>.
3. Fantke P., Charles R., de Alencastro K.F., Friedrich R., Jolliet O., 2011 -Plant uptake of pesticides and human health: Dynamic modeling of residues in wheat and ingestion intake. Chemosphere, 85, p. 1639-1647.
4. Fantke P., Gillespie B.W., Juraske R., Jolliet O., 2014 -Estimating half-lives for pesticide dissipation from plants. Environmental Science & Technology, 48, p. 8588-8602.
5. Fantke P., Juraske R., 2013 - Variability of pesticide dissipation half-lives in plants. Environmental Science & Technology, 47, p. 3548-3562.
6. Hill A.R.C., Reynolds S.L., 2002 -Unit-to-unit variability of pesticide residues in fruit and vegetables. Food Additives and Contaminants, 19, p. 733-747.
7. Hlihor R.M., Pogăcean M.O., Simion I.M., Cozma P., Apostol L.C., Gavrilescu M., 2016 -Assessment of human health risk of twelve pesticides applied in double dose in an apple orchard. Annals of the Academy of Romanian Scientists Series on Physics and Chemistry, 1, p. 25-35.
8. Juraske R., Francesc C., Ashwin V., Pere M., Assumpció A., 2009 -Uptake and persistence of pesticides in plants: measurements and model estimates for imidacloprid after foliar and soil application. Journal of Hazardous Materials, 165, p. 683-689.

9. Lewis A., Du J., Liu J., Ritchie J.M., Oberley L.W., Cullen J.J., 2005 -*Metastatic progression of pancreatic cancer: changes in antioxidant enzymes and cell growth*. Clinical & Experimental Metastasis, 22, p. 523-532.
10. Pogăcean M.O., Hlihor R.M., Gavrilescu M., 2014 -*Monitoring pesticides degradation in apple fruits and potential effects of residues on human health*. Journal of Environmental Engineering and Landscape Management, 22, p. 171-182.
11. Stoleru V., Munteanu M., Hura C., 2015 - *Organophosphorus pesticide residues in soil and vegetable, through different growing systems*. Environmental Engineering and Management Journal, 14, p. 1465-1473.
12. Stoleru V., Munteanu M., Hura C., Sellitto M., Gavrilescu M., 2016 -*Organochlorine pesticide residues in soil and edible vegetable*. Environmental Engineering and Management Journal, 15, p. 527-535.
13. Timme G., Frehse H., 1980 -*Statistical interpretation and graphic representation of the degradational behaviour of pesticide residues I*. Pflanzenschutz - Nachrichten Bayer, 33, p. 47-60.
14. Timme G., Frehse H., Laska V., 1986 -*Statistical interpretation and graphic representation of the degradational behaviour of pesticide residues II*. Pflanzenschutz - Nachrichten Bayer, 39, p. 187-203.
15. Tomlin C.D.S., 2011 -*The pesticide manual, a world compendium*. 15th Edition, CABI Publisher.
16. Tomșa M., Tomșa E., 2003 -*Integrated protection of trees and shrubs in the early millenium*. Mureș Publishing House, Tg. Mures, Romania.
17. Vanclooster M., Ducheyne S., Dust M., Vereecken H., 2000 -*Evaluation of pesticide dynamics of the WAVE-model*. Agricultural Water Management, 44, p. 371-388.
18. Van Klaveren J.D., Boon P.E., 2009 -*Probabilistic risk assessment of dietary exposure to single and multiple pesticide residues or contaminants: summary of the work performed within the SAFE FOODS project*. Food and Chemical Toxicology, 47, p. 2879-2882.

THE IMPORTANCE OF THE PRODUCTION OF GRAFTED TOMATO SEEDLINGS

IMPORTANȚA PRODUCERII RĂSADURILOR ALTOITE DE TOMATE

GUȚUL Margareta¹, ILIEV P.
e-mail: gutulmargareta@gmail.com

Abstract. *Grafting tomatoes is considered one of the most important innovations over the last few years. Modernization of plants variety and parent stock is essential, because it brings us closer to the market needs and sustainable agriculture. The aim of the realized experience was to evaluate phenological phases of tomato plants, the productivity and the quality of the fruit under the grafting method (Beril F1, Abelus F1, Lilos F1 and Maxifort F1 rootstocks, Big Power F1). In this experience were assessed the following characteristics of the phytometric indices: the number of leaves, the diameter of the stem, the height of the plant up to the first bunch, in terms of fruit productivity and quality, or the harvest kg / plant, harvest m²/kg, standard fruit per plot, nonstandard fruit rate (%), cracked fruit rate (%).*

Key words: scion, rootstock, grafting, yield, graft vigor

Rezumat. *Altoirea tomatelor este considerată una dintre cele mai importante inovații din ultimii ani. Inovația soiului și portaltoiului este foarte importantă, ne aduce mai aproape de nevoile pieței și agriculturii durabile. Obiectivul acestei lucrări a fost evaluarea fazelor fenologice a plantelor de tomate, productivitatea și calitatea fructelor în funcție de metoda de altoire (altoi Beril F1, Abellus F1, Lilos F1 și portaltoi Maxifort F1, Big Power F1). Au fost evaluate următoarele caracteristici ai indicilor fitometrici: numărul de frunze, diametrul tulpinii, înălțimea plantei până la prima ciorchină, din punct de vedere a productivității și calității fructelor s-au urmărit recolta kg/plantă, recolta m²/kg, precum și indicii numărul mediu de fructe standard pe parcelă, rata fructelor nestandard (%), rata fructelor crăpate (%).*

Cuvinte cheie: altoi, altoire, hibridi, portaltoi, randament

INTRODUCTION

Due to the considerable global concern about the state of the *environment*, the issue of the development of sustainable agriculture is raised in increasing frequency. It presents model solutions for present and future agricultural practice, capitalizing different categories of agricultural land that guarantee food security and environmental protection.

Because of the rapid evolution of technical, economic and regulatory problems in the field of sustainable agriculture, modern horticulture is highly focused on rootstocks. Among the main factors justifying the use of tomato grafting technology is the reduction of the use of chemical substances for soil

¹Agrarian State University of Moldova, Chișinău, Republic of Moldova

disinfection, and the need to limit the growing pressure of biotic and abiotic factors on the soil. Grafting technology has opened up prospects for a higher production of safer and more qualitative tomatoes.

Tomato grafting is considered one of the most important innovations in recent years. The innovation of sorts and rootstocks is very important, and brings us closer to the needs of the market and sustainable agriculture. Everything must be integrated into a supply chain concept in order to provide practical help to farmers who have to face the environmental challenges of the future till 2020 (Abdelmageed and Gruda, 2009).

One of the most popular organic summer vegetable crops in hothouses is tomato. If in winter, the demand for tomatoes is mostly covered by the producers in Mediterranean countries, during summer, this vegetable can also be profitable in Central European countries in the conditions of adequate production technology. Organic tomatoes must satisfy consumers through their high quality and good taste, and thus to justify the higher price compared to the common produce.

"The world population is growing and the demand for food increases. There were 7 billion people in 2011, and in 2050 there will be 9 billion people, which means that, if in 2011 each hectare was used to feed more than 4 people, in 2050 the same surface will be used to feed more than 6 people. For this reason, we need more efficiency. Technology can help us. One element that contributes to the increase of the economic efficiency of land is the rootstock" (Abdelmageed and Gruda, 2009).

Today the world market needs strong and stable crops during a stress period. Grafting can help to achieve this object, because it tends to improve the quality of fruit, increases their resistance to biotic and abiotic stress, and their flowering ability. It also ensures a better balance of the plant. A rootstock is like an engine which knows that it is necessary to use the substances in the soil. But we have to rely on objective measurements, which provide for better planning and evaluation.

When developing grafting technologies, a special emphasis has been placed on the compatibility with rustic lines that have a well developed root system able to explore deeper layers of soil.

Grafting is a technique that combines two plants or parts of plants in order to make them grow together. This will allow us to combine plants that are strong and disease-resistant with those that are able to produce good fruit and beautiful flowers (Bogdan, 2012; Gavriț and Ghidaspov; Lorenzo, 2015; Morra *et al.*, 1997; Roșca V., 2009; Savvas *et al.*, 2011; Schwarz *et al.*, 2013; Sanchez *et al.*, 2012; Verevkina).

MATERIAL AND METHOD

According to the objectives pursued in the research which deals with tomato grafting, some experiments were performed to study the growth and productivity of tomatoes in protected areas according to the grafting method and the combination a

scion and a rootstock. The study subject was based on the analysis of the importance of the production of grafted seedlings. Three tomato hybrids have been chosen – Abellus F₁, Beril F₁ and Lillos F₁ – registered for greenhouse cultivation, which had to be used as scions, and two hybrids – Maxifort F₁ and Big Power F₁ – recommend as rootstocks.

BigPower RZ F1 is intended for the cultivation of tomatoes that promote a uniform fructification. It is suitable for tomatoes with undetermined growth as well as determined growth. Due to its good vegetative / productive balance, it leads to superior quality fructification without changing the gloss and color of the fruit. It is salinity resistant and can be used throughout the year.

Maxifort F 1 is a rootstock intended primarily for substrate crops, which imparts a great deal of force to scions. It provides a balance of growth that leads to high yields even to vegetative grafted plants.

The most suitable method of grafting was studied in association with the affinity between the scion and the rootstock, establishing the most suitable combination for the production of tomatoes in protected areas, and determining the productivity and quality according to the combination a rootstock and a scion.

The experiments were carried out at the company "Ecoplantera" Ltd. which specializes in the production of flower and vegetable seedlings, in the year 2012. The sowing was made on 25 February of that year in pallets 216 cells each. The seeds of Abellus F₁, Beril F₁ and Lillos F₁ tomato hybrids were dredged and planted on the same day as the MaxifortF1 and BigPowerF1 rootstocks. The grafting was performed by copulation and splitting after thirty days after sowing, when the plants reached the stage of two true leaves and the diameter of the collar was of 2.5 mm.

RESULTS AND DISCUSSIONS

Vegetable grafting is done with the aim of increasing production and improving the quality of the prevention and control of diseases and pests. It is also an ideal solution to get production at least 25 % higher than untreated plants (control plants).

Similar results of grafting influence on plant development have been obtained during other studies on tomatoes (Savvas *et al.*, 2011).

According to the authors Perry (1982) and Lee (1994), climatic conditions, including light, temperature and rootstock, can have an influence on the yield and chemical composition as well as on the quality of fruit.

In this paper, the results indicate that a higher overall yield was obtained in the grafted plants as compared to the control plants. The fructification capacity was statistically significantly different from the grafted plants.

The examination of the grafting effects on tomato quality and production capacity was carried out during the year 2012, taking two factors as the basis (tab.1.):

1. the growth, development and productivity of tomatoes in protected areas **according to the grafting method;**
2. the growth, development of the productivity of tomatoes in protected areas **according to the combination a scion and a rootstock.**

Table 1

The phenological phases of tomato plants according to the grafting method, 2012
(Beril F1 scion; Maxfort rootstock), days after sowing

Variant	Date of sowing	Mass sprout	Appearance of the first true leaf	The beginning of the bloom in the first breed	The beginning of the rebirth	The last harvest
Ungrafted plants (control)	25.02.12	7	13	63	116	16.11
Grafted by splitting	25.02.12	5	11	66	116	16.11
Grafted by copulation	25.02.12	5	11	66	116	16.11

Both the rootstock and the scion were sown on the same day in order for the diameter of the stems to be of the same size at the time of grafting. The index of the appearance of the first true leaf revealed a few days less in the rootstock plants, which was influenced by the biological particularities of the rootstock, which showed a higher growth force compared to the vigor of the scion.

The optimal grafting phenotype is when the plants have from two to four leaflets and are of equal diameter. If the diameters can't be grown to have the same size, then only the diameter of the rootstock seedling is allowed to have a larger diameter than the scion seedling, and not vice versa. The rootstock seedling will be cut at a point above the cotyledons and not below the first two true leaves.



a



b

Fig.1 Grafting through the method of: a) splitting; b) copulation at an angle of 45°.

Using the results of the performed researches, the productivity of tomatoes can be analyzed depending on the method of grafting and compared with the control plants (fig.1.).

Tomato productivity according to grafting method, 2012 (Beril F1 scion, Maxfort rootstock), kg/m²

Variant	harvest, kg/plant	harvest per m ² /kg
Ungrafted plants (control)	8.400	21.0
Grafted by splitting	12.960	32.4
Grafted by copulation	13.248	33.12

Based on the data on tomato productivity according to the grafting method, the results differed significantly from the plants in the control group. When the splitting grafting was used, the plant productivity was 35.2 % higher (32.3 kg/m²) than in the control group. When the grafting method by copulation was used, the grafted plants exceeded the plants in the control group by 36.6 % (tab.2).

The obtained results showed that grafting can greatly increase plant production. The grafting method does not influence productivity.

The grafting effect increased the rate of the standard fruit yield. The grafting also influenced the weight of the fruit and the vigor of the plant (fig.2.).

Phytometric indices of tomato plants according to the combination scion and a rootstock, 2012 (Beril F1, Abellus F1 and Lilos F1 scions; Maxifort F1 and Big PowerF1 rootstocks), after 90 days after planting

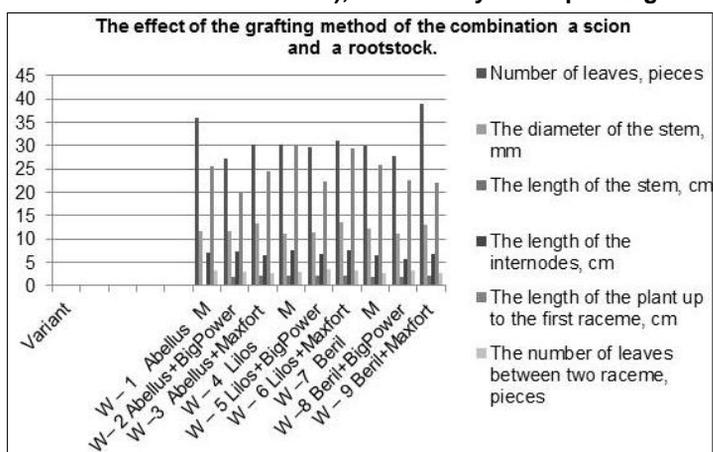


Fig.2 The effect of the grafting method of the combination a scion and a rootstock

When the phytometric indices of tomato plants were measured according to the scion and rootstock combination, differences in biometric indices were observed during the growth period. That happened because they had been positively influenced by the vigorous growth of the rootstock which was able to explore the deeper layers of the soil and fed the plant efficiently because it keeps water and absorbs the soil elements better than the proper root of the plant. Grafted plants have a higher force, which leads to increased production. Grafting

helps to get rid of particularly dangerous diseases and pests such as nematode, which damages tomato crops.

Grated tomatoes have a higher force, a higher production and better fruit quality. Due to its high resistance to diseases and pests, the environment is more protected from chemical treatments. Respectively, the production is environmentally friendly, and it is not very affected.

CONCLUSIONS

In order to specify the results obtained in the experiments, the influence of the biological particularities of the Maxifort F1 and Bif Power F1 rootstocks must be highlighted, which have shown a higher growth and developmental force on the grafted tomato plants, that have resulted in qualitative and quantitative production increases.

As a result of the study and analysis of the biometric indices of the aerial part of the plant, it was concluded that the most optimal results are in grafted variants.

REFERENCES

1. **Abdelmageed A.H.A., Gruda N., 2009** - *Influence of grafting on growth, development and certain physiological parameters of red under controlled conditions of heat stress.* euro. J. Hort. Sci.74, 16-20.
2. **Bogdan Maria, 2012** - *Avantajele răsădurilor altoite de legume.* Revista Lumea Satului, nr.4, 16-29 februarie <http://www.arhiva.lumeasatului.ro/imprimare2012.php?news2012=123>
3. **Gavriț S.F., Ghidasov N.N.** - *Vlianie privivki Pepino (Solanum muricatum AIT.) na tomat pri vâraivanii*
4. **Lee M., 1994** - *Cultivation of grafted vegetables. I. Current status, grafting methods, and benefits.* HortScience. 29: p. .235-239.
5. **Lorenzo Cricca, 2015** - *Pomodoro, quando il portinnesto fa la differenza.* AgroNotizie-riproduzione riservata. 04.02.2015
6. **Morra L., Correale A., Bilotto M., Restaino F., 1997** – *Valitazione di treportinnesti per il Pomodoro însera. ColtureProtette. XXVI (6): 63-70.*
7. **Roșca V., 2009** - *Tehnologii moderne de producere a răsădurilor de legume.* Chișinău, 144 p.
8. **Savvas D., Savva A., Ntatsi G., Ropokis A., Karapanos I., Krumbein Angelika, Olympios C., 2011** - *Effects of three commercial rootstocks on mineral nutrition, fruit yield, and quality of salinized tomato.* Journal of Plant Nutrition and Soil Science. Vol. 174, Issue 1, pp. 154-162.
9. **Schwarz Dietmar, Oztekin Golgen Bahar, Tuzel Yuksel, 2013** - *Rootstocks can enhance tomato growth and quality characteristics at low potassium supply.* Scientia Horticulturae, Vol. 149, pp. 70-79.
10. **Sanchez-Rpdr E., Leyva R., Constant-Aguilar C., Romero L., Ruiz J.M., 2012** - *Grafting under water stress in tomato cherries: improving yield and fruit quality.* Department of Plant Physiology, Faculty of Sciences, University of Granada, Granada, Spain, 7 september 2012, <https://m.eurekamag.com/research/036/064/>
11. **Verevkina T. L.– Results of application cutting at the tomato in the prolonged rotation** p.UDK635.6/631.541/544. 58-60 .

THE EFFECTS OF THE INDUSTRIAL PROCESSING OF THE TOMATO PASTE AND TOMATO JUICE ON THE C VITAMIN CONTENT

EFECTELE PROCESĂRII INDUSTRIALE A PASTEI DE TOMATE ȘI A SUCULUI DE ROȘII ASUPRA CONȚINUTULUI DE VITAMINA C

GOCAN Tincuța-Marta¹, ANDREICA Ileana¹, POȘTA G².,
RÓZSA Melinda³, RÓZSA S.^{1*}

e-mail: drd.rozsa.sandor@gmail.com

Abstract. Nowadays, C vitamin deficiency is much higher than in the past centuries, primarily due to the explosion of processed foods, frozen foods, fast food foods and those cooked for a long time that cannot provide the body with an intake enough vitamins. We no longer eat fruits, for example, but we consume packaged fruit juices, which, due to pasteurization and preservation, largely lose their vitamins. In the present paper, the content of C vitamin in processed tomatoes at different temperatures and for different periods of time was followed. As the processing temperature increases, there is also an increase in C vitamin loss. Maximum C vitamin loss occurred in 15 minutes of heating at 100 °C, and when the processing temperature drops, the additional C vitamin loss rate becomes smaller.

Key words: tomato, processing, storage, C vitamin.

Rezumat. În zilele noastre, deficitul de vitamina C este mult mai mare decât în secolele trecute, în primul rând datorită exploziei de alimente procesate, înghețate, alimentelor de tip fast-food și a celor gătite pentru foarte mult timp, care nu pot aduce organismului un aport suficient de vitamine. Nu mai mâncăm fructe, spre exemplu, ci consumăm sucuri de fructe ambalate, care datorită pasteurizării și conservării își pierd în mare parte vitaminele. În lucrarea de față s-a urmărit conținutul în vitamina C la tomatele prelucrate la diferite temperaturi și pentru diferite perioade de timp. Pe măsură temperatura de procesare crește, se constată și o creștere a pierderii de vitamina C. Pierderea maximă a vitaminei C a avut loc în 15 minute de încălzire la 100 °C, iar la scăderea temperaturii de procesare, rata suplimentară de pierdere a vitaminei C devine mai mică.

Cuvinte cheie: tomate, procesare, păstrare, vitamina C.

INTRODUCTION

Food safety is one of the most important factor that contributes to the health of the population, to the reduction of the illnesses and, implicitly, to the costs of the health system, as well as to the improvement of the quality of life in our country.

¹ University of Agricultural Sciences and Veterinary Medicine, Cluj-Napoca, România

² SC CIUPERCĂRIA SRL, Aghireșu-Fabrici, Cluj County, România

³ Banat University of Agricultural Sciences and Veterinary Medicine, Timișoara, România

C vitamin is very essential for the growth and maintenance of the human body. It is necessary for the normal formation of protein collagen, which is an important constituent of skin and connective tissue. The deficiency of C vitamin causes widespread connective tissue abnormalities (Srivastava and Verma, 1991). They include swelling of the gums, which become soft, spongy and bluish red in colour.

Lesser important sources are sprouts during germination of seeds, cauliflowers, tomatoes and potatoes (Chatwal, 1988).

Oxidation reactions are essential for life, but they produce reactive oxygen species that can cause significant damage to cells. Therefore, complex protection systems have evolved based on antioxidants that help to eliminate these dangerous molecules (Ropciuc *et al.*, 2011).

Oxidative stress plays a role in many human diseases, but its impact can be reduced by the consumption of dietary antioxidants such as ascorbic acid (AsA), which is also known as C vitamin (Giovannucci, 1999).

As well as providing health benefits to humans, higher AsA levels improve both biotic and abiotic stress tolerance in plants (Kuzniak and Sklodowska, 2005) and enhance postharvest fruit quality. The content of C vitamin may vary, under conditions of high humidity and low temperature (Chrubasik *et al.*, 2006).

High C vitamin content (300-4000 mg100g⁻¹) of fruit of rosehip and other substances ensure the normal functioning of the endocrine glands, brain, heart and liver. Ascorbic acid has an important role in the absorption of iron in the body in the biosynthesis of collagen. Due to the presence of C vitamin, fruit of rose hips traditionally are used as a tea in cold weather to prevent and fight fevers and colds (Sies, 1997).

Tomato (*Lycopersicon esculentum*) is one of the most consumed vegetables (botanically a fruit) per capita in the world, second only to the potato. Owing to the high level of consumption, tomatoes are a significant source of C vitamin (19 mg 100 g⁻¹ fresh weight (FW)), A vitamin (623 IU 100 g⁻¹ FW), carotenoids (USDA/NCC) and flavonoids in the diet.

The main flavonoids found in tomatoes are quercetin and kaempferol. Quercetin predominates, with levels ranging from 0.03 to 2.76 mg 100 g⁻¹ in fresh tomatoes and from 0.50 to 4.12 mg 100 g⁻¹ in processed tomato products (EUNMI *et al.*, 2011).

MATERIAL AND METHOD

Total soluble solids (TSS) and were determined using the refractometric method, with an Abbe refractometer and corrected to the equivalent reading at 20 °C (Lazăr, 2015). Determination of the C vitamin in fresh tomatoes, tomato paste and tomato juices by this method compared favourably with similar analyses using the standard indophenol titration method (Lazăr, 2015). In the experiment, tomato juices were heated to 60 °C, 80 °C, 90 °C and 100 °C for different periods of time: 15', 30' and 45'. Tomato paste was purchased from the supermarket. Because it was desired to monitor the amount of C vitamin after applying the treatments, depending on time, these were only followed for tomato juice which was produced in the laboratory.

RESULTS AND DISCUSSION

The results for the soluble dry substance and C vitamin content were determined immediately after harvesting the tomato fruits, after obtaining the juice for tomato juice and immediately upon opening the container for tomato paste. It can be seen that the C vitamin content of tomato juice decreases quite a lot, because much of it remains in the fruit's skin. In case of tomato paste, following processing, C vitamin content is corrected with other ingredients which are added to in the production cycle (tab.1).

Table 1

Content of dry matter and C vitamin, in tomato products

Sample	Dry matter %Bx	C vitamin
Fresh tomato	4.9 ± 0.3	19.76 ± 0.27b
Tomato Juice	4.8 ± 0.1	12.59 ± 0.41c
Tomato paste	17.5 ± 0.2	27.54 ± 1.81a

In table 2 is presented the effect of heating for tomato juice at 60 °C for different periods, the retention and the loss of ascorbic acid. The highest losses in C vitamin are recorded at 45 minutes. The smallest losses are within 15 minutes (7.5 mg 100ml⁻¹).

Table 2

Effect oftomato juices heating to 60 °C for different periods of time on the retention/loss of ascorbic acid

Time of heating (min)	C vitamin mg 100 ml ⁻¹	Retentions of C vitamin mg 100 ml ⁻¹	Loss of C vitamin mg 100 ml ⁻¹
0	15.6	100	0
15 [□]	14.4	92.5	7.5
30 [□]	13.4	86.3	13.7
45 [□]	12.3	79.4	20.6

But in the later stage of heating, steaming atmosphere over the surface of tomato juice and the absence of dissolved oxygen, reduce the loss of ascorbic acid. As compared to other fruits, maximum loss of ascorbic acid has been found in later part of the heating (tab.3).

Table 3

Effect oftomato juices heating to 80 °C for different periods of time on the retention/loss of ascorbic acid

Time of heating (min)	C vitamin mg 100 ml ⁻¹	Retentions of C vitamin mg 100 ml ⁻¹	Loss of C vitamin mg 100 ml ⁻¹
0	15.6	100	0
15 [□]	11.8	75.9	24.1
30 [□]	11.3	72.5	27.5
45 [□]	10.7	69.0	31.0

Retention of C vitamin per 100 ml of juice, recorded the best value at 15 minutes time (tab. 4). C vitamin decrease with the increase of boiling time.

Effect of tomato juices heating to 90 °C for different periods of time on the retention/loss of ascorbic acid

Time of heating (min)	C vitamin mg 100 ml ⁻¹	Retentions of C vitamin mg 100 ml ⁻¹	Loss of C vitamin mg 100 ml ⁻¹
0	15.6	100	0
15	9.9	63.5	36.5
30	9.4	60.7	39.3
45	8.7	55.9	44.1

It can be seen that the initial amount of C vitamin (15.6 mg 100 ml⁻¹) at 100 °C temperature, and 45 minutes of boiling, the C vitamin contents decrease approximately with 10 mg 100 ml⁻¹ (tab. 5). For these samples, the determined retention of C vitamin was 37.9 mg 100 ml⁻¹.

Table 5

Effect of tomato juices heating to 100 °C for different periods of time on the retention/loss of ascorbic acid

Time of heating (min)	C vitamin mg 100 ml ⁻¹	Retentions of C vitamin mg 100 ml ⁻¹	Loss of C vitamin mg 100 ml ⁻¹
0	15.6	100	0
15 [□]	8.2	53.1	46.9
30 [□]	6.5	42.1	37.9
45 [□]	5.9	37.9	62.1

CONCLUSIONS

1. As the heating is increased, the loss of C vitamin also increases.
2. The maximum loss of C vitamin has been takes place in the first 15 minute of heating, regardless of the temperature at which it heats up, then further rate of C vitamin loss becomes lesser.

REFERENCES

1. Chatwal R.G., 1988 - *Organic Chemistry of Natural Products*, vol 1 Himalaya Publishing House, New Delhi, p. 591-592.
2. Chrubasik C., Duke R.K., Chrubasik S., 2006 - *The evidence for clinical efficacy of rose Hip and seed: a systematic review*, *Phytother Res.*
3. Eunmi Koh, Suthawan Charoenprasert, Alyson Mitchell, 2011 - *Effects of industrial tomato paste processing on ascorbic acid, flavonoids and carotenoids and their stability over one-year storage*, *Journal of Science Food Agriculture* (2011) wileyonlinelibrary.com/jfsa
4. Giovannucci E., 1999 - *Nutritional factors in human cancers*. *Advances in Experimental Medicine and Biology.*, 472: 29-42.
5. Kuzniak E., Skłodowska M., 2005 - *Fungal pathogen-induced changes in the anti-oxidant systems of leaf peroxisomes from infected tomato plants*. *Planta.*, 222: 192-200. 10.1007/s00425-005-1514-8.
6. Lazăr V., 2015 - *Tehnologia produselor horticole procesarea legumelor și fructelor*, Editura Academică Pres, Cluj-Napoca;
7. Ropciuc S., Ion Tănase I., Crețescu I., Velicevici G., 2011 - *The variation of the acid ascorbic content in *Cynosbatifructus* influenced by stationary factors*, *Food and Environment Safety*.
8. Sies H., 1997 - *Oxidative stress: oxidants and antioxidants*. *Experimental Physiology*, 82: 291-5.
9. Srivastava V.K., Verma V.P., 1991 - *Introductory Biological Chemistry*, In Edition, RatanPrakashan Mandir, Agra. pp 111-112.

PRELIMINARY STUDIES REGARDING THE IMPROVEMENT OF TOMATO QUALITY THROUGH TECHNOLOGICAL MEASURES

STUDII PRELIMINARE PRIVIND ÎMBUNĂTĂȚIREA CALITĂȚII FRUCTELOR DE TOMATE PRIN DIFERITE MĂSURI TEHNOLOGICE

*INCULET Simona-Carmen*¹, *MUNTEANU N.*, *TELIBAN G.C.*, *STOLERU V.**

e-mail: vstoleru@uaiasi.ro

***Abstract.** The tomatoes represent the most largely spread vegetable species, being valued across all continents and cultivated over the period of the entire year. The tomato nutritional quality largely depends on the genetic potential of the cultivar, the biotope, as well as the fertilization system that was used. The main aim of these studies represents the analysis of the effect of using different technological means (cultivar, fertilization, irrigation) in order to obtain the tomato fruits with a high nutritional content.*

Key words: tomato, quality, fertilizers, irrigation regime

***Rezumat.** Tomatele reprezintă specia legumicolă cu cea mai largă răspândire dintre toate speciile legumicole, fiind apreciată pe toate continentele și pe durata întregului an. Calitatea nutritivă a fructelor de tomate depinde în mare măsură de potențialul genetic al cultivarului, de biotop dar și de sistemul de fertilizare utilizat. Scopul principal al acestor studii îl reprezintă analiza efectului utilizării diferitelor mijloace tehnologice (cultivar, fertilizare, irigare) în vederea obținerii fructelor de tomate cu conținut ridicat în principii nutritive.*

Cuvinte cheie: tomate, calitate nutritivă, fertilizanti, regim irigare

INTRODUCTION

In Romania, tomatoes occupy the highest share of vegetable cultures, growing annually on about 60,000 hectares, approximately 20-25% of the vegetable area in the open field, and 60-80% of that in protected crops by some authors. The efficiency of crop production can be achieved by: mechanized planting of seedlings, the use of cultivation of high productivity and resistance to diseases, obtaining the earliest harvests by using fructification biostimulators, harnessing production with the highest prices obtained as a result of the earliest occurrence of its production and superior quality (Munteanu, 2003; Indrea *et al.*, 2007; Dumitrescu *et al.*, 1998; Voican and Lacatus, 1998).

MATERIAL AND METHODS

The preliminary studies and researches were carried out on the basis of documentary and bibliography study from international and national literature, aimed

¹University of Agricultural Sciences and Veterinary Medicine Iași, Romania

at: choosing the assortment of tomatoes for protected area, studies and research on the use of fertilization and irrigation regim and studies on nutritional value and antioxidant activity of tomatoes.

RESULTS AND DISCUSSION

Studies and research on the use of fertilization regim

The tomato crop in the tunnel uses very intensive soil resources. For a production of 12 kg/m², tomato fruits hold a weight of 74.3% of the fresh mass, 51.1% of N assimilated, 60.9 of K, 53% of P, 31.1% of Ca and 23.4% of Mg. assimilated by the plant. At the same time, at a production of 12 kg fruit/plant and at a fresh table of 19.1% kg/m², tomatoes, extract from soil 158,7 g/m² mineral substances of which: 39 g N/m², 69 g K/m², 4.8 g P/m², 45g Ca/m² and 5.9 g Mg/m².

Instead, at a production of 6 kg/m², corresponds to a fresh mass of 9.4% kg/m², and the sampling of mineral elements amounts to 80.6 g/m², mineral substances of which: 19g N/m², 30g K/m², 2.8 g P/m², 25gCa/m² and 3.8 g Mg/m² (Voican and Lăcătuș, 1998).

In conclusion, we can say that toamatele have a specific consumption per tonne of product, which is in close correlation with the irrigation factor, the stage of development, the system of culture practiced and the biological production (tab. 1).

Table 1

The need for NPK in protected area for tomatoes crop during the vegetation period (by various authors)

Stage development	Ration N:P:K	
	Tomatoes in greenhouse	Tomatoes in tunnel
Planting	1: 0.4 – 0.7 : 2.1 – 3.6	1: 0.6 – 1.0 : 1.8 – 2.8
Opening Inflorescence I	1: 0.4 – 0.6 : 2.0 – 3.0	1: 0.5 – 0.7 : 1.6 – 2.5
Opening Inflorescence III	1: 0.3 – 0.6 : 1.8 – 2.5	1: 0.4 – 0.6 : 1.4 – 2.0
Fruit growth	1: 0.3 – 0.5 : 1.7 – 2.0	1: 0.2 – 0.4 : 1.2 – 1.8
Starting the harvest	1: 0.2 – 0.3 : 1.5 – 1.8	1: 0.2 – 0.4 : 1.4 – 2.0
Intense harvesting	1: 0.1 – 0.2 : 1.8 – 2.0	1: 0.1 – 0.2 : 1.6 – 2.2
Decline of culture	1: 0.2 – 0.3 : 1.5 – 1.8	1: 0.2 – 0.4 : 1.2 – 1.5

Ghidia *et al.*, 1980, quoted by Popescu and Popescu (2003) mentions the complexity of the nutrition regime, specifying that it is taken into account in the case of tomatoes of specific consumption which differ according to: cultivation, vegetation phase, culture system and planned production etc. (tab. 2).

According to the ecological directives, the surface of the tunnel can be fertilized with a quantity of maximum 170 kg N a.s./ha/year (Stoleru *et al.*, 2013).

The production of tomatoes cultivated in organic solar systems can be between 7 and 20 kg per m² depending on the system and climate. The quantity of fertilizers shall be oriented according to the value of production and the subsequent delivery capacity of the nutrients in the soil.

Specific consumption of elements on tomato crops in greenhouses and solariums
(by Ghidia *et al.*, 1980, quoted in Popescu, 2003)

Crop system	Evaluated production (kg/m ²)	Specific consumption (g/m ²)				
		N	P	K	Cu	Mg
Greenhouse – cycle	8-10	3.09	0.64	3.36	2.19	0.63
Greenhouse – cycle II	5-7	4.00	0.39	5.23	3.30	0.48
Tunnel	5-7	5.00	0.47	5.73	4.16	0.63

Studies on the nutritional value of tomatoes and their antioxidant activity

Studies on nutritional value and antioxidant activity in tomatoes has been analyzed along the type of many authors (Guil-Guerreroa *et al.*, 2007, Butnariu si Butu, 2014; Munteanu, 2003). Research conducted in Almeria (Spain), on eight cultivation of tomatoes cultivated in the greenhouse (Cherry, Cherry Pera, Daniela near Vida, Lido, Pera, Racimo, Raf, Rambo) showed that the composition of the analyzed tomatoes is similar, in qualitative terms, with the results Existing in the literature (Raffo *et al.*, 2002), with small differences, namely: higher amounts of vitamin C and carotenoids in these varieties of tomatoes than in conventional varieties, the presence or absence of certain carotenoids. All the varieties present in this study showed high amounts of nitrates ranging from 108 mg to and 470 mg in Cherry Rambo and in Racimo (mg/100g fresh weight).

The vitamin C content of the studied cultivation is higher than those mentioned in the literature: Rambo-263 mg, Racimo – 174 mg, Pera – 164 mg, reported at 100 g fresh product. Chang *et al.*, 1977 reported 21 mg/100 g fresh product.

Raffo *et al.* (2002) indicates a low amount of ascorbic acid for cherry tomatoes during maturation, with an average of 12 mg/100 g fresh weight. The values of the micro-elements recorded variations being likely influenced by agronomic practices (artificial substrate).

The following fatty compounds were found in tomatoes: linoleic acid, palmitic acid and oleic acid. Linoleic acid ranged between 61.8% of the total Cherry fatty acids, 61.0% Racimo and 60.4% in the Lido.

In addition to lycopene, tomatoes and tomato products we also meet other carotenoids such as: Violaxantină, Neoxantină, lutein, Zeaxanthin, A-Cryptoxanthin, B-Cryptoxanthin, A-carotene, B-carotene, G-carotene, Z-carotene, neurosporene, Fitoenă, Fitofluenă, Ciclolopen. The oxalic acid content varies between the value of 9.9 for the Daniela Larga Vida variety and 39.0 for the Pera variety (mg/100g fresh product); From a nutritional point of view, the main problem with oxalic acid is its ability to diminish the bioavailability of calcium phytochemical representative preparations identified in tomatoes are Fitoena, Fitofluena, B-carotene, flavonoids, carotenoids, Lycopene, quercetin, polyphenols and kaempferol. Green, unripe leaves, stems and fruits of the tomato plant contain small amounts of toxic alkaloids such as Tomatina and Solanine (Butnariu and Butu, 2014).

Table 3

Chemical and biochemical composition of certain varieties of tomatoes (by Guil-Guerrero et al., 2009)

Cultivar	Humidity %	Protein (g)	Carbohy- drates (g)	Lipids (g)	Fibre (g)	Ash (g)	Energy (kcal)	C Vitamin (mg)	Saponifica- bil oil (g/100g dw)	β- caroten	Lycopene	Oxalic acid	Nitrates
Cherry	95.2±0.8	0.78±0.02	1.27±0.5	0.49±0.05	1.13±0.11	0.90±0.10	12.3±1.3	82±20	9.06±0.17	73±8	360±34	22.4±2.9	470±69
Cherry Pera	92.6±1.3	1.05±0.06	2.18±0.29	0.42±0.06	1.60±0.11	1.41±0.09	16.2±2.3	39±12	3.35±0.13	48±5	28±4	14.6±1.8	215±48
Daniela Larga Vida	96.0±1.0	0.8±0.02	1.26±0.32	0.28±0.06	0.74±0.10	0.75±0.14	10.4±1.8	62±12	5.51±0.20	20±4	129±11	9.9±1.32	154±33
Lido	94.7±0.8	0.75±0.08	1.56±0.23	0.67±0.04	1.10±0.09	1.00±0.11	14.9±2.0	130±25	11.5±0.20	5±2	291±26	14.7±2.8	329±83
Pera	96.0±1.4	0.56±0.03	1.16±0.09	0.26±0.04	0.78±0.15	0.78±0.13	8.9±1.6	164±22	3.89±0.19	4±1	234±24	39.0±1.9	352±41
Racimo	93.3±1.4	0.91±0.07	1.91±0.44	0.20±0.04	1.25±1.14	1.25±0.16	12.6±1.7	174±21	2.60±0.14	15±3	397±43	19.3±2.3	108±11
Raf	93.9±1.5	0.96±0.07	2.04±0.68	0.47±0.06	1.27±0.11	1.14±0.14	15.7±1.9	155±0.10	6.72±0.14	28±4	97±11	18.7±2.6	459±71
Rambo	95.8±0.8	0.55±0.08	1.01±0.61	0.44±0.03	0.99±0.12	0.82±0.18	9.9±1.0	263±22	7.49±0.12	56±7	120±12	11.4±3.0	108±91

Table 4

Content in macro and microelements in some cultivars analyzed by tomatoes (by various authors)

Cultivar s	Na	K	Ca	Mg	P	S	Mn	Fe	Cu	Zn
	mg/100g fresh product									
Cherry 4	4.0±0. +4	301 +16	15.9± 0.6	22.4± 1.9	17.5± 2.8	28.6± 0.4	253± 6	1539± 18	265 +5	351±5 4
Cherry Pera 1	4.9±0. +1	249 +17	11.6± 1.2	13.9± 1.3	27.3± 3.1	33.6± 0.3	197± 11	2015± 62	317 +4	631±4 2
Daniela Larga Vida 3	7.3±0. +3	290 +12	13.1± 1.5	14.1± 0.9	9.9±3. 6	16.7± 0.6	135± 12	2092± 23	45± 8	1730± 62
Lido 5	5.8±0. +5	278 +14	20.1± 0.8	18.5± 1.4	24.7± 2.9	30.5± 0.5	306± 10	1684± 23	232 +8	4520± 31
Pera 2	5.9±0. +2	253 +14	16.3± 0.7	10.8± 0.8	12.4± 2.8	21.3± 0.4	190± 10	3513± 25	392 +8	1104± 35
Racimo 4	4.0±0. +4	319 +16	10.8± 0.6	14.9± 1.4	24.4± 2.0	27.0± 1.0	129± 6	587±2 4	91± 3	357±2 5
Raf 0.5	17.4± +0.5	299 +21	17.8± 0.8	17.8± 1.1	23.4± 1.8	36.8± 0.4	66±1 1	488±4 7	56± 5	155±3 0
Rambo 6	4.1±0. +6	286 +13	14.7± 1.2	19.7± 1.4	7.8±0. 7	25.1± 0.8	144± 17	1445± 43	110 +7	5479± 24

Red tomatoes are the richest sources of lycopene, and the yellow ones in carotene; Lycopene and carotene annihilate free radicals and prevent the formation of carcinogenic metabolism (Butnariu, 2014).

Lycopene and carotene, are provitamins A, which do not degrade by boiling preserved tomato juices, prepared without preservatives, are effective in the vitaminization of the human body during the winter period. The quantity and quality of tomato fruits is much influenced by the irrigation regime.

Under the same conditions of fertilization, a higher content of lycopene and vitamin C resulted from the decrease of irrigation levels – better results were achieved with a 206 mm/year irrigation regimen and a fertilization regimen between 255 and 382.5 kg/ha a.s. NPK. The fruit ity has been improved by high levels of fertilizer and a low amount of water used for irrigation).

Table 5

Results of the application of various fertigation treatments on tomatoes (by Wang *et al.*, 2015)

Treatments	Yield (10 ³ kg/ha)	Water use efficiency (kg/m ³)	Potential for fertilizers (kg/kg)	Soluble substances (%)	Lycopene (mg/kg)	C Vitamin (mg/100g)	Nitrates (mg/kg)
W ₁ F ₁	95.8	34.5	187.9	4.94	33.41	25.07	51.73
W ₁ F ₂	89.9	32.2	235.1	4.86	27.20	22.47	47.43
W ₁ F ₃	78.0	27.6	305.8	4.67	20.43	20.16	37.94
W ₂ F ₁	85.7	37.0	168.0	5.01	45.68	30.45	56.11
W ₂ F ₂	83.0	36.1	217.0	4.87	38.44	28.48	47.15
W ₂ F ₃	76.2	33.2	299.0	4.81	27.14	26.16	40.27
W ₃ F ₁	78.0	45.3	153.0	5.01	54.28	40.31	64.35
W ₃ F ₂	75.9	44.9	198.5	4.92	46.43	36.11	57.08
W ₃ F ₃	71.2	41.7	279.2	4.84	34.93	32.28	45.75

From the quantitative point of view the highest productions were achieved in the situation of using rules of 262 mm/year and a fertilization regimen of 510 kg/ha a.s. NPK.

In conclusion, proper application of treatment (W2F1) can be a good solution for tomatoes cultivated in the studied area.

CONCLUSIONS

The production and quality of tomato fruits is close correlation with the irrigation factor, the stage of development, the system of culture practiced and the biological production

The irrigation of tomatoes shall be carried out whenever necessary so that the moisture in the soil is 50-60%, from planting up to the appearance of fruit and 60-70%, during the fruit setting period. The irrigation rule for the short cycle is approx. 4000 m³/ha, distributed in 10-12 times and approx. 6000 m³/ha, in the long cycle, distributed in 15-20 times.

REFERENCES

1. **Butnariu M., Butu A., 2014** - *Chemical Composition of Vegetables and their Products*. Handbook of Food Chemistry, în *Chemical Composition of Food Commodities*, Springer – Verlag Berlin Heidelberg.
2. **Dumitrescu M., Scurtu I., Stoian L., Costache M., Diță D., Roman T., Lăcătuș V., Rădoi V., Vlad C., Zagrean V., 1998** - *Producerea legumelor*, Institutul de Cercetări pentru Legumicultură și Floricultură, București;
3. **Guil-Guerreroa J.L., Fuentes R.M.M., 2009** - *Nutrient composition activity of eight tomato (*Lycopersicon esculentum*) varieties*. Journal of Food Composition and Analysis.
4. **Guil-Guerreroa J.L., Giménez-Martínez J.J., Torija-Isasa M.E., 1998** - *Mineral Nutrient Composition of Edible Wild Plants*. Journal of Food Composition and Analysis.
5. **Guil-Guerreroa J.L., Torija M.E., Giménez J.J., Rodríguez-García I., Giménez A., 1996** - *Oxalic acid and calcium determination in wild edible plants*. Journal of Agricultural Food Chemistry.
7. **Indrea D., Apahidean S., Apahidean Maria, Mănuțiu D., Sima Rodica, 2007** - *Cultura legumelor*, Ed. Ceres, București;
8. **Munteanu N., 2003** - *Tomatele, ardeii și pătlăgelele vinete*, Ed. Ion Ionescu de la Brad Iași
9. **Munteanu N., Stoleru, V., 2012** - *Bazele tehnologice ale horticulturii ecologice*, Ed. Performantica, Iași;
10. **Popescu V., Popescu A., 2003** - *Cultura tomatelor în câmp și solarii*. Ed. Mast, București
11. **Raffo A., Leonardo C., Fogliano V., Ambrosino P., Salucci M., Gennaro L., Bugianesi R., Giuffrida F., Quaglia G., 2002** - *Nutritional value of cherry tomatoes (*Lycopersicon esculentum* Cv. Naomi F1) harvested at different ripening stages*. Journal of Agricultural and Food Chemistry.
12. **Stoleru V., 2013** - *Managementul sistemelor legumicole ecologice*, Ed. Ion Ionescu de la Brad, Iași
13. **Voican V., Lăcătuș V., 1998** - *Cultura protejată a legumelor în sere și solarii*, Ed. Ceres, București.
14. **Wang X., Li Z., Xing Y., 2015** - *Effects of mulching and nitrogen on soil temperature, water content, nitrate-N content and maize yield in the Loess Plateau of China*. *Agricult. Water Manage* 161, 53–64 (2015).

THE IMPACT OF DIFFERENT N SOURCES ON THE GROWTH AND YIELD OF CUCUMBER VARIETIES UNDER THE PLASTIC GREENHOUSE

STUDII ASUPRA INFLUENȚEI DIVERSELOR SURSE DE AZOT ASUPRA CREȘTERII ȘI PRODUCȚIEI LA DIVERSE SOIURI DE CASTRAVEȚI DIN SOLARII

MOHAMMED J. M.¹, CIOFU Ruxandra¹, HOZA Gheorghita¹,
NEAȚĂ Gabriela¹, BĂDULESCU Liliana¹
e-mail: daniamo2006@yahoo.com

Abstract. This experiment was conducted at Horticulture Research Station (USAMV Bucuresti) during the summer season of the year 2016. Two cucumbers varieties: Anzor F1 and Trilogy F1, planted under 10 micro plastic greenhouses. The fertilizers treatments included: 300 g/m²DIX 10 N (D); 50 and 100 g/m²NovaTec (N1, N2) ; 200 g/m²Orgevit (O) and unfertilized control (CA,CT). Results indicated that, there are significant differences among treatments but it was observed that for all characters studied, there is an increase with significantly difference with an increase in N level. Generally, all N fertilizer treatments (organic and Inorganic) increased the soil (N-NH₄, N-NO₃, P-PO₄, K) levels in soil. Results showed Anzor F1 fertilized with DIX 10 N (AD) and (Anzor F1 and Trilogy F1) with NovaTec 100 g/m² (AN2) and (TN2) gave the strongly positive effect in plant length, plant and root dry matter %. The highest content of pigments was found in Anzor F1 fertilized with DIX 10 N (AD), NovaTec 100 g/m² (AN2) and Trilogy with DIX 10 N (TD). Also observed a significant increasing in leaf content of N-NO₃ represented by inorganic fertilizer treatments while the highest content of P-PO₄ represented by TN2 and TO (657.86 and 728.93 ppm) respectively). It is clearly showed the highest K content effected strongly with the increase of inorganic fertilizers recorded with AN2 and TN2 (4513 and 4640 ppm). Results showed that all inorganic treatments gave over the normal and healthy concentration of N-NO₂ and K in fruits. All treatments had strongly effect with fruit length but the greatest diameter recorded with TN1 and TN2. The best yield results were recorded by Trilogy F1 fertilized with DIX 10 N (TD) and Orgevit (TO) followed by Anzor F1 with Orgevit (AO) treatment, which were obtained on the plant 4.10 Kg, 4.04 Kg and 4.05 Kg, respectively. There are significant variations between varieties regarding CO₂ concentration in response to the different commercial fertilizers. The highest values was observed to control CA and CT (1449.97 and 1516.76 ppm). All treatments showed significant increase in O₂ comparing with control variants.

Key words: greenhouse, cucumber varieties, fertilizing treatments, plant growth, fruit yield, rates of CO₂ and O₂ in the atmosphere

¹ University of Agronomical Sciences and Veterinary Medicine, Bucharest, Romania

Rezumat. Experimentul a fost implementat în cadrul stațiunii de cercetare horticola a USAMV București pe durata verii 2016. Doi hibrizi de castraveți Ansor F1 și Trilogy F1 au fost plantați în solarii cu folie de plastic de 10 microni. Tratamentele de fertilizare au inclus: 300 g/m²DIX 10 N (D); 50 și 100 g/m²NovaTec (N1, N2); 200 g/m²Orgevit (O) și varianta nefertilizată (CA,CT). Rezultatele au indicat că există diferențe semnificative între tratamente, dar s-a observat că, la toate variantele luate în studiu, există o creștere semnificativă a concentrației de azot. În general, tratamentele cu azot (organic și anorganic) au determinat creșterea nivelurilor de N-NH₄, N-NO₃, P-PO₄, K în sol. Rezultatele au arătat că fertilizarea cu DIX 10 N (AD) a hibridului Ansor F1 și cu NovaTec 100 g/m² (AN2) și (TN2) a hibridurilor Ansor F1 și Trilogy F1 sunt corelate puternic pozitiv cu lungimea plantelor, substanța uscată a plantei și a sistemului radicular. Cel mai ridicat conținut în pigmenți s-a înregistrat în cazul fertilizării cu DIX 10 N (AD), NovaTec 100 g/m² (AN2) și Trilogy with DIX 10 N (TD) asupra hibridului Ansor F1. S-a observat de asemenea o creștere a conținutului de N-NO₃ din frunze reprezentat de tratamentele chimice cu conținut ridicat de P-PO₄ din TN2 și TO (657.86 și respectiv 728.93 ppm). Se observă, de asemenea, că cele mai ridicate concentrații de K au fost determinate în cadrul tratamentelor chimice cu AN2 și TN2 (4513 și 4640 ppm). Rezultatele arată că toate tratamentele chimice au produs concentrații peste cele normale și considerate sănătoase în fructe. Toate tratamentele au influențat pozitiv lungimea fructelor, cel mai mare diametru fiind înregistrat în cazul tratamentelor cu TN1 și TN2. Cea mai mare producție a fost obținută în cazul hibridului Trilogy F1 fertilizat cu DIX 10 N (TD) și Orgevit (TO), urmat de Ansor F1 fertilizat cu Orgevit (AO), cu următoarele rezultate: 4.10 Kg, 4.04 Kg și respectiv 4.05Kg. Există variații semnificative între hibrizi în ceea ce privește concentrația de CO₂ în funcție de diferitele tratamente. Cele mai mari valori au fost obținute în variantele maror CA și CT (1449.97 și 1516.76 ppm). Toate tratamentele au arătat o creștere semnificativă a concentrației de O₂ în comparație cu variantele maror.

Cuvinte cheie: solar, hibrizi de castraveți, fertilizare, creșterea plantelor, producție, concentrația CO₂ și O₂ în atmosferă

INTRODUCTION

Cucumber (*Cucumis sativum* L.) is an important vegetable and one of the most popular member of cucurbitaceae family and one of the oldest vegetables cultivated by man for over than 3,000 years (Adetula and Denton, 2003; Okonmah, 2011). It is second culture after tomato in Europe (Eifediyi and Remison, 2010). In Romania the total area planted with cucumber in 2015 was 12700 ha and the productivity of cucumber was 193800 tons/ha (INS, 2015). Cucumbers contains approximately 95% water, 3.6% carbohydrates, and 0.65% protein, and are low in calories (150 kcal kg⁻¹). They are a good source of the following nutrients (in mg/kg⁻¹): pantothenic acid (B5 0.026); vitamin C (0.28); magnesium (1.3). The consumption of pickles has been waning, but use of cucumbers as a fresh vegetable has been increasing (Lucier and Jerardo, 2007). Inorganic and organic fertilizers are applied to maintain the nutritional condition of different cropping systems (Ginting *et al*, 2003; Watts *et al*, 2010). The importance of fertilizer

application to cucumber has also been reported (Kano *et al.*, 2001; Ruiz and Romero, 2002; Moreno *et al.* 2003; Ciofu *et al.*, 2003; Jasso-Chaverria *et al.* 2005).

Nitrogen is an essential element required for successful plant growth and production. It's required for cellular synthesis of enzymes, proteins, chlorophyll, DNA and RNA. Inadequate supply of available N frequently results in plants that have slow growth, depressed protein levels, poor yield of low quality and inefficient water use (Hayat *et al.*, 2010).

The intensive use of nitrogen fertilizers in order to increase crop yield has a negative impact on various aspects of the environment: nitrate leaching from agricultural land into groundwater, nitrogen losses associated with soil erosion, gaseous nitrogen losses during denitrification and ammonium emission processes. In order to reduce the losses of nitrogen leaching from fertilizers, a variety of techniques that reduce the fertilizer solubility and increase the uptake by plants are being developed (Davidson and Gu, 2012; Liu and Lal, 2015). Using NovaTec classic effectively increased the tuber yield, but produced different effect on their quality. In soil fertilized with NovaTec classic, which contains nitrification inhibitor, potato tubers were most starchy and accumulated the lowest amount of nitrates compared with the other fertilizers and increased the yield of grain barley by 1.8–11.6% on average (Voké, 2017). Although inorganic nitrogen compounds (*i.e.*, NH_4^+ , NO_2 , and NO_3) account for less than 5% of the total nitrogen in soil (Brady and Weil, 2008) they are the main form of the element absorbed by most plants. The chemical fertilizers were first introduced into the agriculture field, most of the problems faced by farmers to increase yield of their plantation have been solved. However, chemical fertilizers slowly started to show their side effect on human and environment (Zakaria, 2009). Orgevit is inorganic fertilizer in the form of pellets derived from organic substances of natural origin and contain micro and macro elements needed. This contains a large percentage of organic elements that are essential for maintaining soil fertility, eases up the gradual absorption of the nutrients from the soil, improves soil structure and increases water retention capacity (Nicolae *et al.*, 2014). As well as organically produced crops have increased nutritional value than conventionally produced crops (Rembiałkowska, 2007; Lairon, 2010). This means that organic agricultural systems have already proved ability to produce food with high quality standards. For that it's noticed that using DIX 10N treatment give highest grain of maize yield and 1.000 grain weight (Vesna *et al.*, 2014).

The aim of experiment was to determine nutritional quality of organic and inorganic fertilizers to produce highest parameters growth and yield in cucumber plants. The influence regarding rates of CO_2 and O_2 in the plastic greenhouse atmosphere has also been studied.

MATERIAL AND METHOD

This experiment was conducted at Horticulture Research field (USAMV) in Bucharest during the summer season of the year 2016. The culture was performed in 10 plastic greenhouse (3m long and 2m wide), each of them divided into 3 replicates. The experiment consisted of studying the effects of different sources of N fertilizers (organic and inorganic) on the growth and yield of two commercial cucumber

varieties Anzor F1 and Trilogy F1 (noted A and T respectively). Four nitrogen treatments with three replications and all the fertilizers resources (organic and inorganic) were bought from the local market. The controls were represented by the unfertilized soil. The combination of experimental factors (varieties, fertilizers and doses) resulted in 10 treatment variants, presented in table 1.

Table 1

Treatment variants

No	Treatments	Dose g/m ²	Symbo l	No	Treatments	Dose g/m ²	Symbo l
1	Control Anzor	0	CA	6-	Control Trilogy	0	CT
2	Anzor + NovaTec classic 12-8-16+3MgO	50 g/m ²	AN1	7	Anzor + NovaTec classic 12-8-16+3MgO	100 g/m ²	AN2
3	Anzor + Dix 10N (N:P:K=10:3:3, 72.5% (organic matter))	300 g/m ²	AD	8	Anzor + Orgevit 4-2.5-2.3+9.3%Ca + 1.1% MgO + organic matter 65%+ ME	200 g/m ²	AO
4	Trilogy + NovaTec classic 12-8-16+3MgO	50 g/m ²	TN1	9	Trilogy + NovaTec classic 12-8-16+3MgO	100 g/m ²	TN2
5	Trilogy + Dix 10N (N:P:K=10:3:3, 72.5% organic matter)	300 g/m ²	TD	10	Trilogy + Orgevit 4-2.5-2.3+9.3%Ca +1.1% MgO + organic matter65%+ ME	200 g/m ²	TO

The seeds were sowed in the nursery on 7/5/2016 and those 2 commercial varieties were planted under experimental micro greenhouses on 4/6/2016. All fertilizers were divided and provided to the soil before planting and after planting by a month.

The results were recorded over 3-month period and the following determinations were performed:

The characteristics of the experimental soil were analyzed before and after applying the treatments, using the specific methods of determination of each studied parameter (EC ; PH ; N-NH₄ ; N-NO₃ ; P-PO₄ ; K).

Yield parameters - number, the weight, the length and diameter of the fruit, total yield /plant (done by collect the fruits from each replicate, measuring them every 3 days, and take the average. All collected cucumbers in each replicate during growing season considered as total yield/plant.

At the end of growing season, 3 plants from each replicate selected to measure plant dry weight and root dry weight. The samples kept in oven for 24 hours in 105°C. After 24 hours the samples weighted with a digital scale then obtained the percentage of plant and root dry matter (% for fresh matter).

Biochemical determinations were performed (leaves and fruits content in N-NO₃ and N-NO₂ according to Katrina , 2001 and for P-PO₄ and K according to the regulations of the Ministry of Agriculture and Food Industry (Academy of Agricultural and Forestry Sciences, 1981).

The gas emissions into the atmosphere inside the plastic micro greenhouses were analyzed by using CO₂ and O₂ gas analyzer devise.

Differences between treatments were determined by analysis of variance (ANOVA) and Tukey's multiple comparison tests using SPSS 18.0 statistical software and mean comparison was done by Duncan multiple range test at the 5% level of significance.

RESULTS AND DISCUSSION

Generally addition of N fertilizers (organic and inorganic) increased the soil N-NH₄ ; N-NO₃ ; P-PO₄ and K levels compared to control (tab. 2). The highest N-NH₄ concentration in soils (173.25 ppm) recorded in Trilogy F1 fertilized with NovaTec 100g/m² (TN2) treatment, while the maximum amount of N-NO₃ content (1091.88 ppm) was recorded in Trilogy F1 fertilized with Dix10N (TD) treatment. The greatest soil concentration in P-PO₄ (282.98 ppm) clearly represented by Anzor F1 fertilized with NovaTec 100g/m² (AN2) and the highest K content (610 ppm) recorded in Trilogy fertilized with NovaTec 100g/m² (TN2) treatment.

The results show that fertilization treatments did not cause significant changes in soil pH, but high fertilizer doses (NovaTec 100g/m² and Dix10N 300 g/m²) resulted in significant increases in EC% in both studied varieties.

The results presented in table 3 show that for both varieties studied all fertilizer treatments tended to increase the vegetative growth of cucumber (plant height and dry biomass) compared with the control, this was apparently due to improved nutrition of the plants. Although inorganic and organic fertilizers are not large differences, it can be noted that in both cases, the application of higher doses led to a more pronounced growth of plants.

The best plant height results were obtained by fertilization with inorganic fertilizer NovaTec classic at a dose of 100 g / m² (254.66 cm at AN2 and 252.00 cm at TN2, compared to 185.63 cm and 173.67 cm respectively at the CA and CT). In the case of organic fertilizers, the first place was Dix 10N at a dose of 300 g/m², at which the plants reached 245.33 cm.

Table 2

Soil analysis before and after treatment

Variety (symbol)	Fertilizers treatment (symbol)	PH	EC%	N-NH ₄ ppm	N-NO ₃ ppm	P-PO ₄ ppm	K ppm
Before experiment		6.56	0.180	92.50	32.75	10.15	91.5
After experiment							
Inorganic fertilizers							
Anzor (A)	NovaTec 50g/m ² (N1)	6.40	0.293	65.25	268.24	36.95	310
	NovaTec 100g/m ² (N2)	6.44	0.643	68.2	325.45	282.98	508
Trilogy (T)	NovaTec 50g/m ² (N1)	6.50	0.202	27.08	108.23	10.16	130
	NovaTec 100g/m ² (N2)	6.26	0.649	173.25	830.85	31.11	610
	Control Trilogy (CT)	6.50	0.156	9.68	35.5	5.08	105
Organic fertilizers							
Anzor (A)	Orgevit 200 g/m ² (O)	6.43	0.235	9.55	369.27	7.62	261
	Dix10N 300 g/m ² (D)	6.43	0.452	55.70	869.05	10.15	235
	Control Anzor (CA)	6.53	0.117	7.95	26.91	6.34	112
Trilogy (T)	Orgevit 200 g/m ² (O)	6.56	0.224	9.55	256.25	5.08	195
	Dix10N 300 g/m ² (D)	6.30	0.570	25.46	1091.88	19.68	328

Regarding plant biomass, the same tendency of applied fertilizers is noted. The highest dry matter values of plants and roots were obtained at all fertilized treatments comparing with control but didn't notice difference variances between all fertilized treatments. All the organic fertilizer treatment had higher root dry matter % than the control, while the highest inorganic treatments represented by Ansor F1 fertilized with NovaTec 100g/m² (AN2) and Trilogy fertilized with NovaTec 100g/m² (TN2) where they were registered 12.92 and 12.95% respectively. Our results corresponding with Dynes (2003).

Table 3
Effect of fertilizer treatments on (plant length , dry weight % and root dry weight %)

Variety (symbol)	Fertilizers treatment (symbol)	Plant length (cm)	Plant dry matter (%)	Root dry matter (%)
Inorganic fertilizers				
Ansor (A)	NovaTec 50g/m ² (N1)	231.66ab	30.74ab	11.17bc
	NovaTec100g/m ² (N2)	254.66a	34.69a	12.92a
Trilogy (T)	NovaTec50g/m ² (N1)	235.66ab	34.61a	11.71b
	NovaTec100g/m ² (N2)	252.00a	33.59ab	12.95a
	Control Trilogy(CT)	173.67c	29.53cb	10.78c
Organic fertilizers				
Ansor (A)	Orgevit(O) 200 g/m ²	225.00b	35.78a	13.81a
	Dix10N (D) 300 g/m ²	245.33a	31.80ab	13.10a
	Control Ansor (CA)	185.63c	19.92c	10.20c
Trilogy (T)	Orgevit(O) 200 g/m ²	221.33b	31.84ab	13.00a
	Dix10N (D)300 g/m ²	226.00b	31.64ab	12.54a

The application of organic and inorganic fertilizers has influenced the content of cucumber leaf photosynthetic pigments and the results indicated significant differences among treatments (tab. 4). It was observed that the increase in N level has led to a significant increase in pigments content.

Table 4
Effect of fertilizer treatments on plant pigments (mg/l)

Variety (symbol)	Fertilizers (symbol)	Chlorophyll A	Chlorophyll B	Total Chlorophyll	Carotene
Inorganic fertilizers					
Ansor (A)	NovaTec 50g/m ² (N1)	125.72bc	143.07b	268.79b	29.51c
	NovaTec100g/m ² (N2)	166.97a	162.44a	319.41a	38.98b
Trilogy (T)	NovaTec50g/m ² (N1)	127.34b	127.72bc	255.06b	26.58c
	NovaTec100g/m ² (N2)	128.67b	166.67a	295.34ab	35.65b
	Control Trilogy(CT)	93.48d	91.54d	185.03c	10.19d
Organic fertilizers					
Ansor (A)	Orgevit200 g/m ² (O)	126.40bc	134.85bc	261.25b	32.12b
	Dix10N 300 g/m ² (D)	188.73a	152.06a	290.79ab	59.02a
	Control Ansor (CA)	96.47d	79.15d	175.62c	12.78d
Trilogy (T)	Orgevit 200 g/m ² (O)	146.33b	115.73cd	262.06b	39.17b
	Dix10N 300 g/m ² (D)	169.660a	154.24a	323.90a	58.30a

The data showed that the maximum concentration of chlorophyllA, chlorophyll B and total Chlorophyll occurred with the AN2, AD and TD treatments while the greatest content of carotene represented by AD and TD which were obtained 59.02 and 58.30 mg /l respectively compared to the others treatment variants and non-fertilized controls CA and CT which had minimal concentrations (12.78 mg/L, 10.19 mg/L respectively).

In table 5 results show that all fertilizer treatments significantly increased of minerals in the leaves comparing with control. Inorganic fertilizer treatments gave highest content of N-NO₃ while the highest content of P-PO₄ represented by TN2 and TO (657.86 and 728.93 ppm respectively) and the greatest K content represented by AN2 and TN2 (4513 and 4640 ppm).

Table 5

Effect of fertilizer treatments on minerals content in leaf (ppm)

Variety (symbol)	Fertilizers (symbol)	N-NO ₃	P-PO ₄	K
	Inorganic fertilizers			
Anzor (A)	NovaTec 50g/m ² (N1)	177.00a	589.28b	3140b
	NovaTec 100g/m ² (N2)	171.00a	539.33b	4513a
Trilogy (T)	NovaTec 50g/m ² (N1)	164.60a	571.52b	3580b
	NovaTec 100g/m ² (N2)	190.00a	657.86a	4640a
	Control Trilogy (CT)	112.760c	365.74d	3620b
	Organic fertilizers			
Anzor (A)	Orgevit 200 g/m ² (O)	145.81ab	467.36c	3420b
	Dix 10N 300 g/m ² (D)	137.70b	354.51d	3720b
	Control Anzor (CA)	101.20c	354.21d	3420b
Trilogy (T)	Orgevit 200 g/m ² (O)	143.62b	728.93a	3620b
	Dix 10N 300 g/m ² (D)	140.01b	467.35c	3660b

The analysis of fresh fruit cucumber (tab. 6) showed different variable between the treatments. The greatest concentration of N-NO₃ represented by TN2 (253.33 ppm) while the highest content of P-PO₄ recorded by TN1 and TN2 (274.32 and 259.18 ppm respectively). It is important to note that all the data recorded for N-NO₃ and P-PO₄ were including the normal concentration.

With regard to N-NO₂ and K in fruit, it is found superior content and above the normal concentration to all inorganic fertilizer for both varieties.

These results confirm Herencia *et al.* (2011) remarks after which the release of nitrogen in organic fertilizers is slower than that inorganic fertilizers since organic fertilization typically does not provide nitrogen in a readily accessible form.

Effect of fertilizer treatments on minerals content in fruit

Variety (symbol)	Fertilizers(symbol)	N-NO ₃ ppm	N-NO ₂ ppm	P-PO ₄ ppm	K ppm
Inorganic fertilizers					
Ansor F1(A)	NovaTec 50g/m ² (N1)	183.66b	6.33*a	205.74b	2220*a
	NovaTec100g/m ² (N2)	164.66bc	5.66*ab	175.26c	2026*b
Trilogy F1(T)	NovaTec50g/m ² (N1)	145.66c	6.33*a	274.32a	2300*a
	NovaTec100g/m ² (N2)	253.33a	7.00*a	259.18a	2270*a
	Control Trilogy(CT)	152.05c	3.75b	160.02c	1786c
Organic fertilizers					
Ansor F1(A)	Orgevit200 g/m ² (O)	182.43b	3.66b	190.50b	1806c
	Dix10N 300 g/m ² (D)	139.67c	2.66d	137.16d	1926b
	Control Ansor (CA)	114.30d	3.33bc	216.70b	1740c
Trilogy F1(T)	Orgevit 200 g/m ² (O)	182.16b	4.33b	210.82b	1906b
	Dix10N 300 g/m ² (D)	177.33bc	3.66b	170.18c	1886bc

After David (1999) the maximum admissible levels for minerals in fruit are: N-NO₃ = 0 - 400ppm; N-NO₂ = 0-5ppm; P-PO₄ = 200-400ppm; K = 1000-2000ppm

The results presented in table 7 show that all N fertilizer treatments produced significantly increase to fruit length, fruit diameter and total yield per plant compared with control variants, for both varieties. Taking into account the standards for the size of type gherkins cucumber fruit, we can appreciate that good results were obtained at AD and TD variants, to which fruits have minimum length (10.16 cm and 9.73cm). For the fruit diameter, the highest diameter recorded to TN1 and TN2 (3.06cm and 3.04cm). Due to nitrogen in fertilizers can induced protein production that causes more meristem cells and cell division that finally led to higher cucumber diameter and cucumber length compared with control treatments our results agree with Tisdale and Nelson (1975), Salardini and Mojtahedi (1988), Salardini (1993).

The results highlight the differences between the organic and inorganic fertilizer treatments but all the organic treatments showed significantly more cucumber yield per plant. The best results were obtained to TD (4.10 Kg), AO (4.05Kg) and TO (4.04 Kg).

Our results agree with Shafiee Zargar (1996), Baybordi *et al.* (2000), Ghosh *et al.* (2004), Kamkar and Mahdavi (2008), according to which, due to the organic fertilizers improved the soil conditions for crop establishment as well as released adequate nutrient elements for yield enhancement and finally causes higher yield production with higher dry weight.

Effect of fertilizer treatments on fruit characters (length and diameter) and on total yield per plant

Variety (symbol)	Fertilizers (symbol)	Fruit length cm	Fruit diameter cm	Yield/plant Kg
Inorganic fertilizers				
Ansor (A)	NovaTec 50g/m ² (N1)	10.24a	2.79b	3.21b
	NovaTec 100g/m ² (N2)	10.39a	2.82b	3.65ab
Trilogy (T)	NovaTec 50g/m ² (N1)	10.77a	3.06a	3.36b
	NovaTec 100g/m ² (N2)	10.52a	3.04a	3.72ab
	Control Trilogy (CT)	9.42c	2.60bc	2.36c
Organic fertilizers				
Ansor (A)	Orgevit (O) 200 g/m ²	10.38a	2.83b	4.05a
	Dix10N (D) 300 g/m ²	10.16a	2.77b	3.92ab
	Control Ansor (CA)	9.62bc	2.57c	2.13c
Trilogy (T)	Orgevit (O) 200 g/m ²	10.30a	2.91ab	4.04a
	Dix10N (D) 300 g/m ²	9.73bc	2.91ab	4.10a

The results presented in table 8 indicate that all fertilizer treatments improve the leaf gas exchange. In the plants treated with fertilizer (organic and inorganic) the photosynthesis rate was significantly higher compared with the control plants in both varieties. Application of N fertilizer resulted in significantly highest O₂ concentration with decrease of CO₂ concentration at atmosphere of the micro greenhouse for all treatments. Comparing with other treatments, the lowest concentration of CO₂ at atmosphere represented by AD treatment (972.86 ppm) and the highest concentration of O₂ was recorded in TD treatment (21.98 ppm). The lowest concentration of O₂ and highest concentration of CO₂ were recorded in unfertilized controls: CA (18.59 ppm O₂ and 1449.97 ppm CO₂) and CT (18.74 ppm O₂ and 1516.76 ppm CO₂).

Table 8

Effect of fertilizer treatments on respiration

Variety (symbol)	Fertilizers (symbol)	CO ₂ (ppm average 24h)	O ₂ (ppm average 24h)
Inorganic fertilizers			
Ansor (A)	NovaTec 50g/m ² (N1)	1317.76ab	20.68a
	NovaTec 100g/m ² (N2)	1244.40b	20.94a
Trilogy (T)	NovaTec 50g/m ² (N1)	1301.73ab	20.84a
	NovaTec 100g/m ² (N2)	1136.66b	21.55a
	Control Trilogy (CT)	1516.76a	18.74b
Organic fertilizers			
Ansor (A)	Orgevit 200 g/m ² (O)	1104.40b	20.56a
	Dix10N 300 g/m ² (D)	972.86c	21.56a
	Control Ansor (CA)	1449.97a	18.59b
Trilogy (T)	Orgevit 200 g/m ² (O)	1198.30b	20.59a
	Dix10N 300 g/m ² (D)	1135.50b	21.98a

These results indicate that along with the stomata conductance, the increased pigment content is one of the reasons for the higher photosynthetic rate in plants treated with N fertilizer.

CONCLUSIONS

1. The administration of N fertilizers (organic and inorganic) has determined the modification of some physical and chemical characteristics of the soil. It was recorded a slight reduction of the soil PH, and at high fertilizer doses resulted in significant increases in EC%. Organic fertilizer NovaTec determined the highest increases in soil content for N-NH₄, P-PO₄ and K, while the maximum amount of N-NO₃ was recorded to inorganic fertilizer Dix10N.

2. All fertilizer treatments tended to increase the growth characters (plant height, dry biomass) of cucumber compared with the control. Between treatments with organic and inorganic fertilizers there were no significant differences but in both cases, the application of higher doses (NovaTec100g/m² and Dix10N 300 g/m²) led to a more pronounced growth of plants.

3. There are significant variations between varieties Anzor F1 and Trilogy F1 in responding to the fertilizer treatments due to the genetic factor.

4. Organic and inorganic fertilizers has influenced the content of cucumber leaf photosynthetic pigments and the increase in N level has led to a significant increase in pigments content. In both varieties, high fertilizer doses have significantly increased the content in chlorophyll A, chlorophyll B, total chlorophyll and carotene.

5. Fertilization has affected the contents in mineral substances of cucumber leaves and fruits. The recorded values in fruits for N-NO₃ and P-PO₄ were including within the permissible limits, while for N-NO₂ and K the content were over the normal and healthy concentration to all inorganic fertilizer for both varieties.

6. All fertilizer treatments produced significantly increase to fruit length, fruit diameter and total yield per plant compared with control variants, for both varieties. Organic fertilizers have resulted in significantly higher yields of cucumbers per plant (up to 4.04 - 4.10 Kg, compared to 2.13 Kg in control).

7. Applying of N fertilizer improved the leaf gas exchange and photosynthesis rate, resulting significantly highest O₂ concentration with decrease of CO₂ concentration at atmosphere of the micro greenhouse for all treatments.

REFERENCES

1. Adetula O., Denton L., 2003 - *Performance of vegetative and yield accessions of cucumber (Cucumis sativa L.)*. Horticultural Society of Nigeria (HORTSON) Proceedings of 21st annual conference 10-13 Nov.
2. Baybordi Y.M., Maakooti M.J., Amiri Makri H., Nafisi M., 2000 - *Production and application of chemical fertilizer in sustainable agriculture*. Agricultural education publication.
3. Brady N.C., Weil R. R., 2008 - *The nature and properties of soils*. Pearson Education Inc., New Jersey, USA.
4. Ciofu Ruxandra, Stan N., Popescu V. et al., 2003 - *Tratat de Legumicultură*, Ed.Ceres, București

5. Davidescu T., David Saidel, 1999 - *Compendium Agrochimic*. Ed.Academiei Romane
6. Davidson D., Gu F. X, 2012 - *Materials for sustained and controlled release of nutrients and molecules to support plant growth*. Journal of Agricultural and Food Chemistry,60 (4): 870–876. <https://doi.org/10.1021/jf204092h>
7. Dynes R.A., 2003 - *Earthworm: Technology information to enable the development of earthworm production*. A report for the Rural Industries Research and Development Corporation. Australian Government. Canberra, Australia 33 p.
8. Eifediyi E.K., Remison S. U., 2010 - *Growth and yield of cucumber (Cucumissativum L.) as Influenced by farm yard manure and inorganic fertilizer*. Journal of Plant Breeding and Crop Science 2(7): 216-220.
9. Ghosh P.K., Ramesh P., Bandyopadhyay K.K., Tripathi A.K., Hati K.M., Misra A.K., 2004 - *Comparative effectiveness of cattle manure, poultrymanure, phosphocompost and fertilizer- NPK on three cropping systems in vertisols of semi-arid tropics. I. Crop yields andsystems in performance*. Bioresource Technology 95: 77-83.
10. Ginting D., Kessavalou A., Eghball B., Doran J.W., 2003 - *Greenhouse gas emissions and soil indicators four years after manure compost applications*. J. Environ. Qual. 32:23–32
11. Hayat R., Ali S., Amara U., Khalid R., Ahmed I., 2010 - *Soil beneficial bacteria and their role in plant growth promotion: A review*.Annal. Microbiol., 60: 579-598.
12. Herencia J. F., García-Galavís, P. A., Maqueda C., 2011 - *Long-Term Effect of Organic and Mineral Fertilization on Soil Physical Properties Under Greenhouse and Outdoor Management Practices*. Pedosphere 21(4), 443–453.
13. Jasso-Chaverria C., Hochmuth G. J., Hochmuth R. C., Sargent S. A., 2005 -*Fruit yield, size and color responses of two greenhouse cucumber types to nitrogen fertilization in perlite soilless culture*. HortTechnology 15: 565–571.
14. Kamkar B, Mahdavi Damghani A., 2008 - *Principle of Sstainable Agriculture*. Jihad of Mashhad University press.
15. Kano Y., Goto H., Fukuda H., Ishimoto K, 2001 - *Relationship between the occurrence of bitter cucumber (Cucumis sativa L. cv.Kagafutokyuri) and total nitrogen, nitrate-N, amino acid-N and protein contents in the leaf and peel*. J. Jpn. Soc. Hortic. Sci. 70: 438–442.
16. Katrina M. Miranda, Michael G. Espey, David A. Wink, 2001 - *A Rapid, Simple Spectrophotometric Method for Simultaneous Detection of Nitrate and Nitrite*. NITRIC OXIDE: Biology and Chemistry. Vol. 5, No. 1, pp. 62–71.
17. Lairon D, 2010 - *Nutritional quality and safety of organic food*.Agron. Sustain. Dev., 30, 33– 41.Ministerul Agriculturii si a industriei alimentare academia de stiinte agricole sislvice ,1981. Nr.13 . metode , rapoarte,indruiari.
18. Liu R., Lal R., 2015 - *Potentials of engineered nanoparticlesas fertilizers for increasing agronomic productions*. Science of the Total Environment, 514: 131–139.<https://doi.org/10.1016/j.scitotenv.2015.01.104>
19. Lucier G., Jerardo A., 2007 - *Electronic Outlook Report from the Economic Research Service*. Economic Research Service, USDA
20. Moreno D. A., Villora G., Romero L., 2003 - *Variations in fruit micronutrient contents associated with fertilization of cucumber with micronutrients*. Sci. Hortic. 97: 121–127.
21. Nicolae I, Camen D., Lascu N., Ploae Marieta, 2014 - *Physiological research in Citrulluslanatus(Thunb.) Matsum.&Nakai plants cultivated on sandy soils organic fertilized* . JOURNAL of Horticulture, Forestry and Biotechnology .Vol 18(2), 84- 89, 2014
22. Okonmah LU, 2011 - *Effects of different types of staking and their cost effectiveness on the growth, yield and yield components of cucumber (Cumumis sativa L)*. Int. J. of Agric. Sci. Vol. 1 (5): 290-295. International Academic Journals, Germany.
23. Rembiałkowska E., 2007- *Quality of plant products from organic agriculture*.J. Sci. Food Agric., 87, 2757–2762.

24. Ruiz J. M., Romero, L., 2002 - *Relationship between potassium and nitrate assimilation in leaves and fruits of cucumber (Cucumis sativa) plants*. Ann. Appl. Biol. 140: 241–245.
25. Salardini A., Mojtahedi A., 1988 - *Principal of plant nutrition*. University of Tehran Press, Tehran, Iran
26. Salardini A.A., 1993 - *Soil fertility*. Tehran University Press, Tehran, Iran.
27. Shafiee Zargar A., 1996 - *Study on quantitative and qualitative of cucumber under the effect of organic and mineral fertilizer in autumnplanting*. Mstthesis.TarbiatModarresUniversity.Tehran. Iran
28. Tisdale SL, Nelson WL ; 1975 - *Soil Fertility and Fertilizers*. (3rded). Macmillan Pub. Co. New York
29. Vesna Dragicevic, Igor Spasojevic, Milovan Stojiljkovic, Milena Simic, Milan Brankov, 2014 - *Possible availability of Mg, Fe Mn and Zn from organically produced maize*. Fifth International Scientific Agricultural Symposium „Agrosym. Vinča Institute of Nuclear Sciences, Belgrade, Serbia.
30. Voké Branch, 2017- *Effect of fertilizers with different chemical composition on crop yield, nitrogen uptake and leaching in a sandy loam Luvisol*.Zemdirbyste-Agriculture, vol. 104, No. 3 (2017), p. 203–208.
31. Watts D.B., Torbert H.A., Prior S.A., Huluka G., 2010 - *Long-term tillage and poultry litter impacts soil carbon and nitrogen mineralization and fertility*. Soil Sci. Soc. Am. J. 74:1239–1247. doi:10.2136/sssaj2008.0415
32. Zakaria A.A.B, 2009 - *Growth optimization of potassium solubilizing bacteria isolated from biofertilizer*.Engineering Thesis, Faculty of Chemical and Natural Resources Engineering, University Malaysia, Pahang,Malaysia.
- 33.***ISN ;2015-*Vegetable production to the main cultures in the year 2015*. National De Statistica (2015).
- 34.*** **Ministry of Agriculture and Food Industry, 1981** - Academy of Agricultural and Forestry Sciences, 1981

STUDY ON GOLDEN OYSTER MUSHROOM MYCELIUM *PLEUROTUS CITRINOPILEATUS* SINGER

STUDIU PRIVIND MICELIUL CIUPERCII AURII *PLEUROTUS CITRINOPILEATUS* SINGER

*RÓZSA Melinda*¹, *APAHIDEAN Maria*², *GOCAN Tincuța-Marta*²
e-mail: apahidean_maria@yahoo.com

Abstract. Few mushrooms are as spectacular as *Pleurotus citrinopileatus* Singer. Its brilliant yellow color astonishes all who first see it. This species forms clusters hosting a high number of individual mushrooms, whose stems often diverge from a single base. Spicy and bitter at first, this mushroom imparts a strong nutty flavour upon thorough cooking. *P. citrinopileatus* grows quickly through pasteurized straw and sterilized sawdust, and thrives at high temperatures. The present study carried out to evaluate suitable grain substrates for spawn development, growth and yield of *P. citrinopileatus*. The grains taken for this study were wheat, sorghum, millet and maize. A total of four treatments replicated five times were taken under the complete randomized design. The minimum time taken for mycelium run was 17 days and maximum time taken from simulation to primordial initiation was recorded by millet grain spawn.

Key words: mushrooms, *Pleurotus citrinopileatus*, grain substrates, spawn

Rezumat. Puține ciuperci sunt la fel de spectaculoase ca *Pleurotus citrinopileatus* Singer. Culoarea sa strălucitoare galbenă uimește pe toți cei care o văd prima dată. Această specie formează buchete care găzduiesc un număr mare de ciuperci individuale, ale căror tulpini pornesc adesea de la o singură bază. Picant și amar la început, această ciupercă conferă o aromă puternică de nuci la gătit. *P. citrinopileatus* crește rapid pe substrat de paie pasteurizate sau rumeguș sterilizat și se dezvoltă la temperaturi ridicate. Prezentul studiu a fost realizat pentru a evalua substraturile de cereale adecvate pentru producerea miceliului. Cerealele utilizate în acest studiu au fost grâul, sorgul, meiul și porumbul. Un total de patru experiențe repetate de cinci ori au compus randomizarea. Timpul minim necesar pentru împânzirea miceliului a fost de 17 zile, iar timpul maxim de la simulare până la inițierea primordiilor a fost înregistrată la miceliul pe semințe de mei.

Cuvinte cheie: ciuperci, *Pleurotus citrinopileatus*, substrat de cereale, miceliu

INTRODUCTION

Oyster mushroom contains 19-35% protein on dry weight basis as compared to 7.3% in rice, 13.2% in wheat and 25.2% in milk. It is rich in essential minerals and trace elements. Mushrooms are source of niacin (0.3 g 100g⁻¹d.m.) and riboflavin (0.4 mg 100g⁻¹d.m.) and good source of trypsin

¹ SC CIUPERCĂRIA SRL, Aghireșu-Fabrici, Cluj County, România

² University of Agricultural Sciences and Veterinary Medicine, Cluj-Napoca, România

enzyme. It is also rich in iron, copper, calcium, potassium, D vitamin and folic acid (Hasan *et al.*, 2015).

Oyster mushrooms modulate the immune system, inhibit tumour growth and inflammation, have hypo-glycaemic and antithrombotic activities, lower blood lipid concentration, prevent high blood pressure and atherosclerosis, antimicrobial and other activities (Biswas and Biswas, 2015).

Edible mushrooms have been treated as important tools in modern medicine for their medicinal values (Rahman *et al.*, 2015).

Taxonomic synonyms and considerations: *Pleurotus citrinopileatus* is closely allied to *P. cornucopiae* (Paulet) Rolland and is often considered a variety of it. Moser (1978) and Singer (1986) described *P. cornucopiae* var. *cornucopiae* as having a tawny brown cap whereas *P. citrinopileatus* has an unmistakably brilliant yellow pileus. Singer (1986) separated *P. Citrinopileatus* Singer from *P. cornucopiae* (Paulet ex Fr.) Rolland sensu Kuhn. and Rom. (= *P. Macropus* Bagl.) on the basis of the arrangement of the contextual hyphae. According to Singer, *P. Citrinopileatus* has monomitic hyphae, whereas *P. Cornucopiae* has dimitic hyphae.

Description: Caps golden to bright yellow, 2-5 cm, convex to plane at maturity, often depressed in the centre, thin fleshed, with decurrent gills that show through the partially translucent cap flush. Stems white, centrally attached to the caps. Usually growing in large clusters arising from a single, joined base (fig. 1). Clusters are often composed of fifty to one hundred or more mushrooms. As strains of this species senesce, the yellow cap color is lost, becoming beige, and fewer mushrooms are produced in each primordial cluster (Stamets, 2010).



Fig. 1 *Pleurotus citrinopileatus* mushroom (original)



Fig. 2 *Pleurotus citrinopileatus* mycelium (original)

Microscopic features: spore pale pinkish buff, 7.5-9.0 x 3.0-3.5 μ . Clamp connections are present. Hyphal system is dimitic.

Mycelial Characteristics: cottony, whitish mycelium, often with tufts of dense growth, sometimes with yellowish tones and occasionally run through with underlying rhizomorphic strands (fig. 2). Primordia are yellow at first.

Fragrance signature: grain spawn smells astringent, acrid, nutty and sometimes fishy, with a scent that, in time, is distinctly recognizable to this species (Stamets, 2010).

Spawn is a pure culture of mycelium growing on a solid substrate such as grain. Mushroom spawn has a fundamental role in global agricultural productivity. The most frequently used substrate for spawn production is wheat grain. Spawn grains such as wheat, millet and corn have been reported to affect carpophores production (Gupta and Sharma, 2014).

MATERIAL AND METHOD

In this experiment four different grains with five replications were taken up to achieve the desired objectives: wheat (*Triticum aestivum*), sorghum (*Sorghum vulgare*), millet (*Pennisetum glaucum*) and maize (*Zea mays*). The grains were cleaned to remove inert matter, stubble and debris. The cleaned grains thoroughly washed in sufficient water three to four times. Washed grains were soaked in water for 20 to 30 minutes. The grains were boiled until they became soft. After cooling down calcium sulphate (CaSO_4) at the rate of 2% and calcium carbonate (CaCO_3) at the rate of 1% were added (on dry weight basis of grains) (Rózsa *et al.*, 2016).

About 200g prepared grains substrate was filled in conical flask up to 2/3 volumes and plugged with non-absorbent cotton. These flasks were autoclaved at 121 °C for 2 hours. After cooling, the flasks were inoculated with a piece of growing mycelium and incubated at 26 °C (Rózsa *et al.*, 2016).

Recorded parameters were: days required for complete mycelium run, time taken for primordial initiation, time taken from primordial stage to harvesting stage.

The processing of the obtained results was made by analysing the polyfactorial variance, on each analysed character, and the statistical interpretation was made with the ANOVA program by the Duncan test.

RESULTS AND DISCUSSION

The days required for *P. citrinopileatus* mycelium run on each type of grain spawn substrates was recorded and are presented in table 1. The minimum mycelium run time was recorded by maize grain spawn substrate (16.75 days) followed by wheat grain (17 days), then by millet grain spawn (18.25 days) which was similar to sorghum grain spawn (18.75 days).

The probable reason for such results may be due the availability of specific nutrient in maize grain (eg. maize grain contains 3.6% protein, 66.2% carbohydrates, 2.6% minerals and small amount of B complex vitamins and E vitamin (Singh and Singh, 2013), that may have accelerated the mycelium run. The results of present study corroborate with the study of Chaubey *et al.*, (2010). They recorded mycelium run days for complete colonization of substrate (wheat straw) from 18.33-26.00 days. This variation may be due to ecological factors. (Sahu *et al.*, 2014) reported that time taken for mycelium run ranged from 9.66 to 11 days for different grain spawn substrates.

Siddhant *et al.* (2014) also reported that time taken for complete mycelium run, ranged from 13-18 days by use of different grain spawn. These

results are similar to results of the present study. The probable reason for such findings may be due to the size of grains. Small grains provide more points of inoculum per gram of spawn. The spawn prepared on small grains cover the substrates sooner. Chauhan and Gupta (2015) reported the time taken for complete mycelium run ranged from 13.67 to 18.33 days. This may be due the different types of substrates, wheat straw substrate took 14.67 days for complete mycelium run.

Table 1

Mycelial growth of *P. citrinopileatus* on different grains

Spawn type	Complete mycelium run – days	Primordial initiation – days	Time taken from primordial stage to harvesting stage – days
Wheat grain spawn	17 b	6 a	2.37 b
Sorghum grain spawn	18.75 a	4.75 c	3 a
Millet grain spawn	18.25 ab	5.25bc	2.95 a
Maize grain spawn	16.75 c	5.50 ab	2.5 ab

The time taken from stimulation to primordial initiation of *P. Citrinopileatus* mushrooms ranged from 4.75 to 6 days. The minimum time taken for primordial initiation was recorded in sorghum grain spawn (4.75 days) followed by millet grain spawn (5.25 days), maize grain spawn (5.50), as compared to wheat grain spawn time taken from stimulation to primordial initiation (6 days) as presented in table 1. The variation probably occurred due to lignocellulosic materials, especially carbon and nitrogen ratio in grain spawn substrates which greatly contributed to primordial development.

Similar findings have been reported by Bhattachrjya *et al.* (2014), who found that oyster mushroom, took 6-8 days for primordial initiation, but in present study, it ranged from 4.75 to 6 days. The probable reason for such findings due to different grain spawn substrates or varieties. The results of present study are similar to results of Sahu *et al.* (2014) who reported the time taken for primordial initiation ranged from 2-5.90 days in case of different grain spawn substrates cultivated on wheat straw. Similar findings have been reported by Hasan *et al.* (2015) who recorded the time taken for primordial initiation ranged from 3.33 to 6.50 days, which was in accordance to the present results.

The minimum time taken from primordial stage to harvesting stage of *P. Citrinopileatus* mushrooms was recorded on wheat grain spawn (2.37 days) followed by maize grain spawn (2.5 days) and millet grain (2.95 days). The maximum time from primordial stage to harvesting stage was observed at sorghum grain spawn (3 days). The minimum time from primordial stage to

harvesting stage was recorded from wheat grain spawn substrate, the probable reason may be due to carbon and nitrogen ratio in substrate. Carbon and nitrogen plays an important role in growth of fruiting body. Shah *et al.*, (2014) reported that time taken for fruiting body formation of oyster mushroom is 3-6 days. Hasan *et al.* (2015) reported time from primordial stage to harvesting stage, ranged from 3.39 to 5.00 days. The probable reason for such findings may be due to low protein content or supplementation of substrates.

CONCLUSIONS

1. Mycelium run days varied significantly due to different grain spawn substrate used.
2. The maximum time taken for mycelium run was recorded by wheat grain spawn substrate.
3. The maximum time taken from stimulation to primordial initiation was recorded by wheat grain spawn and the minimum time by sorghum grain.
4. The minimum time taken from primordial stage to harvesting was recorded by wheat grain spawn.
5. Millet grains proved to be best for *P. Citrinopileatus* spawn preparation.

REFERENCES

1. **Bhattachrjya D.B., Paul R.K., Miah M.N., Ahmed K.U., 2014** - *Effect of different sawdust substrates on the growth and yield of oyster mushroom (Pleurotusostreatus)*. Journal of Agriculture and Veterinary Science. 7(2): 38-46.
2. **Biswas K.M., Biswas B.S., 2015** - *Recycling of ligno-cellulosic waste materials through oyster mushroom cultivation for sustainable food production*. International Quarterly Journal of Environmental Science. 9 (3-4): 655-659.
3. **Chaubey A., Dehariya P., Vyas D., 2010** - *Seasonal productivity and morphological variation in Pleurotusdjamor*. Indian Journal of Science Research. 1(1): 47-50.
4. **Chauhan P., Gupta D., 2015** - *Bioconversions of low quality lignocellulosic agricultural waste into edible protein by Pleurotusdjamor*. International journal of Bio-resource and Stress Management. 6(1): 135-139.
5. **Gupta A., Sharma P., 2014** - *Comparative study of different grains on spawn development of Pleurotussajor-caju (Fr.) Singer*. International Journal of Plant Science. 9(1): 190-192.
6. **Hasan M.T., Khatun M.H.A., Sajib M.A.M., Rahman M.M., Rahman M.S., Roy M., Miah M.N., Ahmed K.U., 2015** - *Effect of wheat bran supplemented with sugarcane bagasse on growth, yield and proximate composition of pink oyster mushroom (Pleurotusdjamor)*. American Journal of Food Science and Technology. 3 (6): 150-157.
7. **Moser M., 1978** - *Keys to Agarics and Boleti*. Roger Phillips, London.
8. **Rahman M.M., Ahmad K.U., Miah M.N.U., Khatoun S., Hossain A., 2015** - *Effect of watering frequency on proximate analysis of pink oyster mushroom*. Journal of Boresearch and Communication. 1(1): 36-39.
9. **Rózsa S., Măniuțiu D.N., Sima Rodica, Gocan Tincuța-Marta, Butuza-Bumb Felicia-Suzana, 2016** - *Research on the transfer material to obtain mycelium on the*

- granular support at Agaricus blazei Murrill mushrooms. Lucrări științifice – seria Agronomie, USAMV Iași, vol. 59.*
10. **Rózsa S., Măniuțiu D.N., Gocan Tincuța-Marta, David Stela, Butuza-Bumb Felicia-Suzana, 2016** - *Research on the influence of temperature on the growth of Agaricus blazei Murrill mushroom mycelium.* Agriculture – science and practice, USAMV Cluj-Napoca, anul XXV, nr. 1-2 (97-98), 53-57.
 11. **Rózsa S., Măniuțiu D.N., Gocan Tincuța-Marta, David Stela, Butuza-Bumb Felicia-Suzana, 2016** - *Dynamic of Agaricus blazei Murrill mushroom mycelium growth,* Journal of Horticulture. Forestry and Biotechnology, USAB Timișoara, 20(1), 120-122.
 12. **Rózsa S., Măniuțiu D.N., Gocan Tincuța-Marta, David Stela, Butuza-Bumb Felicia-Suzana, 2016** - *Research on the biology of the Agaricus blazei Murrill mushroom mycelium,* Journal of Horticulture, Forestry and Biotechnology, USAB Timișoara, 20(1), 123-126.
 13. **Sahu S.K., Singh D.P., Patel R., Awadhiya G.K., 2014** - *Screening of suitable grains substrates for spawn development, growth and yield of Pleurotus.* American International Journal of Research in Formal, Applied and Natural Sciences. 86-89.
 14. **Shah Z.A., Ashraf M., Ishtiaq M., 2014** - *Comparative study on cultivation and yield performance of oyster mushroom (Pleurotus ostreatus) on different substrates (wheat straw, leaves, saw dust).* Pakistan Journal of Nutrition. 3(3): 158-160.
 15. **Siddhant Yadav, Singh C.S., 2013** - *Spawn and spawning strategies for the cultivation of Pleurotus.* International Journal of Pharmacy and Chemical Science. 2(3): 1494-1500.
 16. **Singer R., 1986** - *The Agaricales in Modern Taxonomy.* Koeltz Scientific Books, Germany.
 17. **Singh S.S., Singh R., 2011** - *Crop management.* Kalyani Publishers, New Delhi, India.
 18. **Stamets P., 2000** - *Growing Gourmet and Medicinal Mushrooms,* Third edition, ten Speed Press Berkeley, CA.

THE INFLUENCE OF TEMPERATURE AND pH ON *CORDYCEPS MILITARIS* MUSHROOM MYCELIUM GROWTH

INFLUENȚA TEMPERATURII ȘI A pH-ULUI ASUPRA CREȘTERII MICELIULUI CIUPERCII *CORDYCEPS MILITARIS*

RÓZSA MELINDA¹, APAHIDEAN MARIA²

e-mail: apahidean_maria@yahoo.com

Abstract. *Cordyceps* is from the Greek *kordyle* meaning “club” and *ceps* for “head”. *Sinensis* means “from China”. *Militaris* is related to the growth pattern that looks like a regiment of toy soldiers. *Cordyceps* is the fruiting body of fungi parasitizing other fungi, such as the deer truffle (*Elaphomyces* spp.), or insects, such as caterpillars of moths, ants, and beetles. It grows inside the caterpillars and other insects to produce hyphae. When they die, the fungus produces a fruiting body that sporulates into the wind to infect another generation. For the successful cultivation of any mushroom on a small scale or commercial scale, one of the most important requirements is the mycelium of that species or variety. The spawn is a pure culture of the mycelium grown on a special medium. The growing temperature and substrate pH are specific for each species and variety.

Key words: mushrooms, *Cordyceps militaris*, spawn, temperature, pH

Rezumat. *Cordyceps* provine din grecescul *kordyle* care înseamnă "club" și *ceps* care înseamnă "cap". *Sinensis* înseamnă "din China". *Militaris* este legat de modul de creștere, care arată ca un regiment de soldați de jucărie. *Cordyceps* este un organ de fructificare al unei ciuperci, care parazitează alte ciuperci, cum sunt Truftele de cerb (*Elaphomyces* spp.) sau insectele, cum sunt omizii de molii, furnicile și gândacii. Ea crește în interiorul omizi și în insecte pentru a produce hife. Când mor, ciuperca produce un corp fructifer, care sporulează în vânt pentru a crea o altă generație. Pentru cultivarea cu succes a oricărui ciuperci la scară mică sau la scară comercială, una dintre cele mai importante cerințe este miceliul acestei specii sau varietății. Miceliul este o cultură pură pe un mediu special. Temperatura de creștere și pH-ul substratului sunt specifice fiecărei specii și tulpini.

Cuvinte cheie: ciuperci, *Cordyceps militaris*, miceliu, temperatură, pH

INTRODUCTION

Cordyceps sinensis is the most well-known, but the genus can claim several other medicinal stars. It parasitizes the larvae of a bat moth. It is estimated that over 680 varieties of *Cordyceps* have been discovered and named, and more than thirty are common in alpine terrain.

¹ SC CIUPERCĂRIA SRL, Aghireșu-Fabrici, Cluj County, România

² University of Agricultural Sciences and Veterinary Medicine, Cluj-Napoca, România

In ancient times, its use was restricted to the Emperor's Palace, and baked in duck as a tonic similar to Ginseng. It sold at one time for four times its weight in silver. It has a spicy cinnamon fragrance that lends itself to soups and broths.

Cultivation

Although the use of wild fungi for medicinal purposes is appealing, the fermentation of mycelium on wheat and other grains produces a safer and more consistent product. Various studies indicate similar antioxidant properties between wild and cultivated strains. Another advantage of the fermented product is that it is 100 percent vegetarian. Various substrates have been used including wheat, rice, sorghum, and even organic purple corn.

Isaka *et al.* (2005) isolated a new *C. sinensis* anamorph with potential to improve cultivated lines.

Traditional Uses

Adder's tongue is mild, slightly acrid, and used in traditional Chinese medicine as a lung and kidney tonic. It increases production of red blood cells, increases sperm production, and strengthens qi.

It combines well with Garden Burnet (*Sanquisorba officinalis*) root for menorrhagia and irregular menstrual cycles. This is probably due to two compounds isolated from the mycelium that possess estrogenic activity (Kawagishi *et al.* 2004).

Chinese Caterpillar mushroom (*C. sinensis*) has been used as an aphrodisiac for nearly two thousand years, with the first written record in the Classic Herbal of the Divine Plow-man from 200 AD.

Cordyceps strengthen both the mind and body at a very basic level, replenishing yin jing and restoring the deep energy depleted by excessive stress.

In traditional Chinese medicine, the mushroom is used for fatigue, wheezing, shallow breathing, and loss of stamina associated with kidney and lung yang deficiency.

Because it tonifies both yin and yang, it can be used safely in nearly any endocrine condition to help relieve fatigue and calm the nervous system. To be more exact, Cordyceps is both yin-nourishing and yang-invigorating.

Medicinal Use

Chemical Constituents

■ *C. sinensis*: various sterols, polysaccharides, galactomannans, cordycepic acid, protein, adenine, adenosine, uridine, uracil, cordycepin, mannitol, eighteen amino acids, ergosterol, vitamin B12, trace elements, and saturated and unsaturated fatty acids.

■ *C. militaris*: cordycepin, ergosterol, beta sitosterol, adenosine, adenine, and D-mannitol.

C. militaris contains cordycepin that shows reverse transcriptase inhibition (Penman *et al.*, 1970). According to Christopher Hobbs, in his inspiring book Medicinal Mushrooms, cordycepin (3'-deoxyadenosine) was dropped as a clinical isolate for cancer due to its toxic side effects.

Hui Mei Yu *et al.* (2006) compared the oxidative damage protection of *C. militaris* and *C. sinensis*. The content of adenosine and cordycepin is higher in the former and both show antioxidant protection.

Kim *et al.* (2006) found *C. militaris* more hypoglycaemic in activity than in *C. sinensis*. Rukachaisirikul *et al.* (2004) identified cordycepin, pyridine-2,6-dicarboxylic acid, and cepharosporides C, E, and F in this species.

Work by Lin *et al.* (2007) on sub fertile boars found both the quality and quantity of sperm increased by supplementation with *C. militaris* powder.

Water extracts of *C. militaris* have been found to induce apoptosis and growth inhibition of U937 leukaemia cells. The regulation of several major growth gene products such as Bcl-2 family expression and caspase protease activity suggests therapeutic potential for human leukaemia (Park *et al.*, 2005).

The fungi induced IL-18 and acted on IFN- γ production (Kim *et al.* 2008).

Extracts of *C. militaris* have been found to exhibit anti-angiogenic properties and repress growth of B16-F10 melanoma cells in mice compared to Controls (Yoo *et al.*, 2004).

Pokhrel *et al.* (2006) found a hot-water extract of *C. militaris* inhibited cancer cell proliferation by inducing cell apoptosis through the activation of caspase-3, and that the extract may have potential in human leukemia.

A polysaccharide isolated from culture, CPS-1 has been shown to possess significant anti-inflammatory activity and suppressed the humoral immunity in mice, but no significant effect on cellular and non-specific immunity has been found (Yu *et al.*, 2004).

MATERIAL AND METHOD

For the experiments with the *Cordyceps militaris* mushroom mycelium was used a semisolid agar medium using the following formula/recipes:

1. PDA – potatoes dextrose agar, composed by 200g sliced potatoes, 20g agar, 20g dextrose, 1000ml distillate water, sterilized at 121 °C for 1 hour (Rózsa *et al.*, 2016a, b).

2. CEA – compost agar, composed by 50g dry *Agaricus* compost extract, 20g agar, 1000ml distillate water, sterilized at 121°C for 1 hour in the first day, repeated after 24 hours and 48 hours (Rózsa *et al.*, 2016b, c).

3. MEA – malt extract agar, composed by 50g malt extract, 20g agar and 1000ml distillate water, sterilized at 121°C for 1 hour (Rózsa *et al.*, 2016c, d).

The tested temperature ranges in this study were: 22, 23, 24, 25, 26, 27, 28, 29, 30, 31°C. The pH ranges used in the experience were: 4*, 4.5*, 5* (* - adjusted with citric acid C₆H₈O₇), 5.5, 6**, 6.5**, 7**, 7.5** and 8** (** - adjusted with sodium hydroxide 1n NaOH).

The results were recorded during 10 days of mycelium run and was expressed in mm/day.

RESULTS AND DISCUSSION

The influence of temperature on mycelial growth, is presented in figure 1.

Following the results presented in figure 1, we can see that the maximum mycelial growth was recorded at 26 °C on PDA recipe with 9.8 mm / 10 days, being followed by MEA recipe at 27 °C with 9.7 mm of growth on 10 days.

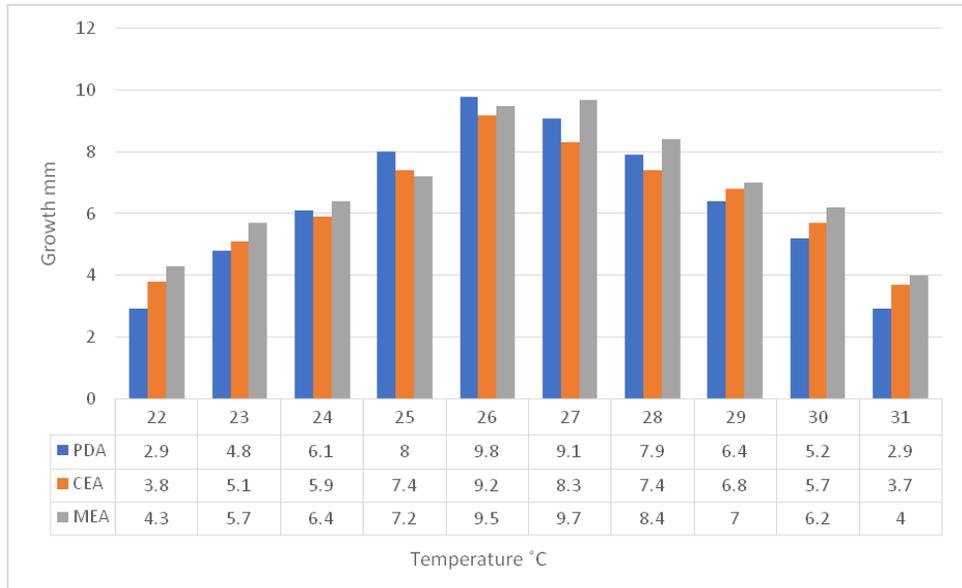


Fig. 1 The influence of temperature and recipe on *Cordyceps militaris* mycelium growth.

Taking into account the unilateral influence of recipe used in experience on the *C. militaris* mycelial growth (fig.1), we recorded a difference of 1.85 mm/day being very significant positive, to PDA taken as controls which registered value 9.8 mm/ 10 days.

Taking into account the unilateral influence of temperature used in experience on the *C. militaris* mycelial growth, we recorded a difference of 2.21 mm/day at 26 °C being very significant positive, to 24 °C taken as controls (fig. 1) which registered 6.1 mm/ 10 days.

The influence of combined factors, temperature on the growth recipe of mycelium, at 26°C, were recorded the highest values, on PDA recipe, followed by 27 °C and 26 °C on MEA recipe. On the last place was located 22 and 31 °C, both temperatures for PDA recipe.

The influence of pH on mycelial growth, is presented in figure 2.

Following the results presented in Fig. 2, we can see that the maximum mycelial growth was recorded at 5.5 pH value on CEA recipe with 9.9 mm / 10 days, being followed by MEA recipe at the same pH value with 8.9 mm of growth on 10 days.

Taking into account the unilateral influence of recipe used in experience on the *C. militaris* mycelial growth (fig. 2), we recorded a difference of 1.35

mm/day being very significant positive, to PDA taken as controls which registered value 9.2 mm/ 10 days.

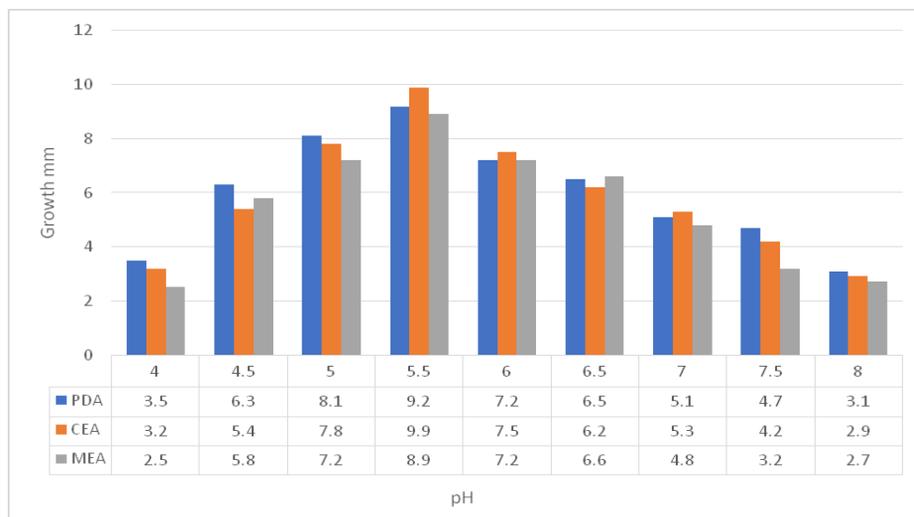


Fig. 2 The influence of pH and recipe on *Cordyceps militaris* mycelium growth.

Taking into account the unilateral influence of temperature used in experience on the *C. militaris* mycelial growth, we recorded a difference of 1.27 mm/day at 5.5 pH value, being very significant positive, to pH value 5 taken as controls (fig. 2) which registered 8.1 mm/ 10 days.

The influence of combined factors, pH on the growth recipe of mycelium, at 5.5 pH value, were recorded the highest values, on CEA recipe, followed by 5 pH value with 8.1 mm / 10 days on PDA recipe and 7.5 mm of growth / 10 days at 6 pH value. On the last place was located pH 4 with 2.5 mm growth on MEA recipe and pH 8 with 3.1 mm of growth on PDA recipe.

CONCLUSIONS

Mycelium run days varied significantly due to different recipes, pH and temperature values.

The optimal temperature range for *Cordyceps militaris* studied strain is 26-28 °C, on PDA and MEA recipe, at 5.6 pH value.

REFERENCES

1. Isaka M., Kittakoop P., Kirtikara K., Hywel-Jones N. L., Thebtaranonth Y., 2005 - Bioactive substances from insect pathogenic fungi. Accounts of Chemical Research, 38(10), 813-823.
2. Kawagishi Hirokazu et al., 2004 - Estrogenic substances from the mycelia of medicinal fungus *Cordyceps ophioglossoides* (Ehrh.) Fr. International Journal of Medicinal Mushrooms 6(3): 255-259.

3. Kim J. S., Sapkota K., Park S. E., Choi B. S., Kim S., Hiep N. T., ... Park Y., 2006 - A fibrinolytic enzyme from the medicinal mushroom *Cordyceps militaris*. The Journal of Microbiology, 44(6), 622-631.
4. Kim Chung Sung et al., 2008 - *Cordyceps militaris* induces the IL-18 expression via its promoter activation for IFN production. Journal of Ethnopharmacology 120(3): 266-371.
5. Lin W. H., Tsai M. T., Chen Y. S., Hou R. C. W., Hung H. F., Li C. H., ... Jeng K. C. G., 2007 - Improvement of sperm production in subfertile boars by *Cordyceps militaris* supplement. The American journal of Chinese medicine, 35(04), 631-641.
6. Park Cheol et al., 2005 - Growth inhibition of U937 leukemia cells by aqueous extract of *Cordyceps militaris* through induction of apoptosis. Oncology Reports 13(6): 1211-1216.
7. Penman et al., 1970 - Messenger and heterogeneous nuclear RNA in HeLa cells: Differential inhibition by cordycepin. Proceedings of the National Academy of Science 67(4): 1878-1885.
8. Pokhrel C.P. and Ohga, S., 2007 - Submerged culture conditions for mycelial yield and polysaccharides production by *Lyophyllum decastes*. Food chemistry, 105(2), 641-646.
9. Rózsa S., Măniuțiu D.N., Sima Rodica, Gocan Tincuța-Marta, Butuza-Bumb Felicia-Suzana, 2016a - Research on the transfer material to obtain mycelium on the granular support at *Agaricus blazei* Murrill mushrooms. Lucrări științifice – seria Agronomie, USAMV Iași, vol. 59.
10. Rózsa S., Măniuțiu D.N., Gocan Tincuța-Marta, David Stela, Butuza-Bumb Felicia-Suzana, 2016b - Research on the influence of temperature on the growth of *Agaricus blazei* Murrill mushroom mycelium. Agriculture – science and practice, USAMV Cluj-Napoca, anul XXV, nr. 1-2 (97-98), 53-57.
11. Rózsa S., Măniuțiu D.N., Gocan Tincuța-Marta, David Stela, Butuza-Bumb Felicia-Suzana, 2016c - Dynamic of *Agaricus blazei* Murrill mushroom mycelium growth. Journal of Horticulture, Forestry and Biotechnology, USAB Timișoara, 20(1), 120-122.
12. Rózsa S., Măniuțiu D.N., Gocan Tincuța-Marta, David Stela, Butuza-Bumb Felicia-Suzana, 2016d - Research on the biology of the *Agaricus blazei* Murrill mushroom mycelium. Journal of Horticulture, Forestry and Biotechnology, USAB Timișoara, 20(1), 123-126.
13. Rukachaisirikul et al., 2004 - 10-membered macrolides from the insect pathogenic fungus *Cordyceps militaris* BCC 2816. Journal of Natural Products 67(11): 1953-1955.
15. Yoo Hwa-Seung et al., 2004 - Effects of *Cordyceps militaris* extract on angiogenesis and tumor growth. Acta Pharmacologica Sinica 25(5): 657-665.
16. Yu H.M., Wang B.S., Huang S.C., Duh P.D., 2006 - Comparison of protective effects between cultured *Cordyceps militaris* and natural *Cordyceps sinensis* against oxidative damage. Journal of Agricultural and Food Chemistry, 54(8), 3132-3138.
17. Yu Rongmin et al., 2004 - Isolation and biological properties of polysaccharide CPS-1 from cultured *Cordyceps militaris*. Fitoterapia 75(5): 465-472.

INTERACTION BETWEEN GROWING SUBSTRATE NITROGEN CONTENT AND *AGARICUS BLAZEI* MURRILL MUSHROOMS PROTEIN CONTENT

INTERACȚIUNEA DINTRE CONȚINUTUL DE AZOT AL SUBSTRATULUI DE CULTURĂ ȘI CONȚINUTUL DE PROTEINĂ AL CIUPERCILOR *AGARICUS BLAZEI* MURRILL

RÓZSA S.^{1*}, LAZĂR V.¹, GOCAN Tincuța Marta¹,
RÓZSA Melinda², POȘTA G.³
e-mail: drd.rozsa.sandor@gmail.com

Abstract. *Mushrooms provide important sources of protein extracted from materials of very low economic value, such as manure, agricultural waste, forestry, wood industry. Cultivated mushrooms having a saprophyte diet are forced to feed their enzymes from decomposing organic substances. During the composting and pasteurization of the substrate, the protein nitrogen is transformed into peptides and amino acids that are absorbed by mycelial hippocampal cells. Research has shown that there is a direct correlation between the total nitrogen content of the nutrient substrate (up to 2.7%), the production of mushrooms and the protein content of the mushrooms. In this study, four types of compost and three types of additional protein additions were investigated. The highest values of correlation coefficient ($r = 0.88187$) were obtained with the addition of 3% wheat bran, additional protein supplement in the substrate.*

Key words: mushrooms, *Agaricus blazei* Murrill, protein, substrate, protein addition

Rezumat. *Ciupercile asigură importante surse de proteine extrase din materiale cu valoare economică foarte scăzută, cum ar fi gunoiul de grajd, deșeurile din agricultură, din silvicultură, industria lemnului. Ciupercile de cultură, având un regim de nutriție heterotrof saprofit sunt obligate să-i ia hrana din substanțele organice în descompunere, cu ajutorul enzimelor. În timpul compostării și pasteurizării substratului, azotul proteic se transformă în peptide și acizi aminici, care sunt absorbiți de celulele hifelor miceliene. În urma unor cercetărilor, s-a constatat că între conținutul de azot total al substratului nutritiv (de până la 2,7%), producția de ciuperci și conținutul în proteină al ciupercilor, există o corelație directă. În studiul de față s-au efectuat cercetări pe patru tipuri de compost și trei tipuri de adaosuri proteice suplimentare. Valorile cele mai ridicate ale coeficientului de corelație ($r=0,88187$) au fost obținute în cazul utilizării ca și adaos proteic suplimentar în substrat a tărâțelor de grâu 3%.*

Cuvinte cheie: ciuperci, *Agaricus blazei* Murrill, proteină, substrat, adaos proteic

¹University of Agricultural Sciences and Veterinary Medicine, Cluj-Napoca, România

²SC CIUPERCĂRIA SRL, Aghireșu-Fabrici, Cluj County, România

³Banat University of Agricultural Sciences and Veterinary Medicine, Timișoara, România

INTRODUCTION

The chemical composition of fungi differs from one species to another, their stage of development, the nutritive substrate used to produce them, the part of the mushroom from which the samples are harvested, the duration of growth and development of the mushrooms, as well as the microclimate in the spaces of culture (Manzi *et al.*, 1999). Compared with spontaneous flora, mushrooms are much appreciated due to the increase in protein content and higher commercial quality (Abah and Abah, 2010).

The use of mushrooms with therapeutic effects is one of the most exciting areas of natural medicine, offering a significant therapeutic benefit, backed by a long history of traditional use and more and more scientific evidence (Wasser, 2010). The *Agaricus blazei* Murrill species (fig.1) is called popular the royal fungus, God's mushroom, the goddess's mushroom, the fungus of the sun.



Fig.1 *Agaricus blazei* Murrill mushrooms (original)

semi-globular in the beginning, then convex, smooth on the edges and in the centre, white, yellow-creamy like an almond, or light brown to dark brown, brown. On the edge of the hat remain veils. It has almond flavour. The lamellas are free, dense, 8-10 mm wide in white, pale pink when young, and later chocolate brown. Basidiospores are dark brown up to chocolate, 6-8 x 4-5 microns, wide-elliptical, without episore. The leg is short and stout, like a column, filled in, cylindrical, white, attached to a mycelian base. Touched with hand is coloured in yellow. On the leg remains a ring after the velvet breaks. The length is 6-13 cm, and the diameter is 1-3 cm (Stamets, 2000).

Agaricus blazei Murrill mushrooms are secondary saprophytes, which develop on a partially processed substrate in which microorganisms reduce complex ligno-cellulosic compounds (Chen, 2003).

Increasing the nutritional quality of mushroom compost is a prime factor in increasing yield. Schisler and Sinden (1966) have shown that when the compost was supplemented with various seeds ground together with refined and crude seed oils applied to the compost before applying the coating, the production of mushrooms increased. The addition of compost with various protein additions was also attempted by Sinden and Sehialer (1962). Vijay *et al.* (2002) have found that supplements in compost and coating have increased the yield of *Agaricus bisporus*.

Following Siqueira *et al.* (2011), if an adequate amount of nitrogen is added to a carbon-rich substrate, the mycelium growth and the quality of the fructification bodies are considerably improved. According to Andrade *et al.* (2007) and Siqueira *et al.* (2011), the optimal initially nitrogen content of the substrate should be 1-1.5%. Selection of the nitrogen source is essential because the *Basidiomycetes* mushrooms do not produce nitrate reduction enzymes (Gerrits, 1998). For *Agaricus blazei* Murrill mushrooms, the best source of nitrogen is urea and the most useful C: N ratio ranges from 10:1 to 50:1 (Mantovani *et al.*, 2007). The nutrient substrate must exhibit degradation or microbial synthesis products in assimilable form as quickly as possible by the fungus, having a biochemical specificity corresponding to the metabolic requirements of the fungus (Zicari *et al.*, 2012).

MATERIAL AND METHOD

To study the influence of compost recipes on substrate quality and mushroom production, a bifactorial experience has been organized. Factor A was the culture substrate with 4 graduations: a₁-classical compost, a₂-synthetic compost, a₃-mixed compost and a₄-groove + horse manure compost. Factor B was the protein addition with 3 graduations: b₁ - without protein addition, b₂ - 3% wheat bran protein addition and b₃ - 3% corn flour protein addition. The combination of experimental factors resulted in 12 variants.

RESULTS AND DISCUSSION

At the beginning of the anaerobic composting phase, the water content of the mixtures for each experimental variant ranged from 74-78%, organic matter determined at 63-68%, nitrogen 1.7-1.9%, calcium 82-95 mg/l, magnesium 4-5 mg/l, ammonia (NH₃) 0.5-0.6%, pH 8.87-8.98, and electrical conductivity (EC) 3.45-3.78 dS/cm. The data obtained are also found in the literature (Andrade *et al.*, 2007, Chatterjee *et al.*, 2013, Xiang *et al.*, 2014).

At the end of the aerobic composting phase, the water content of the mixtures was in the range of 67-71%, the organic matter determined at DM 53-56%, nitrogen between 1.7-1.8%, calcium between 79-90 mg/L, magnesium between 3.7-4.85 mg/L, ammonia (NH₃) between 0.20-0.29%, pH between 7.98-8.24, and the electrical conductivity (EC) determined in this phase was in the range 2.83-2.98 dS/cm.

By comparing the data presented above, it can be said that during aerobic composting, water content in compost decreases from 74-75% to 67-71%, the content of organic matter drops from 63-68% to 53-56% nitrogen content drops by about 0.1%, calcium content decreases by 5mg/l, magnesium decreases by 0.1-0.3mg/L, ammonia (NH₃) decreases by 0.3% and pH decreases at 8.95 to 8.24, the best values being obtained on the mixed compost version.

Following the dynamics of physicochemical transformations during pasteurization for each type of compost, it was observed that after the pasteurization, the relative humidity of the compost decreased and stabilized in the range of 63-65% for each type of compost, the data being also found in the literature Garcia *et al.*, (1992) mentions 60-0%. After pasteurization, the pH of the compost decreased from 7.98-8.24 to 7.21-7.5, being in the range set by Gonzales Matute *et al.* (2011), 7.1-7.9. After pasteurization, total nitrogen in compost increased by 85%, ranging from 2.1-2.6%. Colak (2004) mentions 2.8% total nitrogen after pasteurization.

From the presented data, it can be noticed that during the pasteurization of the compost there are losses of up to 36.3% of the fresh matter and up to 30.1% of the dry matter of the compost, the biggest losses being recorded in the cane compost for the fresh substance and for the dry matter in the mixed compost. Gerrits *et al.* (1997) reported losses during compost pasteurization of up to 40% of the fresh and 35% of the dry matter of the compost, values higher than those in our experience.

At the end of the pasteurization phase, the compost water content for each experimental variation ranged from 63-65%, Horm and Ohga (2008) mentioning 60-65%, Chatterjee *et al.*, (2013) 60-70%.

Organic matter determined at DM at this stage, it was in the range of 49-52%, falling within the studied values by other authors Stanek (2010) 45-50% and Siqueira *et al.* (2011) 50%.

Nitrogen determined at DM at this stage, it was in the range of 2.1-2.6%, below the value obtained by Gerben *et al.*, (1998) 2.8%.

The interaction of experimental factors on the correlation between the amount of nitrogen in the culture substrate and the amount of protein in the harvested mushrooms highlights the close link between them.

From the results obtained it was found that the amount of protein in the mushrooms increase with the amount of nitrogen in the culture substrate. Regardless of the culture substrate, linear equations calculated for each protein addition were emphasized.

In the first case, on the supplementary proteinfree substrate (fig. 2) it can observe the value of the correlation coefficient $r = 0.76603$ is distinctly significant.

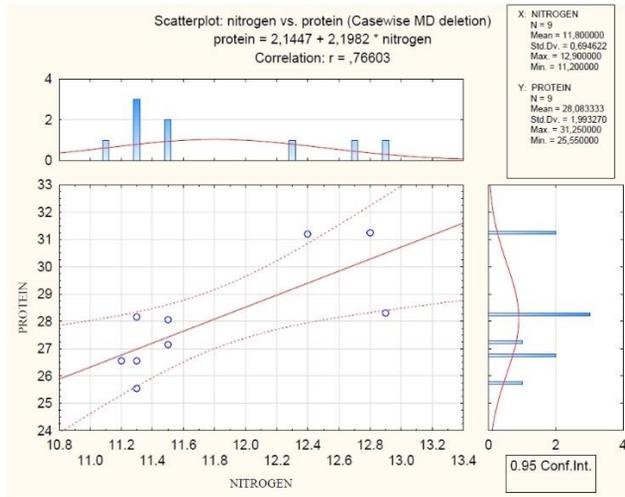


Fig. 2 Correlation between the amount of nitrogen in the substrate without added protein and the amount of mushroomsprotein content

In the case of the use of additional proteinaceous wheat bran 3% in the culture substrate, the coefficient of correlation increases ($r = 0.88187$) being very significant (fig. 3).

Higher correlation coefficients show a much closer direct link between the nitrogen content of the culture substrate and the protein content of the mushrooms. The addition of 3% wheat bran has positively influenced the amount of mushrooms protein.

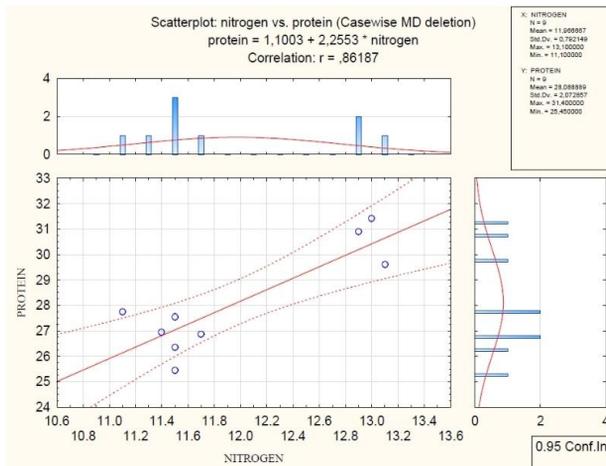


Fig. 3 Correlation between the amount of nitrogen in the 3% wheat bran addition substrate and the amount of mushroomsprotein content

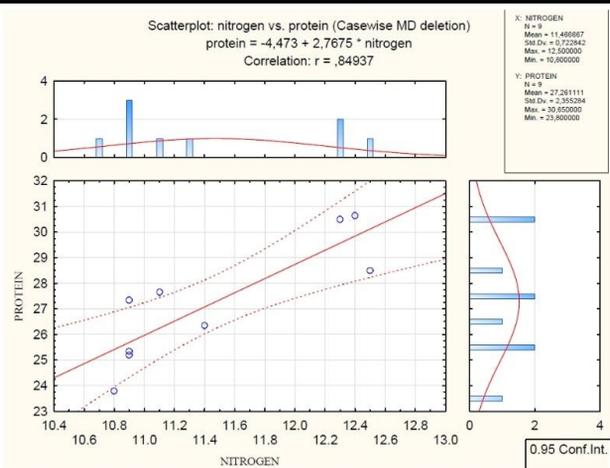


Fig.4 Correlation between the amount of nitrogen from the 3% corn flour addition substrate and the amount of mushroom protein content

In case 3% corn flour protein added as a protein additive, correlating the nitrogen content of the substrate with the amount of protein of the mushrooms, very significant linear correlations ($r = 0.84937$) were obtained (fig. 4). However, these values were lower than in the case of additional protein supplement with 3% wheat bran.

Regarding the protein content of *Agaricus blazei* Murrill mushroom, Tsai *et al.* (2008) mentions 26.7% protein from DM, Carneiro *et al.* (2013) 31.3%, Cohen *et al.* (2014) 28% and Stojkovic *et al.* (2014) 13.4%.

Compared with *Agaricus bisporus* mushroom, the protein content of *Agaricus blazei* Murrill is similar. Thus, Matilla *et al.* (2002) reported 26.5-27.1%, Akyuz and Kirbag (2010) 36.3%, Ulzijjargal and Mau (2011) 26.5%, Reis *et al.* (2012) 14.1-15.4%.

CONCLUSIONS

1. From the obtained results, it was found that as the amount of nitrogen in the substrate increases, will increase also the amount of mushroom protein.

2. Regardless of the culture substrate, linear equations calculated for each protein addition were emphasized.

3. The closest connection between the amount of nitrogen in the culture substrate and the protein content of the mushrooms is found in the case of compost with 3% wheat bran addition, the correlation coefficient being very significant ($r = 0.88187$).

4. It can be argued that the two additional protein additions lead to an increase in the correlation coefficient, being beneficial to the culture of *Agaricus blazei* Murrill mushrooms.

REFERENCES

1. Abah S.E., G. Abah, 2010 - *Antimicrobial and antioxidant potentials of Agaricus bisporus*. Advances in Biological Research, Nigeria, 4 (5): 277-282.
2. Akyuz M., Kirbag S., 2010 - *Nutritive value of wild edible and cultured mushrooms*. Turk. J. Biol. 34, 97-102.
3. Andrade M.C.N., Kopytowski Filho J., Minhoni M.T.A., Coutinho L.N., Figueiredo M.B., 2007 - *Productivity, biological efficiency, and number of Agaricus blazei mushrooms grown in compost in the presence of Trichoderma sp. and Chaetomium olivacearum contaminants*. Braz. J. Microbiol. 38, 243-247.
4. Carneiro A.A.J., Ferreira I.C.F.R., Dueñas M., Barros L., Da Silva R., Gomes E., 2013 - *Chemical composition and antioxidant activity of dried powder formulations of Agaricus blazei and Lentinus edodes*. Food Chem. 138, 2168-2173.
5. Chatterjee N., Flury M., Hinman C., Cogger C.G., 2013 - *Chemical and Physical Characteristics of Compost Leachates*. Washington State University Journal, p. 79-85.
6. Chen A., 2003 - *A practical Guide to the Cultivation of Agaricus blazei, a Mushroom of Culinary and Biomedical Importance*. Mush World website, <http://www.mushworld.com>.
8. Cohen N., Cohen J., Asatiani M.D., Varshney V.K., Yu H.T., Yang Y.C., 2014 - *Chemical composition and nutritional and medicinal value of fruit bodies and submerged cultured mycelia of culinary-medicinal higher Basidiomycetes mushrooms*. Int.J. Med. Mushrooms 16, 273-291.
9. Colak M., 2004 - *Temperature profiles of Agaricus bisporus in composting stages and effects of different composts formulas and casing materials on yield*. African Journal of Biotechnology Vol. 3 (9), pp. 456-462.
10. Garcia C., Hernandez T., Costa F., Ceccanti B., Ciardi C., 1992 - *Changes in ATP content, enzyme activity and inorganic nitrogen species during composting of organic wastes*. Can. J. Soil. Sci 72: 243-253. <http://dx.doi.org/10.4141/cjss92-023>.
11. Gerben Straatsma, Jan P.G., Jac T.N.M., Jos G.M., 1998 - *Adjustment of the composting process for mushroom cultivation based on initial substrate composition*. Bioresource Technology 72:67-74.
12. Gerrits J.P.G., 1998 - *Nutrition and compost*. In: *The cultivation of mushrooms*. L.J.L.D. van Griensven (red.). Mushroom Experimental Station, Horst. Netherlands, 29-38.
13. Gerrits J.P.G., Amsing J.G.M., Straatsma G., 1997 - *Vochtgehalte en volumegegewicht van indoor compost*. Champignoncultuur 41, 179-183.
14. Gonzalez Matute R., Figlas D., Curvetto N., 2011 - *Agaricus blazei production on non-composted substrates based on sunflower seed hulls and spent oyster mushroom substrate*, World J. Microbiol. Biotechnol. 27, 1331-1339.
15. Horm V., Ohga S., 2008 - *Potential of compost with some added supplementary materials on the development of Agaricus blazei Murill*. J. Fac. Agr. Kyushu Univ. 53(2), 417-422.
16. Mantovani T.R.D., Linde G.A., Colauto N.B., 2007 - *Effect of addition of nitrogen sources to cassava fiber and carbon-to-nitrogen ratios on Agaricus brasiliensis growth*. Can. J. Microbiol. 53, 139-143.
17. Manzi P., Gambelli, L., Marconi, S., Vivanti, V., Pizzoferrato, L., 1999 - *Nutrients in edible mushrooms: An inter-species comparative study*. Food chem. 65:477-482.
18. Mattila R, Salo-Vaanane P., Konko K., Aro H., Jalava T., 2002 - *Basic composition and amino acid contents of mushrooms cultivated in Finland*. J. Agric. Food Chem. 50, 6419-6422.

19. Reis F.S., Barros L., Martins A., Ferreira I.C.F.R., 2012 - *Chemical composition and nutritional value of the most widely appreciated cultivated mushrooms: an inter-species comparative study*. Food Chem.Toxicol. 50,191-197.
20. Schisler, L.C., Sinden, J.W., 1966 - *Nutrient supplementation of mushroom compost at casing*. Canadian Journal of Botany, 4, 287-293.
21. Sinden J.W., Sehialer, L.C., 1962 - *Nutrient supplementation of mushroom compost at casing*. Mushroom Science, 5, 267-280.
22. Siqueira F.G., Martos E.T., Silva E.G., Silva R., Dias E.S., 2011 - *Biological efficiency of Agaricus brasiliensis cultivated in compost with nitrogen concentrations*. Hortic. Bras. 29, 157-161.
23. Stamets P., 2000 - *Growing Gourmet and Medicinal Mushrooms*. Third edition, ten Speed Press Berkeley, CA.
24. Stanek M., 2010 - *Microorganisms inhabiting mushroom compost during fermentation*. Mushroom Sci 8: 797-811.
25. Stojkovic D., Reis F.S., Glamoclija J., Ciric A., Barros L., Van Griensven L.J.L.D., 2014 - *Cultivated strains of Agaricus bisporus and A. brasiliensis: chemical characterization and evaluation of antioxidant and antimicrobial properties for the final healthy product - natural preservatives in yoghurt*. Food Funct. 5, 1602-1612.
26. Tsai S.Y., Tsai H.L., Mau J., 2008 - *Non-volatile taste components of Agaricus blazei, Agrocybe cylindracea and Boletus edulis*. Food Chem. 107, 977-983.
27. Ulziijargal E., Mau J.H., 2011 - *Nutrient compositions of culinary-medicinal mushroom fruiting bodies and mycelia*. Int.J. Med. Mushrooms 13, 343-349.
28. Vijay B., Sharma, S.R., Lakhanpal T.N., 2002 - *Effect of treating post-composting with different concentrations of formaldehyde on the yield of Agaricus bisporus*. Mushroom Biology and Mushroom Products, 239-242.
29. Wasser S.P., 2010 - *Medicinal mushroom science: history, current status, future trends and unsolved problems*. International Journal of Medicinal Mushroom, 12(1):1-16.
30. Xiang Z., Kenlin C., Xingdong W., Meng L., Yin W., 2014 - *Effects of Biochar from Spent Mushroom Substrate on Physic-chemical Properties during Pig Manure Composting*. Frontier of Environmental Science, June 2014, Volume 3, Issue 2, PP.67-74.
31. Zăgrean V., 2003 - *Cultivarea ciupercilor champignon*. Ed. Rentrop&Straton, București.
32. Zicari G., Rivetti D., Soardo V., Cerrato E., 2012 - *The cultivation of the mushroom Agaricus bisporus (Champignon) and some environmental and health aspects*. Brazilian Sanita Pubbl. May-Jun, 68(3):435-46.

CORRELATION BETWEEN SOLUBLE DRY MATTER AND β -1,3 D-GLUCAN CONTENT IN *AGARICUS BLAZEI* MURRILL MUSHROOMS

CORELAȚIE ÎNTRE SUBȘTANȚA USCATĂ SOLIBILĂ ȘI CONȚINUTUL DE β -1,3 D-GLUCAN LA CIUPERCILE *AGARICUS* *BLAZEI* MURRILL

RÓZSA S.¹

e-mail: drd.rozsa.sandor@gmail.com

Abstract. Experiments carried out by the researchers, about the extraction of the anti-tumour substances, like protein complex polysaccharides, which have demonstrated favorable effects of the immunostimulatory preparations and biologically active biomass obtained from certain species of fungi from the Basidiomycetae group. Thus, the antitumor activity of the β -1,3-D-glucan polysaccharide fractions extracted from mycelial biomass and fructification bodies of *Agaricus blazei* Murrill are well known. Mushrooms grown on synthetic substrate with wheat bran addition have a higher content of soluble dry substance (8.80%) and proteins (30.63% of the dm). The content of β -1,3-D-glucan, a specific substance in *Agaricus blazei* Murrill mushrooms, with a high biological value, is relatively high in the product obtained on the classic compost with the addition of corn flour and wheat bran (3.22-3.41 mg 100g⁻¹dm). Regression obtained from the correlation of these, shows strong link between the two components being very significant in both cases.

Key words: mushrooms, *Agaricus blazei* Murrill, polysaccharides, β -1,3-D-glucan, protein addition

Rezumat. Experimentele realizate de cercetători, privind extracția de substanțe antitumorale de tipul unor polizaharide complexe cu proteine, au demonstrat efectele favorabile și imunostimulatoare ale preparatelor biologic active obținute din biomasa anumitor specii de ciuperci din grupul basidiomicetelor. Astfel, este bine cunoscută activitatea antitumorală a fracțiilor polizaharidice de tip β -1,3 D-glucan, extrase din biomasa miceliană și corpurile de fructificație ale ciupercii *Agaricus blazei* Murrill. Ciupercile cultivate pe compost sintetic cu adaos de tărâțe de grâu, au un conținut mai ridicat de substanță uscată solubilă (8,80%) și proteine (30,63% din s.u.). Conținutul de β -1,3 D-glucan, substanță specifică în ciupercile *Agaricus blazei* Murrill, cu valoare biologică ridicată, este relativ ridicat în produsul obținut pe compost clasic cu adaos de făină de mălai și cu tărâțe de grâu (3.22-3.41mg100g⁻¹ s.u.). Dreapta de regresie obținută în urma corelației dintre acestea, arată legătura strânsă între cele două componente, fiind foarte semnificativă în ambele cazuri.

Cuvinte cheie: ciuperci, *Agaricusblazei* Murrill, polizaharide, β -1,3-D-glucan, adaos proteic

¹ University of Agricultural Sciences and Veterinary Medicine, Cluj-Napoca, România

INTRODUCTION

In addition to their food value, the mushrooms are also a cost-effective crop, which ensures a high yield, which is obtained on the used surface unit, in spaces arranged for this purpose. It is also worth noting that the cultivation of mushrooms does not use agricultural land. The advantages of a mushroom culture are many, both economic, occupational, medicinal, and reconversion of ligno-cellulosic waste (Stamets, 2005).

Worldwide, specialists are looking for new products from different plants as well as mushrooms, containing vitamins, minerals, enzymes to improve people's health. Viewed from this point of view, mushrooms are a food of high nutritional value, containing essential amino acids in the structure of complex proteins, and some species also have real therapeutic and medicinal virtues (Stamets, 2000).

Traditionally, mushrooms have also been given therapeutic, antitumor and immunological virtues that have begun to be scientifically tested, especially over the past three decades. The most important medical effects of the mushrooms are as follows: immunomodulators, antioxidant genoprotective, antiallergic, antitumoral, hepatoprotective, antidiabetic, antiatherogenic, hypocholesterolemic. Mushroom growers provide consumers with a fresh and valuable product (Stamets, 2010).

Nowadays, nutritional supplements and natural medicines are also provided by many mushroom-based, cultivated and medicinal basidiomycetes (Halpern, 2007).

Bioactive compounds in fungi can be isolated from fruit plants or extraction of pure mycelial culture (Chang and Miles, 2004). It has been reported that the *Agaricus blazei* Murrill mushroom produces various bioactive compounds that have the potential to treat several diseases (Firenzuoli *et al.*, 2008). This mushroom has been used as a drug for the prevention of cancer, diabetes, hyperlipidemia, arteriosclerosis and chronic hepatitis and is known as an immune system stimulator (Takaku *et al.*, 2001).

Polysaccharides from *Agaricus blazei* Murrill include several immunologically active low molecular weight fractions: α -1.6 and α -1.4 complex glucan, several polysaccharide-protein complexes and a heteropolysaccharide composed mainly of glucose, arabinose and mannose, all presenting anti-tumour properties (Kawagishi *et al.*, 1989; Fujimiya *et al.*, 1999; Ebina and Fujimya, 1998; Fujimiyama *et al.*, 2000; Ohno *et al.*, 2004; Gonzaga *et al.*, 2005; Dong *et al.*, 2007; Johnson *et al.*, 2009; Niu *et al.*, 2009, Forland *et al.*, 2010; Zhang *et al.*, 2010). Importantly, there is an increase in the structural diversity of polysaccharides with fruit maturation (Camelini *et al.*, 2005).

MATERIAL AND METHOD

To study the influence of compost recipes on the quality of mushrooms, a bifactorial experience has been organized. Factor A was the 4-gradient culture substrate: C1 classic substrate (composed of horse manure and wheat straw 70-75%, calcium sulphate, superphosphate, ammonium sulphate); C2 synthetic substrate (composed of wheat straw, poultry manure, calcium sulphate, urea); C3 Mixed substrate (horse manure, poultry manure, wheat straw, calcium sulphate, urea); C4 reed substrate (shredded reed, horse manure, poultry manure, calcium sulphate and urea). Factor B was the protein addition with 3 graduations: A1 without addition; A2 wheat bran 3%; A3 corn flour 3%.

The physical and chemical determinations in each experimental compost variant were made from an aqueous extract using 100 grams of compost in one liter of distilled water, and after filtration the obtained solution was used to perform the determinations.

The amount of 100 grams of compost was composed of 5 random harvests of 20 grams of compost from different sites of each experimental variation.

Sample preparation required the use of chromatographic purity extraction solvents (96% ethanol - Fluka Chemie AG, bidistilled water) for the interpretation of the results for the study of the growth conditions of mycelium *Agaricus blazei* Murrill. The observations were made using the current technique of making them based on specific descriptors and bonuses (CIULCA, 2002).

Experimental data on the soluble dry substance and the amount of β -glucan of the *Agaricus blazei* Murrill mushrooms, the calculation of the regression line was made using the data processing program "Statistica 10".

RESULTS AND DISCUSSION

Analysing the results of two years of experience on total and soluble dry matter content in mushrooms (tab. 1), it is noted that in 2015 the total dry substance variation range was 7.60% in the mushrooms harvested from the cane compost (C4) with no additional protein supplement (A1) and 9.77% for mushrooms harvested on the mixed compost (C3) with wheat bran (A2) supplementary protein addition.

In 2016, lower dry matter content was recorded for all experimental variants compared to 2015.

Experimental factors had the same effect in 2015 as well as in 2016. Mushrooms harvested from the mixed compost (C3) with the addition of wheat bran (A2) recorded the best values for the soluble dry matter of 8.83% in 2015 and 8.17% in 2016. The recorded average of the dry substance in the two years was 8.50%.

With regard to the insoluble dry matter (i.d.m.), it can be noticed that in the year 2015 the mushrooms harvested from the cane compost (C4) with the addition of wheat bran (A2) have the lowest content of i.d.m. (0.13%), and for the year 2016 the lowest values were obtained in the mushrooms harvested from the synthetic compost (C2) with added corn flour (A3), (0.04% i.d.m.).

Table 1

Effect of compost x protein addition (C x A) interaction on the mushrooms dry matter content (g/100g d.m./f.m.)

Experimental variant		Content of:								
		Total dry matter (d.m.)			Solubled.m.			Insolubled.m.		
		%			%			%		
		2015	2016	Avg.	2015	2016	Avg.	2015	2016	Avg.
V1	C1 A1	9.03	8.23	8.63	7.73	7.07	7.40	1.30	1.16	1.23
V2	C1 A2	9.43	8.70	9.07	8.80	8.13	8.47	0.63	0.57	0.60
V3	C1 A3	9.73	8.87	9.30	8.07	7.40	7.73	1.66	1.47	1.57
V4	C2 A1	8.20	7.57	7.87	8.17	7.30	7.75	0.13	0.27	0.12
V5	C2 A2	9.10	8.50	8.80	8.50	7.77	8.13	0.60	0.73	0.67
V6	C2 A3	8.70	7.77	8.23	8.33	7.73	8.03	0.37	0.04	0.20
V7	C3 A1	9.40	8.60	9.00	7.93	7.27	7.60	1.47	1.33	1.40
V8	C3 A2	9.77	9.10	9.43	8.83	8.17	8.50	0.94	0.93	0.93
V9	C3 A3	8.47	7.80	8.13	7.43	6.77	7.10	1.04	1.03	1.03
V10	C4 A1	7.60	6.83	7.13	7.37	6.67	7.10	0.23	0.16	0.03
V11	C4 A2	8.37	7.83	8.10	7.63	6.87	7.25	0.74	0.96	0.85
V12	C4 A3	7.70	7.17	7.43	7.57	6.57	7.07	0.13	0.60	0.36

The content of β -1.3-D-glucan (mg 100g⁻¹d.m.) in *Agaricus blazei* Murrill mushroom, ranged between 2875 and 3605 mg 100g⁻¹d.m. in 2015 and 2640 and 3381 mg 100g⁻¹d.m. in 2016 (tab. 2).

Both in the 2015 and 2016 experimental years, the maximum value was recorded in the mushroom harvested from classical compost (C1) with corn flour protein admixture (A3), with a maximum of 3414 mg 100g⁻¹d.m. in 2015, and 3411 mg 100g⁻¹d.m. in 2016.

Table 2

 β -1.3 D-glucan content of *Agaricus blazei* Murrill mushrooms (mg 100g⁻¹d.m.)

Experimental factors		β -1.3 D-glucan content (mg 100g ⁻¹ d.m.)	
Variant	Combination	2015	2016
V1	C1 A1	3143	3143
V2	C1 A2	3208	3244
V3	C1 A3	3414	3411
V4	C2 A1	2917	2917
V5	C2 A2	3076	3078
V6	C2 A3	3155	3158
V7	C3 A1	3109	3110
V8	C3 A2	3133	3133
V9	C3 A3	3167	3167
V10	C4 A1	2581	2651
V11	C4 A2	2766	2766
V12	C4 A3	2990	2990

Regarding the content of β -1.3 D-glucan in *Agaricus blazei* Murrill mushroom, Zied *et al.* (2010) found the amount of 5000 mg 100g⁻¹d.m., Cohen *et al.* (2014) 2550 mg 100g⁻¹d.m., so that the values determined by us are found within these ranges.

The therapeutic quality is given in particular by the amount of β -1.3 D-glucan, which is correlated with the soluble dry matter and depends on the experimental factors.

As a result of the calculations, the correlation coefficient between the amount of soluble dry substance and the mushrooms β -1,3 D-glucan content, in the variant without additional protein supplement yielded $r = 0.45652$, being significant (fig. 1).

Comparing this value with the correlation coefficient with the probability of 5% and 1%, respectively, $r = 0.95 > 0.50$ and 0.80 on the basis of these comparisons, it can be stated that between the amount of soluble dry matter and the content in β -1.3 D-glucan from mushrooms, the correlation coefficient is significantly positive, indicating a relationship between the dry matter content and the β -1.3 D-glucan content of *Agaricus blazei* Murrill mushroom. A higher amount of dry matter in mushrooms, induced a higher β -1.3 D-glucan content.

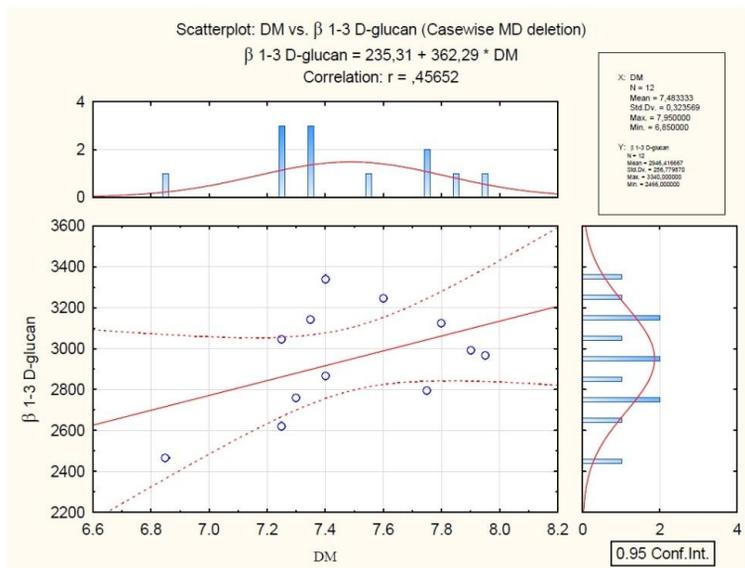


Fig. 1 Correlation between dry substance and β -1.3 D-glucan content of *Agaricus blazei* Murrill mushrooms, harvested from composts without added protein supplement

The additional protein supplement with 3% wheat bran indicates that with increasing quantity of dry matter the content of β -1.3 D-glucan increases (fig. 2).

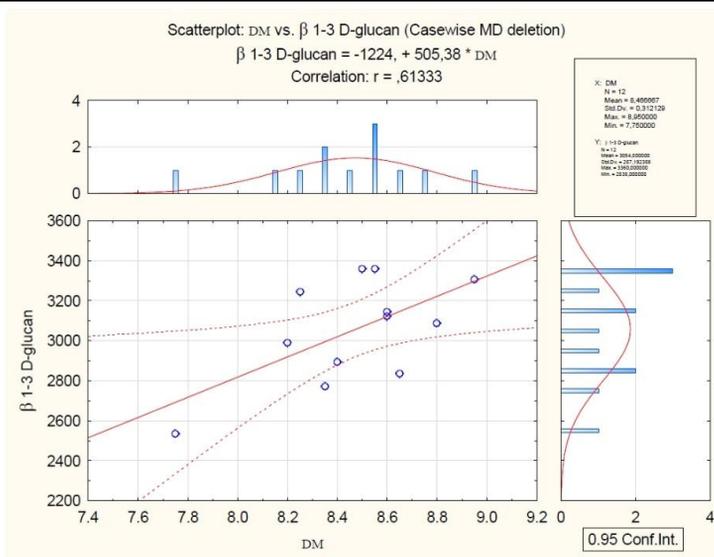


Fig. 2 Correlation between dry substance and β -1.3 D-glucan content of *Agaricus blazei* Murrill mushrooms, harvested from composts with 3% wheat barn protein supplement

It is noted that the experimental data faithfully follows the right regression. The relation between the two characters estimated by simple linear regression is illustrated by the following equation of degree I: $y = 1224 + 505.38 * d.m.$ and the value of the coefficient of determination $r = 0.61333$ is distinctly significant.

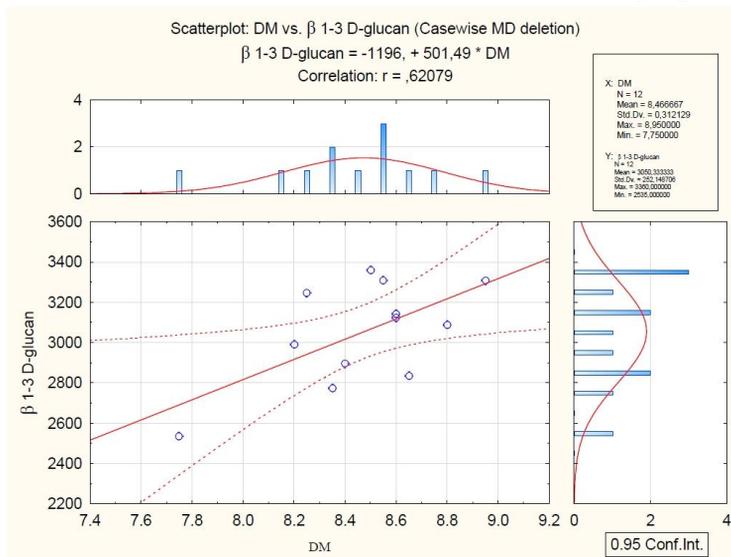


Fig. 3 Correlation between dry substance and β -1.3 D-glucan content of *Agaricus blazei* Murrill mushrooms, harvested from composts with 3% corn flour protein supplement

The experimental results in the case of 3% corn flour protein addition, accurately follow the right regression (fig. 3). The relation between the two characters estimated by linear regression is illustrated by the following equation of degree I: $y = 1196 + 501.49 * d.m.$ and the value of the coefficient of determination $r = 0.62079$. On the basis of these comparisons it can be stated that between the quantity of dry substance and β -1.3 D-glucan the correlation coefficient is distinctly significant.

CONCLUSIONS

1. From the results obtained, the content of β -1.3 D-glucan was increased with the increase in the amount of soluble dry substance.
2. Regardless of the culture substrate, linear equations were calculated for each protein addition.
3. It can be argued that the two additional protein additions lead to an increase in the correlation coefficient, so it is beneficial for the cultivation of *Agaricus blazei* Murrill mushrooms using additional protein additions.
4. Based on the results obtained and the data processing through correlations, the regression has highlighted the link between the studied factors.

REFERENCES

1. **Camelini C.M., Maraschin M., De Mendona M.M., Zucco C., Ferreira A.G., Tavares L.A., 2005** - *Structural characterization of beta-glucans of Agaricus brasiliensis in different stages of fruiting body maturity and their use in nutraceutical products*. Biotechnol Lett. 27(17): 1295-9.
2. **Chang S.T., P.G. Miles, 2004** - *Mushrooms: cultivation, nutritional values, medicinal effect and environmental impact*. 2nd ed. Boca Raton: CRC, 451 p.
3. **Ciulca S., 2002** - *Tehnică experimentală*, Editura Mitron, Timișoara.
4. **Cohen N., Cohen J., Asatiani M.D., Varshney V.K., Yu H.T., Yang Y.C., 2014** - *Chemical composition and nutritional and medicinal value of fruit bodies and submerged cultured mycelia of culinary-medicinal higher Basidiomycetes mushrooms*. Int.J. Med. Mushrooms 16, 273-291.
5. **Dong Q., Yao J., Yang X.T., Fang J.N., 2007** - *Structural characterization of a water-soluble β -d-glucan from fruiting bodies of Agaricus blazei Murrill.*, Carbohydrated. Research, 337:1417-1421.
6. **Ebina T., Fujimiya Y., 1998** - *Antitumour effect of a peptide-glucan preparation extracted from Agaricus blazei in a double-grafted tumour system in mice*. Biotherapy. 11:259-265.
7. **Firenzuoli F., Gori L., Lombardo G., 2008** - *The medicinal mushroom Agaricus blazei Murrill: Review of literature and Pharmacotoxicological problems*. Evid Based Complement Alternat Med. 5(1):3-15.
8. **Forland D.T., Johnson E., Tryggstad A.M., Lyberg T., Hetland G., 2010** - *An extract based on the medicinal mushroom Agaricus blazei Murrill stimulates monocyte-derived dendritic cells to cytokine and chemokine production in vitro*. Cytokine. 49 (3):245-50.
9. **Fujimiya Y., Suzuki Y., Katakura R., Ebina T., 1999** - *Tumour-specific cytotoxic and immunopotentiating effects of relatively low molecular weight products derived from the basidiomycete Agaricus blazei Murrill*, Anticancer Research 19:113—118.

10. **Fujiyama Y., Yamomoto H., Noji M., Suzuki I., 2000** - *Peroral effect on tumour progression of soluble beta 1-6 glucans prepared by acid treatment from Agaricus blazei Murrill*, International Journal of Medicinal Mushrooms 2:43-49.
11. **Gonzaga C., Ricardo N.M.P.S, Heatley F., Soares S.A., 2005** - *Isolation and characterization of polysaccharides from Agaricus blazei Murrill*. Carbohydr. Polym. 60(43) 19.
12. **Halpern G.M., 2007** - *Healing mushrooms efective treatments for today's illnesses*, Square One Publishers, New York
13. **Johnson E., Forland D.T., Saetre L., Bernardshaw S.V., Lyberg T., Hetland G., 2009** - *Effect of an extract based on the medicinal mushroom Agaricus blazei murill on release of cytokines, chemokines and leukocyte growth factors in human blood ex-vivo and in vivo*. ScandJ.Immunol. 69(3):242-50.
14. **Kawagishi H., Inagaki R., Kanao T., Mizuno T., Shimura K., Ito H., Hagiwara T., Nakamura T., 1989** - *Fractionation and antitumor activity of the water insoluble residue of Agaricus blazei Murrill fruiting bodies*, Carbohydrate Research, Mar. 15; 186(2):267-273.
15. **Morimoto T., Michihiro T.M., Masashi M.M., 2008** - *Oral administration of Agaricus brasiliensis S. Wasser et al. (Agarico-mycetideae) extract downregulates serum immuno-globulin E levels by enhancing Th1 response*. International Journal of Medicinal Mushrooms, 10(1):30.
16. **Niu Y.C., Liu J.C., Zhao X.M., Su F.Q., Cui H.X., 2009** - *Immunostimulatory activities of a low molecular weight antitumoural polysaccharide isolated from Agaricus blazei Murill (LMPAB) in Sarcoma 180 ascitic tumour-bearing mice*, Pharmazie. 64(7):472-6.
17. **Ohno N., Furukawa N., Miura N., 2004** - *Antitumour beta-glucan from the cultured fruit body of Agaricus blazei*, Biology Pharmacology Bulletin 24:820-828.
18. **Stamets P., 2000** - *Growing Gourmet and Medicinal Mushrooms*, Third edition, ten Speed Press Berkeley, CA.
19. **Stamets P., 2005** - *Mycelium running – How the mushrooms can help save the world*, Ten Speed Press, Berkeley
20. **Stamets P., 2010** - *Growing gourmet and medicinal mushrooms*, Ten Speed Press, Berkeley
21. **Takaku T., Kimura Y., Okuda H., 2001** - *Isolation of an antitumor compound from Agaricus blazei Murrill (sic) and its mechanism of action*, Journal of Nutrition May 131(5):1409-1413.
22. **Zhang S., He B., Ge J., Zhai C., Liu X., Liu P., 2010** - *Characterization of chemical composition of Agaricus brasiliensis polysaccharides and its effect on myocardial SOD activity, MDA and caspase-3 level in ischemia-reperfusion rats*, International Journal of Biology Macromolecular, 46(3):363-6.
23. **Zied D.C., Minihoni M.T.A., Kopytowski Filho J., Andrade M.C.N., 2010** - *Production of Agaricus blazei ss. Heinemann (A. brasiliensis) on different casing layers and its environments*. World J. Microbiol. Biotechnol. 26, 1857-1863.

CHANGES IN CHERRIES SIZE AND QUALITY ACCORDING TO COLOR

MODIFICĂRI ALE DIMENSIUNII ȘI CALITĂȚII CIREȘELOR ÎN FUNCȚIE DE CULOARE

BALAN V.¹, IVANOV I.¹, ȘARBAN V.¹, BALAN P.¹, VAMAȘESCU S.¹

e-mail: v.balan@uasmd.md

Abstract. *The objective of the current research was to investigate the changes during maturation of cherries (*Prunus avium* L.). The studies were conducted in the commercial orchard of the Republic of Moldova, at Vindex-Agro SRL, Orhei (47° 46'S, 29° 13'E) during the three and four years of cherry tree fructification. The orchard was established in autumn 2011 with cherry trees of Ferrovia and Regina varieties, grafted on Gisela 6 rootstock, at a planting distance of 4x2.5 m. The trees are formed according to the Slender Spindle Ameliorated system. Experience includes four rehearsals of eight trees each (n = 32). Fruit recording and evaluation was performed during the ripening period, according to the color of the skin, according to the CTIFL Colored Color (Yellowish-pink, Very light red, Red Bright red color, Dark red, Dark brown-red, Dark brown) and the content of soluble solids content (SSC). By deduction and calculation, the notion of calculating the cherry diameter was introduced in fruit growing knowing their mass. The last weeks before harvest, from the time the fruits begin to mature and the color of the skin changes from green to yellowish, a period determines fruit development and orchard productivity. In this period, as the fruit grows, their diameter increases, but with a much lower rhythm.*

Key words: cherry, variety, soluble substances, fruit mass and diameter, harvest

Rezumat *Obiectivul cercetării actuale a fost de a investiga modificările în timpul maturizării cireșelor (*Prunus avium* L.). Studiile s-au efectuat în livada comercială din zona pomicolă de centru a Republicii Moldova, la SRL Vindex-Agro, r. Orhei (47° 46'S, 29° 13'E) pe parcursul anului trei și patru de fructificare a pomilor de cireș. Livada s-a înființat, în anul 2011 toamna, cu pomi de cireș din soiurile Ferrovia, Regina, altoite pe portaltoiul Gisela 6, la distanța de plantare de 4x2,5 m. Pomii sunt formați după sistemul Fus subțire ameliorat. Experiența include 4 repetiții a câte 8 pomi fiecare (n=32). Evidența și aprecierea fructelor s-a efectuat în perioada de maturare, după culoarea pielii, conform fișei de culori CTIFL (Roz-gălbui, Roșu foarte deschis, Roșie, Rumână aprinsă, Roșie închisă, Brună-roșietică închisă, Cafeniu închis) și a conținutului de substanțe uscate solubile. Prin deducție și calcul s-a introdus în pomicultură noțiunea de calcul a diametrului cireșelor știind masa lor. Ultimele săptămâni înainte de recoltare, din momentul când fructele încep să se matureze și culoarea pielii se transformă din culoarea verde în roz-gălbui, este o perioadă care determină dezvoltarea fructelor și productivitatea livezilor. În această perioadă, pe măsura creșterii masei fructelor se mărește și diametrul lor, dar cu un ritm mult mai mic.*

Cuvinte cheie: cireș, soi, substanțe uscate solubile, masa, diametrul, recolta

¹Agrarian State University of Moldova, Chișinău, Republic of Moldova

INTRODUCTION

Cherry is a high-value crop where fruit quality is essential for competitive production and particularly important for economic sustainability in a high production cost situation. To maximize efficiency, fruit must be large and firm, with high sugar levels. The moment of harvesting has the greatest impact for the production of fruits with the desired qualities (Serrano *et al.*, 2005; Long, 2014). Fruit color seems to be the best indicator for deciding when to harvest (Tudela *et al.*, 2005), but it is also necessary for the sugar content of dry soluble substances (SSC), titratable acidity (TA), the mass and diameter of the fruit (Predieri *et al.*, 2004).

For export, it is very important for cherries to be harvested at the right time, to be firm, to have a uniform color and to be very resistant to crushing and scratching. Cherries that are dark red in reddish brown are more resistant to mechanical damage than other stages of development (Romano *et al.*, 2006). For cherries to remain firm, trees must have enough water in the soil to allow the fruit to regain its turgidity quickly, especially immediately before harvesting. During this period, cherry plantations irrigate more frequently, but with lower doses (Long *et al.*, 2014; Neilsen *et al.*, 2014). In the last two weeks of cherry development, the total dry fruit weight is increased 3 times, and a quarter of the weight accumulates during the week immediately preceding the harvest (Keller and Loescher, 1989). This is one of the basic reasons for correctly determining the harvest time and the fruit growing technology.

MATERIAL AND METHOD

The studies were conducted in the commercial orchard of the Republic of Moldova, at Vindex-Agro SRL, Orhei (47 ° 46'S, 29 ° 13'E) during the three and four years of cherry tree fructification. The orchard was established in autumn 2011 with cherry trees of Ferrovia and Regina varieties, grafted on Gisela 6 rootstock, at a planting distance of 4x2.5 m. The trees are formed according to the Slender Spindle Ameliorated System. The soil is maintained by the natural way, the orchard drip irrigation, and Watermark transducers are used to monitor the soil moisture. The water is distributed through drilled bridges fixed 40 cm from the ground in the direction of the row. The strips between the 2.5 m wide rows, with spontaneously growing weeds, are mown to necessity and remain as mulch.

Experience includes four rehearsals of eight trees each (n = 32). Measurements were performed in field and laboratory conditions according to approved research methods in fruit growing. Fruit recording and evaluation was performed during the maturing period, according to the color of the skin, according to the CTIFL color card (Long, 2014) and the SSC. The harvesting for each variety was done individually by weighing the fruits of 32 trees in the variant.

The diameter and mass of the cherries in the period of fruit development and maturation was identified by means of a calipers and a template with holes of 26, 28, 30, 32, 34 and 36 mm corresponding to the mass of 8.5; 10; 11.5; 13; 14.5; 16 g corresponding. These analyzes were recorded from the time the fruit began to change the color of the skin from green to yellowish to full ripening every 3 days according to the CTIFL color chart (Yellowish-pink, Very light red, Red Bright red color, Dark red,

Dark brown-red, Dark brown) on 20 cherries in four identical samples (n = 80) of each variety. The content of SSC was determined in the orchard by using the portable ATAGO N-20E refractometer, which expresses values in Brix%.

RESULTS AND DISCUSSIONS

Cherry varieties Ferrovia and Regina, grafted on Gisela 6, entered the fruit from the third year after planting and the harvest recorded average values of 400-500 kg/ha. The harvest in the second year of fructification recorded average values of 4900-5000 kg/ha, and in the third year of fructification (2016) the harvest is three times higher compared to the second year, constituting 11890-13290 kg/ha. In 2017, the cherry harvest decreased due to unfavorable conditions at the time of the flowering of trees, expressed by low temperatures on April 19 and abundant snow on 20-21 April (tab. 1).

Table 1

Fruit harvest on cherry trees (*Cerasus avium L.*), kg/ha

Variety	Years				Average (2014-2017)
	2014	2015	2016	2017	
Ferrovia	500	4900	13290	7933	6656
Regina	400	5000	11890	7573	6216
DL, 5%	-	-	1053	682	-

For the correct assessment of the time of cherry harvesting, the color, mass and diameter of the fruit was evaluated from three to 3 days during fruit maturation. The growth rate of the fruit mass during the cherry maturing period was different (tab. 2). When fruit begins to mature and the color of the skin changes from green to pink, the growth rate is higher compared to the following maturation periods. For example, in Ferrovia variety, the color of the rosé skin, the cherry mass was 5.15 g, in the very light red color - 6.53 g or 15.7% more. The fruit table, from the very light red color, grew by 4.4% in the red color and by 4% in the light brown color. The change of color from roasted red to dark red was manifested by a growth rate of fruit weight by 8.5%, and from the light brown to dark brown color, the growth rate of the fruit weight was 12.7%. From the moment, the fruits begin to change their color from green to yellowish to the dark brown and dark brown color, the Ferrovia fruit mass increases by 40.3%.

Table 2

The weight and the diameter of cherries (*Cerasus avium L.*) according to their variety and color

Nr.	The color of the skin	Ferrovia variety		Regina variety	
		Fruit weight, g	Fruit diameter, mm	Fruit weight, g	Fruit diameter, mm
1	Yellowish-pink	5.15	20.87	6.05	22.13
2	Very light red	6.53	22.79	7.55	24.21
3	Red	6.91	23.32	7.75	24.49
4	Bright red color	7.26	23.81	8.30	25.26
5	Dark red	8.01	24.85	9.10	26.37
6	Dark brown-red	8.35	25.32	9.21	26.52
7	Dark brown	8.62	25.70	9.51	26.93

The same findings also arise for the Regina variety in the sense that, as soon as the color of the fruit skin becomes yellowish, the fruit mass grows rapidly to the dark brown-red color, then the rhythm of fruit growth decreases. It follows that determining the optimal harvesting period for cherries is the first step in obtaining quantitative and qualitative fruits.

With regard to the diameter of the fruit, it is observed that from the moment the cherries turn green in color, the diameter of the fruit at Ferrovía increases considerably from 20.87 mm to 25.7 mm. Thus, at Ferrovía since the color change of the yellowish-red fruit very open, the cherries increased in diameter by 7.6%. In the next stages of pulp ripening, color change from red very light to red and then to the brightly colored rosemary, the fruit diameter growth rate is slower and is 1.8-2.1%. Changing the color of the rust skin in the dark red has resulted in a 4.1% increase in the fruit diameter. In the fruit-ripening stages, which follow from dark red to dark brown and dark brown, the growth rate of the cherry diameter is only 1.5-1.8%.

Ripening the pulp of the Regina variety is marked by an increase in fruit diameter of 22.13 mm when the skin is a yellowish color at 26.93 mm when the fruits are dark brown. In the Regina variety, the higher fruit growth rate was recorded when the color of the skin from reddish yellowish to very light red (7.6%) and from red to brownish brown (4.8%).

We mention that in the first two weeks prior to harvest the cherry diameter increased to Ferrovía variety from 20.87 to 25.7 mm and Regina variety from 22.13 to 26.93 mm or on average by 17.7-18.8%.

The color of the fruit, their size and their mass determine the right time to harvest the quality export cherries. Cherries that are dark red in reddish brown are more resistant to mechanical damage than other stages of development (Long *et al.*, 2014). Cherries intended for export are harvested at full maturity or 2-3 days earlier when the fruits are dark brown and red because they do not continue the maturing process.

The last weeks before harvest, from the time the fruits begin to mature, and the color of the skin turns from greenish to yellowish, a period determines fruit development and orchard productivity. During this period, the Ferrovía variety accumulating 40.3%, and in the Regina variety 39.5% of the total fruit weight. Obviously, as the fruit grows, their diameter increases, but with a much lower rhythm. Thus, in the Ferrovía variety during the curing of the fruit, the diameter of the cherries increases by 18.8% and the Regina variety by 17.7%.

Here it is appropriate to specify that although the quality of cherries has different meanings for different stakeholders in the value chain of fruit (producers, distributors, consumers etc.), consumer acceptance seems to be the most important factor to be taken into account.

Regardless of consumer preferences, firmness is a key issue for marketing cherries abroad. However, the factors that define fruit productivity and quality are the variety, rootstock, planting distance, crown form, pedoclimatic conditions, and agro-technical conditions that require a full assessment of the current situation to quality standards (Balan, 2015).

Research has shown significant relationships between the size of the fruit and its mass (fig. 1). Analyzing the values of the diameter and the mass of the cherries was determined by deduction and calculation the following formula:

$$Y = 1.39x + 13.72$$

where:

Y - Cherry diameter, mm;

X - The mass of cherries, g.

The experimental data show that the relationship between the diameter and the mass of cherries at harvesting is linear. The researches undertaken have allowed introducing in fruit growing the notion of calculating the diameter of the cherries knowing their mass.

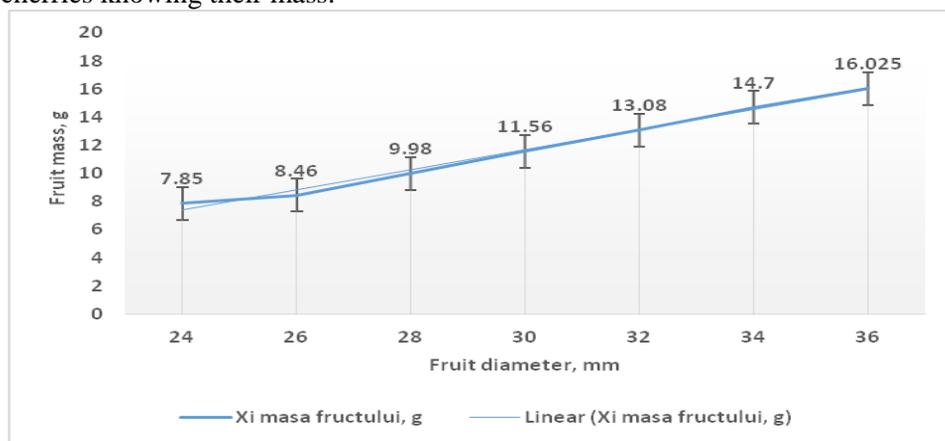


Fig. 1 Relationship between the diameter and the mass of cherries at harvest

The dry substance soluble in cherries was determined from the moment the fruits flushed until the time of harvesting (tab. 3). From the moment the fruit skin is red SSC in the fruit grows considerably. Thus, in the Ferrovía variety in 2016, the cherry SSC increased from 4.3 Brix% to red to 18.5 Brix% dark brown and Regina variety to 3.9 Brix% To 18.3 Brix%. The same findings also arise for the year 2017 in the sense that, from the moment the color of the fruit skin becomes red, the SSC in the fruit grows rapidly until the dark red-brown color, then the SSC rhythm decreases. Therefore, the SSC concentration is approaching the maximum during the fast color change period. Hence, skin color change could be used to determine the optimal harvest date.

Table 3

Dry cherry-soluble substance according to color, %

Variety	The color of the skin									
	Red		Bright red color		Dark red		Dark brown-red		Dark brown	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Ferrovía	4.3	3.5	6.8	6.4	12.8	13.4	17.5	17.2	18.5	18.8
Regina	3.9	3.5	7.0	6.0	13.3	13.8	17.0	17.4	18.3	18.5

Fruits of the Ferrovia and Regina varieties were harvested at dark brown-red stadiums, with SSC in fruits being 17.0 -17.8 Brix% in 2016 and 17.2-17.4 Brix% in 2017.

Early harvesting can affect not only the biochemical characteristics but also the size of the crop as it has been found that in the last two weeks of cherry development, the fruit mass has increased by 39.5-40.3% of the total fruit weight, and the SSC has increased with 14.2-15%.

CONCLUSIONS

From the moment the fruits begin to mature and the color of the skin turns from green to yellowish, the fruit mass grows rapidly to the brown-red color, then the growth rate of the fruit decreases.

By deduction and calculation, the notion of calculating the diameter of the cherries was introduced in fruit growing, knowing their mass by the formula: $Y = 1.39x + 13.72$, where Y - cherry diameter, mm; X - the mass of cherries, g.

The last weeks before harvest, from the time the fruits begin to mature and the color of the skin changes from green to yellowish, a period determines fruit development and orchard productivity. During this period, the Ferrovia variety accounted for 40.3% and for Regina 39.5% of the total fruit weight, and the cherry diameter increased by 18.8% and 17.7%, respectively.

From the moment the color of the skin becomes red, the dry substance soluble in fruit grows rapidly to the dark red-brown color, then the SSC accumulation rate decreases.

Fruit color is the main indicator of maturity and it is important to establish the relationship between the skin color and the SSC to identify the color of the skin, as the cherries are harvested to meet the requirements of consumers.

REFERENCES

1. Balan V., 2015 - *Tehnologii în intensificarea culturii mărului și cireșului*. *Academos* 2, pp. 74-79
2. Keller J.D., Loescher W.H., 1989 - *Non-structural carbohydrate partitioning in perennial parts of sweet cherry*. *Jou. of the American Society for Horticultural Science*, 114(6):969–975.
3. Long L.E., Long M., Peșteanu A., Gudumac E., 2014 - *Producerea Cireșelor*. Manual tehnologic. Chișinău, 262p.
4. Neilsen G.H., Neilsen D., Kappel F., Forge T., 2014 - *Interaction of Irrigation and Soil Management on Sweet Cherry Productivity and Fruit Quality at Different Crop Loads that Simulate Those Occurring by Environmental Extremes*. *HortScience* February, vol. 49, 215-220
5. Predieri S., Dris R., Rapparini F., 2004 - *Influence of growing conditions on yield and quality of cherry*. II. Fruit quality. *Food, Agriculture & Environment*, 2(1):307–309.
6. Romano G.S., Cittadini E.D., Pugh B., Schouten R., 2006 - *Sweet cherry quality in the horticultural production chain*. *Stewart Postharvest Review*, 6:2 www.stewartpostharvest.com
7. Serrano M., Guillén F., Martínez-Romero D., Castillo S., Valero D., 2005 - *Chemical constituents and antioxidant activity of sweet cherry at different ripening stages*. *Journal of Agricultural and Food Chemistry*, 53: 2741–2745.
8. Tudela, J.A., Luchsinger, L., Artés-Hdez, F., Artés, F., 2005 - "Ambrunés" sweet cherry quality factors change during ripening. *Acta Hortic.* 667, 529–534.

MORPHOMETRIC AND PHYTOPATHOLOGICAL ANALYSIS OF ROMANIAN JUJUBE FRUITS DURING THE STORAGE PERIOD

ANALIZA MORFOMETRICĂ ȘI FITOPATOLOGICĂ A FRUCTELOR DE JUJUBE DIN ROMÂNIA ÎN TIMPUL PERIOADEI DE DEPOZITARE

DICIANU Elena Diana¹, IVAN Elena Ștefania², JERCA I.O.²,
CICEOI Roxana², STĂNICĂ F.¹
e-mail: elenamardare184@yahoo.com

Abstract. Chinese jujubs are one of the most appreciated fruits. In Romania, jujube culture has begun to increase the interest both among producers and consumers, and the study of 15 genotypes is currently carried out at the Faculty of Horticulture in Bucharest. Our research focuses on the post-harvest behavior of jujube fruits and on morphometric and phytopathological analyzes. The fruits were stored in a controlled atmosphere. To date, jujube fruits have proven to be resistant to diseases and pests, being grown without phytosanitary treatments for 19 years. Our observations in the field in the year 2016 have demonstrated the existence of four species of mushrooms per fruit before full maturation. The pathogens identified by the fruits belong to the genus: *Alternaria* spp., *Rhizopus* spp., *Fusarium* spp. and *Monilinia* spp. The results showed an indirect correlation between the incidence of fungi and the resistance of the jujube fruit to the crack.

Key words: morphometric characteristics, *Ziziphus jujuba*, postharvest, pathogens

Rezumat. Jujubele chinezești este unul dintre cele mai apreciate fructe. În România, cultura de jujube a început să crească interesul atât între producători, cât și consumatori, iar studiul a 15 genotipuri este în prezent efectuat la Facultatea de Horticultură din București. Cercetările noastre se concentrează pe comportamentul post-recoltă a fructelor de jujube și pe analizele morfometrice și fitopatologice. Fructele au fost depozitate în atmosferă controlată. Până în prezent, fructele de jujube s-au dovedit a fi rezistente la boli și dăunători, fiind cultivate fără tratamente fitosanitare timp de 19 ani. Observațiile noastre din teren în cursul anului 2016 au demonstrat existența a patru specii de ciuperci pe fructe, înainte de maturarea completă. Patogenii identificați pe fructe aparțin genurilor: *Alternaria* spp., *Rhizopus* spp., *Fusarium* spp. și *Monilinia* spp. Rezultatele au arătat o corelație indirectă între incidența fungilor și rezistența fructului jujube la crăpare.

Cuvinte cheie: caracteristicile morfometrice, *Ziziphus jujuba*, post-recoltare, agenți patogeni

¹University of Agricultural Sciences and Veterinary Medicine Bucharest, Romania

²Laboratory of Diagnosis and Plant Protection, The Research Center for Studies of Food and Agricultural Products Quality

INTRODUCTION

The jujube (*Ziziphus jujuba* Mill) is cultivated and appreciated in China since 4000 years and today is more and more cultivated all over the world. After harvesting, the fruits are either eaten fresh or are dried and used as food or for pharmaceutical products, given the high number of pharmacological compounds, nutrients and amino acids (Xue *et al.*, 2009; Choi *et al.*, 2011).

Ziziphus jujuba fruit shape varies from round, oval to elliptical. The size of the fruit varies from the size of a cherry to the size of a plum and some varieties can reach the dimensions of a hen's egg (Markovski *et al.*, 2015). The fruit epidermis is thin, shiny, reddish-brown to chocolate colour (Soliman *et al.*, 2013). The fruit maturity is visually established by the fruit colour. When the fruits have more than 50% dark brown pigment, they have the best taste and juiciness. At full maturity, when the fruit is fully coloured, the organoleptic properties are average, but the fruits are good for drying. (Chen *et al.*, 2015). Some other good indicators of fruit maturity are their specific weight, the total dry matter content and the sugar index (Yao, 2013).

Despite the presence of so many bioactive compounds, *Ziziphus jujuba* is very tolerant to diseases and pests so that the fruits are less chemically treated if compared with other types of fruit (Velkoska-Markovski *et al.*, 2013). The fruit quality is highly correlated with their phytosanitary condition in the moment of storage initiation and the phytosanitary measures that must be applied during the storage, in order to avoid the spread of the diseases (Chira, 2008). The jujube fruits are susceptible to losses due to fungal diseases that occur after the harvest (Tian *et al.*, 2005).

The fruit cracking is a physiological disorder related to water, which can destroy entire harvest in the less favorable years. The disorder severity depends on water management during the growing season, precipitation and varietal resistance to cracking (Yao, 2013). In China, Shandong Province was mentioned that once in 5 years, due to climate conditions, the cracked fruits were attacked by rot, causing 40% losses (Yao, 2013). The drip irrigation is the most efficient for the growth and development of jujube fruit (Yaragattikar and Itnal, 2010), but even in perfectly balanced irrigation conditions throughout the whole growing season, the most important factor that influences the cracking phenomenon is the variety (Yao, 2013).

In Romania, jujube grows semi-spontaneous, in the Dobrogea area (Stănică, 2008), being represented mainly by two biotypes, *Ostrov* and *Jurilovca*. The first one grows as a garden plant close to the border of the Danube River and the second one, found at 150 km from the Ostrov village, not far from the Black Sea, is represented by spontaneous shrubs (Stănică and Dumitrașcu, 2008). At the Faculty of Horticulture from Bucharest, has been started in 1996 a research program regarding this new fruit species, 15 genotypes being analysed, as well as different propagation techniques, using *in vitro* and classical methods (Stănică, 2002).

Considering its high tolerance to pests and diseases, few phytopathological agents had been recorded on jujube. The plants may be affected by crown gall disease, *Agrobacterium tumefaciens*, anthracnose, *Gloesporium* sp., gray mold, *Botrytis cinerea* or rust, *Phakopsora zizyphi-vulgaris*. In our country, so far, no phytosanitary problems have been recorded (Stănică, 1997). Instead, the stored fruits are susceptible to fungal diseases and quality losses, characterized by pulp softness and the decrease of the content of amino acids (Lin *et al.*, 2004). After the harvest, *Ziziphus jujuba* is very sensitive to pathogenic infections which strongly limits the shelf life and continuous market supply. The infections are mainly caused by *Alternaria alternata* (Fr.) Keissl and *Monillinia fructicola* (G. Winter) and can usually lead to severe losses even if the fruits are stored at 0°C (Qin *et al.*, 2004, Tian *et al.*, 2005; Yan *et al.*, 2011; Wang *et al.*, 2011) while the blue mold caused by *Penicillium expansum*, is one of the most important diseases of jujube fruits (Qin and Tian, 2004). All three pathogens can enter in the fruit tissues in the early stages of growth and remain hidden there during ripening, while the symptoms will only be visible after harvest and during storage (Qin and Tian 2004, Tian *et al.*, 2005, Yan *et al.*, 2011).

Our research shows that in the ripening period several pathogens as *Alternaria* spp, *Stemphyllium* spp, *Rhizopus* spp, *Penicillium* spp., *Fusarium* spp. and *Monilinia* spp. can be present on the fruits and threatens the jujube fruits quality during storage.

MATERIAL AND METHOD

The aim of the study was to identify the pathogens present on Chinese jujube fruit immediately after harvest. We analyzed samples from 15 *Ziziphus jujuba* genotypes grown in the south-eastern Romania, at harvest, the climatic conditions of the year 2015.

The fruits were harvested manually in perfect condition and were stored in controlled atmosphere, in the following storage conditions: temperature -2- 0°C, humidity 95%, O₂ 3%-5%, CO₂ less than 2%. We have studied a number of 15 genotypes of *Ziziphus jujuba*. The morphometric parameters were determined measuring the average weight, length, diameter at the base and the upper diameter, with the calipers, rulers, the refractometer and the balance. For the phytosanitary determinations regarding the pathogen loads, we examined the fruit of all the studied genotypes. To identify the fungus was used the stereomicroscope Euromex Stereo Blue and the microscope Euromex Ox Range.

RESULTS AND DISCUSSIONS

The morphometric determinations of jujube fruits during the storage period, in 2015 are presented in table 1.

The length of the fruit had a variation between 35.39 mm (R1P6) and 47.93 mm (R1P7). The Romanian genotype had a medium length of 14.00 mm (R1P5). Regarding the fruit shape, the largest diameter at the base of the fruit had R1P7, with 30.98 mm and the smallest was at R2P5, 10.96 mm. The top diameter was

the largest for R1P3, 30.35 mm and the smallest at R1P2, 21.85 mm. The of fruit length and diameters are presented in table 1.

Table1

Morphometric determinations of jujube fruits during the storage period in 2015

Nr. Crt.	Genotype	Weight / 10 fruit	Fruit length media (mm)	Diameter base media (mm)	Diameter top media (mm)
1	R1P2	0.160	43.48	23.60	23.60
2	R1P3	0.200	43.59	25.26	30.35
3	R1P4	0.175	42.45	27.04	27.60
4	R1P6	0.105	35.39	20.07	20.13
5	R1P7	0.220	47.93	30.98	28.45
6	R1P8	0.105	40.62	27.72	26.50
7	R1P9	0.155	39.64	22.94	27.59
8	R1P10	0.140	37.50	25.90	28.30
9	R2P5	0.220	14.00	10.63	10.96
10	R2P6	0.190	38.16	26.09	27.63
11	R2P7	0.180	40.37	26.35	27.48
12	R2P8	0.140	36.56	22.14	27.40
13	R3P2	0.175	43.09	26.20	27.45
14	R3P3	0.225	45.53	26.82	27.09
15	R3P6	0.175	43.96	27.22	26.80

The data presented in table 2 shows that the pathogen species identified on *Ziziphus jujuba* fruits in the year 2015, after one month of storage in controlled conditions, belongs to the genus *Alternaria* spp., *Stemphylium* spp., *Monilinia* spp. and *Fusarium* spp. The *Alternaria* fungus was present on 10 of the 15 studied genotypes. The only genotype with no pathogen agent was R1P7.

Table2

The phytopathogenic agents found during the storage period in 2015

No. ctr.	Genotype	The phytopathogenic agent (2015)			
		<i>Alternaria</i> spp.	<i>Stemphylium</i> spp.	<i>Monilinia</i> spp.	<i>Fusarium</i> spp.
1	R1P1	+	+	-	+
2	R1P2	+	-	-	+
3	R1P3	-	-	-	+
4	R1P4	-	-	+	+
5	R1P5	+	-	-	-
6	R1P6	+	-	+	-
7	R1P10	+	-	+	-
8	R2P6	+	-	+	+
9	R2P7	-	-	+	-
10	R2P7	+	-	+	-
11	R3P1	+	-	-	+
12	R3P2	+	-	-	-
13	R3P3	+	-	+	-
14	R3P6	-	+	-	-

Following our observations in 2015 in the experimental jujube field, we identified especially on the cracked fruits, but also on the fruits presenting different lesions caused by insect feeding, four phytopathogenic agents were found on the fruits: *Alternaria* spp., *Monilinia* spp., *Fusarium* spp. and *Rhizopus* spp. The *Rhizopus* spp., fungus was present on all the fruits of the studied genotypes.

CONCLUSIONS

The fruit characteristics in terms of size, recorded the highest value at R1P7 genotype with 47.93 mm and the smallest value at R1P5 genotype, with 14.00 mm. The highest basal diameter of 30.98 mm was found at R1P7 genotype and the lowest was 10.96 mm at R2P5 genotype. The fruit weight ranged between 14 g at R2P8 genotype and R1P10 and 22,5 g at R3P3 genotype. In terms of phytosanitary status, we have identified the following pathogens: *Alternaria* spp, *Stemphyllium* spp, *Rhizopus* spp, *Penicillium* spp., *Fusarium* spp. and *Monilinia* spp. The highest pathogen incidence was determined for the *Alternaria* spp. fungus while *Stemphyllium* spp. was found only on two genotypes, R1P1 and R3P6. A good resistance to the pathogen attack showed the R1P3, R1P4, R3P2, R3P6 genotypes, where the values of the pathogens incidence is lower. The only genotype detected with no pathogen was R1P7.

REFERENCES

1. **Chen J., Chan P. H., Lam C. T., Li Z., Lam K. Y., Yao P., Tsim K. W., 2015** - *Fruit of Ziziphus jujuba (Jujube) at two stages of maturity: distinction by metabolic profiling and biological assessment.* Journal of agricultural and food chemistry, 63(2), 739-744.
2. **Chira L., 2008** - *Controlul calității fructelor. (Fruit quality control).* Editura CERES, București
3. **Choi S. H., Ahn J. B., Kozukue N., Levin C. E., Friedman M., 2011** - *Distribution of free amino acids, flavonoids, total phenolics, and antioxidative activities of jujube (Ziziphus jujuba) fruits and seeds harvested from plants grown in Korea.* Journal of agricultural and food chemistry, 59(12), 6594-6604.
4. **Lin L., Tian S. P., Wan Y. K., Xu Y., Yao H. J., 2004** - *Effects of temperature and atmosphere component on quality of stored jujube fruit.* Acta Botanica Sinica-English Edition-,46(8), 928-934.
5. **Markovski A., Velkoska-Markovska L., 2015** - *Investigation of the morphometric characteristics of jujube types (Ziziphus jujuba Mill.).* Fruits in republic of Macedonia Genetika-Belgrade, 47(1), 33-43
6. **Qin G. Z., Tian S. P., 2004** - *Biocontrol of postharvest diseases of jujube fruit by Cryptococcus laurentii combined with a low dosage of fungicides under different storage conditions.* Plant disease, 88(5), 497-501.
7. **Soliman, H. I., & Hegazi, G. A. E., 2013-** *In vitro clonal propagation and molecular characterization of jujube (Ziziphus jujuba Mill.).* Life Science Journal, 10(2), 573-582.

8. **Stănică F., 1997** - *Curmalul chinezesc (Ziziphus jujuba Mill.), specie pomicolă pentru partea de sud a României, (The Chinese date (Ziziphus jujuba Mill.) a new fruit tree species for the southern part of Romania)*. Hortinform, 4.
9. **Stănică F., 2008** - *Characterization of Two Romanian Local Biotypes of Ziziphus jujuba*. 1st International Jujube Symposium ISHS, Baoding, China, September 21–25, Acta Horticulturae 840, pp. 259–262
10. **Stănică F., 2002** - *Multiplication of Chinese date (Ziziphus jujuba Mill.) using conventional and in vitro techniques*, XXVI-th. International Horticultural Congress ISHS, 11-17 Aug., Toronto, Canada, On-site Program, S11-P-30, pp 303-304.
11. **Stănică F., Dumitrașcu M., 2008** - *Chinese Date - a New Promising Plant for Romania Southern Areas -ISHS International Symposium for Underutilized Plant Species for food, nutrition, income and sustainable development*, Arusha, Tanzania.
12. **Tian, S., Qin, G., Xu, Y., 2005** - *Synergistic effects of combining biocontrol agents with silicon against postharvest diseases of jujube fruit*. Journal of Food Protection®, 68(3), 544-550.
13. **Velkoska-Markovska L., Petanovska-Ilievska B., 2013** - *Optimization and development of SPE-HPLC-DAD method for the determination of atrazine, malathion, fenitrothion and parathion pesticide residues in apple juice*. Macedonian Journal of Chemistry and Chemical Engineering, 32(2), 299-308.
14. **Wang Y., Tang F., Xia J., Yu T., Wang J., Azhati R., Zheng X. D., 2011** - *A combination of marine yeast and food additive enhances preventive effects on postharvest decay of jujubes (Zizyphus jujuba)*. Food chemistry, 125(3), 835-840.
15. **Xue Z., Feng W., Cao J., Cao D., Jiang W., 2009** - *Antioxidant activity and total phenolic contents in peel and pulp of Chinese jujube (Ziziphus jujuba Mill) fruits*. Journal of Food Biochemistry, 33(5), 613-629.
16. **Yan J., Li J., Zhao H., Chen N., Cao J., Jiang W., 2011** - *Effects of oligochitosan on postharvest Alternaria rot, storage quality, and defense responses in Chinese jujube (Ziziphus jujuba Mill. cv. Dongzao) fruit*. Journal of Food Protection®, 74(5), 783-788.
17. **Yao S., 2013** - *Past, present, and future of Jujubes-Chinese Dates in the United States*. Hort Science, 48(6):672–680
18. **Yaragattikar A. T., Itnal C. J., 2010** - *Studies on Water Requirement During Early Growth Stages of Ber Through Drip Irrigation*. Karnataka Journal of Agricultural Sciences, 16(1)

RESEARCH ON THE BEHAVIOR OF SOME SWEET CHERRY CULTIVARS IN IAȘI AREA

CERCETĂRI PRIVIND COMPORTAREA UNOR SOIURI DE CIREȘ ÎN ZONA IAȘI

IUREA Elena¹, SÎRBU Sorina¹, CORNEANU Margareta¹
e-mail: iurea_elena@yahoo.com

Abstract. *The aim of the paper is to present the valuable features of sweet cherry cultivars obtained at RSFG Iasi but also of some foreign cultivars which improve the range with different fruit ripening period throughout during entire harvest season. Regarding on the three years average yield (2015-2017) it is reported statistically that all the cultivars recorded insignificant differences compared to the average of cultivars (20.3 kg/tree) with values between 16.7 kg/tree (Cătălina) and 24.3 kg/tree (Marina). In terms of weight and equatorial diameter of fruits, Cetățuia (5.0 g respectively 21.07 mm) recorded significant negative differences compared to the average of the variants (6.9 g and 23.53 mm) and all cultivars taken in the study registered insignificant differences compared with control.*

Key words: assortment, sweet cherry, cultivars, fruit, quality

Rezumat. *Scopul lucrării este de a prezenta caracterele valoroase ale unor soiuri de cireș create la SCDP Iași și ale unor soiuri cosmopolite care îmbunătățesc sortimentul autohton cu soiuri cu diferite epoci de maturare a fructelor eșalonate pe tot parcursul sezonului de recoltare. Referitor la producțiile medii pe trei ani (2015-2017), din punct de vedere statistic, se constată că toate soiurile luate în studiu au înregistrat diferențe nesemnificative față de media soiurilor (20,3 kg/pom), valorile fiind cuprinse între 16,7 kg/pom (Cătălina) și 24,3 kg/pom (Marina). Sub aspectul greutatei fructelor și a diametrului ecuatorial, soiul Cetățuia (5,0 g și 21,07 mm) a înregistrat diferențe semnificativ negative față media variantelor (6,9 g și 23,53 mm), iar celelalte soiuri luate în studiu au înregistrat diferențe nesemnificative.*

Cuvinte cheie: sortiment, cireș, soiuri, fruct, calitate

INTRODUCTION

The soil and climate conditions from the NE area of Romania are favourable to grow sweet cherry trees, excepting a few years when natural calamities occurred (on the 19th of April 2017 when the sweet cherry tree was in bloom, the minimum temperature got to -2.5°C, affecting the flower's pistil and compromising the production of fruits).

The promoting of a sweet cherry assortment that can make production every year, having low vigour trees, with valuable self-fertile cultivars that are productive, resistant to biotic and abiotic factors and have ripening time at the

¹ Research Station for Fruit Growing Iasi, Romania

extremities of the sweet cherries season is a permanent work of the researchers (Budan *et al.*, 1997; Budan and Grădinariu, 2000; Cociu, 1990; Petre, 2006).

Although the sweet cherry tree is characterised as having a high ecological plasticity, the novelty of the assortment and the claims that refer to the intensification of this species' crops imposed the necessity to place comparative crops responsible to respond at the behaviour of the cultivars to the ecological conditions from the Iași area and at the trees' density per surface unit (Istrate and Petre, 2003).

The aim of the paper is to present the valuable features of sweet cherry cultivars obtained at RSFG Iasi but also of some foreign cultivars which improve the range with different fruit ripening period throughout during entire harvest season.

MATERIAL AND METHOD

The studies have been performed during 2015-2017, using as research material, six sweet cherry cultivars created at SCDP Iași, homologated during 1999 - 2007 (Cetățuia, Cătălina, Maria, Bucium, Marina and George) and three cosmopolitan cultivars (Stella, Van and Kordia), each grafted on mahaleb.

Competition comparative crops have been placed linearly, in three repetitions of 3 trees, at a distance of 5 x 4 m and they have been trained as free flattened palmette canopy without sustaining system or irrigations system. On the row with trees, the soil has been prepared using the lateral disk with palpation and between the rows with trees, the soil has been grassed. The control of diseases and pests has been done in regard to the received warnings, phytosanitary treatments being performed.

In the experimental plantation, observations and measurements concerning the trees' vigour, main growing phenophases and fructification (Fleckinger, 1960) and concerning resistance to anthracnosis and monilia have been performed.

The experimental data have been statistically interpreted by analysing the variance.

RESULTS AND DISCUSSIONS

The cultivars chosen for study have medium vigour and concerning the resistance to diseases, as 2016 has been a rainy year (with an excess of 173 mm), a year that was favourable for pathogenic evolution (monilia and anthracnosis), they manifested a slight sensibility both to anthracnosis (the attack frequency being between 1.8-3.8%) and to monilia (the attack frequency being between 1.8-3.3%) (tab. 1). This fact, associated with the degree of attack which was reduced for aphids (0.09-5.00%), gives the possibility to assure an economical harvesting volume with healthy trees during the entire year by applying 5-6 chemical treatments at the optimal moments.

The tree's characteristics in two sweet cherry cultivars
(RSFG Iași; average 2015-2017)

Genotype	Tree's vigour*	Resistance to:					
		Leaves' anthracnosis** (<i>Coccomyces hiemalis</i> Higg.)			Monilia** (on fruits) (<i>Monilinia fructigena</i>)		
		F%	I%**	G.A.%	F%	I%**	G.A.%
Cetățuia	5	1.9	5	0.04	2.9	10	0.04
Cătălina	5	3.1	5	0.06	2.8	10	0.06
Bucium	5	2.9	5	0.06	3.3	10	0.07
Maria	5	2.0	5	0.04	1.8	5	0.04
Van	5	2.2	10	0.04	2.8	5	0.06
Stella	5	2.0	5	0.04	1.8	5	0.04
Kordia	5	1.8	5	0.04	2.8	10	0.06
Marina	5	2.1	5	0.04	2.2	15	0.07
George	5	3.8	5	0.08	2.1	5	0.04

*- degree of tree's vigour on a 1-9 scale: 1= very weak; 3= weak; 5 = middle; 7= strong; 9= very strong (***, 2006)

**- the degree of attack intensity on a 1-6 scale: 1 = 3% attacked area; 3 = 25%; 4 = 50%; 6 = 100% (Cociu and Oprea, 1989)

The beginning of flowering for the studied sweet cherry cultivars during 2015-2017 was recorded between the 1st and 18th of April and the end of flowering between 8th and 26th of April (tab. 2)

In 2016 the flowering was launched with 7-16 days earlier in comparison with 2015 and 2017. The duration of the flowering has been between 6-11 days, while the nine sweet cherry cultivars have pollinated each other.

The higher the temperatures, the earlier the flowering epoch takes place.

The harvesting maturity was recorded in the second (Cetățuia) and third decade (Cătălina) of May for all the early cultivars, in the first (Bucium, Maria, Stella, Kordia) and second decade (Van) of June for all the middle cultivars and in the first decade of July (Marina, George) for the late cultivars, the number of days from the end of flowering to maturation ranging between 33-84 days (tab. 2).

Regardless the climatic conditions of the year, the order in which the sweet cherry cultivars get to maturity maintains every time the same, the difference being that the time interval between two successive cultivars is longer or shorter (Darbyshire *et al.*, 2012).

The average fruits' productions obtained during the studied period (2015-2017) have been influenced by the climatic conditions (the precipitations excess in 2016, the snow and extremely slow temperatures in April 2017) and by the cultivar.

The main phenophases of fructification for the studied sweet cherry cultivars (RSFG Iași; 2015-2017)

Cultivar	Flowering			Harvesting period	The number of days from the end of flowering to the harvesting period
	Start	End	Duration (days)		
Boundary dates (earliest-latest)					
Cetățuia	1.04 – 15.04	08.04 – 20.04	6 - 8	11.05 – 22.05	33 - 34
Cătălina	2.04 – 17.04	10.04 – 22.04	6 - 9	17.05 – 31.05	38 - 40
Bucium	6.04 – 17.04	14.04 – 24.04	8 - 9	07.06 – 18.06	55 - 56
Maria	4.04 – 17.04	11.04 – 24.04	8 - 8	06.06 – 17.06	55 - 57
Van	4.04 – 16.04	14.04 – 26.04	11 - 11	11.06 – 17.06	53 - 59
Stella	4.04 – 16.04	14.04 – 25.04	10 - 11	08.06 – 16.06	53 - 56
Kordia	6.04 – 17.04	15.04 – 24.04	8 – 10	07.06 – 12.06	50 - 54
Marina	4.04 – 17.04	11.04 – 26.04	8 – 10	24.06 – 06.07	72 - 75
George	4.04 – 18.04	14.04 – 26.04	9 - 11	06.07 – 09.07	75 - 84

Analysing the average productions on three years (2015-2017), from the statistical point of view it can be observed that the cultivars recorded insignificant differences in comparison with the average of the cultivars (20.3 kg/tree) which was taken as witness, but the cultivars that recorded the highest values were Marina (24.3 kg/tree), Bucium (23.3 kg/tree), Van (22.0 kg/tree), Cetățuia (21.4 kg/tree) and Stella (21.3 kg/tree) (tab. 3).

The physical traits of the fruits vary from a cultivar to another and they also vary from a tree to another from the same cultivar, depending on the stock for grafting, trees' age, applied technology, soil and climate factors, fruits' load etc. (Beceanu and Bostaca-Sîrbu, 2007). The fruit quality is determined by the size of the fruit, the epidermis colour, the stone size and the easy detachment of the stone from the pulp.

The cultivar named Cetățuia recorded in terms of fruits' weight and equatorial diameter (5.0 g and 21.07 mm), statistical differences significantly negative in comparison with the variants average (6.9 g and 23.53 mm) (tab. 3). All the other studied cultivars recorded insignificant differences in comparison with the average of the cultivars (tab. 3).

For the stone's size, the cultivars recorded a weight between 0.23-0.36 g, classifying it as small to middle size according the UPOV questionnaire.

The report fruit/stone was between 16.6 (George) and 26.7 (Van), in comparison with the average of the cultivars (22.9). The percentage of the stone from the fruit's weight recorded values between 3.81% (Van) and 6.14% (George). From the statistical point of view, the cultivar named George recorded significant positive differences and all the other studied cultivars recorded insignificant differences in comparison with the average of the cultivars (4.55%) (tab. 3).

Table 3

Fruits' production and physical traits of the fruit for the studied sweet cherry cultivars (RSFG Iași; 2015-2017)

Genotype	Average production of fruits (kg/tree)	Average weight of the fruit (g)	Average weight of the stone (g)	Fruit/stone report	Stone from the fruit's weight (%)	Equatorial diameter of the fruit (mm)
Cetățuia	21.4	5.0 ⁰	0.23 ⁰	24.1	4.57	21.07 ⁰
Cătălina	16.7	7.3	0.33	22.2	4.50	23.08
Bucium	23.3	7.7	0.32	24.5	4.09	24.97
Maria	18.2	6.6	0.26	25.3	3.96	23.30
Van	22.0	8.0	0.30	26.7	3.81	24.33
Stella	21.3	7.5	0.30	24.8	4.11	24.17
Kordia	18.0	7.0	0.33	20.9	4.84	24.60
Marina	24.3	7.2	0.36	20.5	4.96	24.30
George	17.3	5.7	0.35	16.6	6.14 ⁺	21.20 ⁰
X (Average)	20.3	6.9	0.31	22.9	4.55	23.53
DL 5%	10.1	1.46	0.06	7.80	1.38	2.05
DL 1%	13.8	2.01	0.08	10.74	1.89	2.83
DL 0.1%	19.1	2.70	0.11	14.79	2.61	3.89

Note: - the year of plantation: 1991, planting distance 5 x 4 m

The colour of the fruits varies as follows: double coloured (Marina), shining red (Maria, Van, Stella, Bucium, George) and dark red (Cetățuia, Cătălina and Kordia) (tab. 4).

The pulp firmness is an important quality item, especially for the fruits targeted for fresh consumption (Kappel *et al.*, 2000). The two cultivars with early maturation (Cetățuia, Cătălina) have a semi firm pulp, while the cultivars with average and late maturation have a firm pulp.

Table 4

Physical-chemical and quality traits of the fruits for the studied sweet cherry cultivars (RSFG Iași; 2015-2017)

Cultivar	Epidermis colour	Pulp firmness	Fruit's shape	DM* (%)	Pulp adherence to stone	Cracking resistance (%)
Cetățuia	dark red	semi firm	kidney-shaped	15.0	semi-adherent	16.0
Cătălina	dark red	semi firm	kidney-shaped	18.5	non-adherent	6.3
Bucium	shining red	firm	heart-shaped	18.9	non-adherent	21.0
Maria	shining red	firm	heart-shaped	18.4	non-adherent	9.3
Van	shining red	firm	globular	17.4	non-adherent	45.0
Stella	shining red	firm	heart-shaped	18.7	non-adherent	29.0
Kordia	dark red	firm	heart-shaped	18.4	non-adherent	18.0
Marina	double coloured	firm	heart-shaped	17.3	non-adherent	19.3
George	shining red	firm	heart-shaped	17.9	non-adherent	4.0

*dry matter

Concerning the pulp adherence to stone, only the early cultivar Cetățuia presents semi-adherence to stone, all the other studied cultivars being non-adherent.

The content of dry substance is very important in sweet cherries as the taste of the fruits depends on it. The values of this parameter were between 15.0% (Cetățuia) and 18.9% (Bucium) (tab. 4).

Analysing the cracking phenomenon in fruits, the recorded values were between 4% and 45%, the most valuable cultivars from this point of view being George (4%), Cătălina (6.3%) and Maria (9.3%) (tab. 4).

CONCLUSIONS

1. Soil and climate factors from the Iași, Romania area assure good conditions for growing and fructification for sweet cherry trees, however, in the latest years, the excess of precipitations and very low temperatures recorded in the vegetation and fructification phenophases, especially at flowering time can act as limitation factors for the production.

2. The results that have been obtained highlight the cultivars named Bucium, Marina, Van and Stella, that got remarked from all the points of view of the parameters studied during the years of study.

REFERENCES

1. **Beceanu D., Bostaca Sîrbu Sorina, 2007** – *European criteria to appreciate the cherries qualities*, lucr. Șt.UAS Moldova, Chișinău, p. 306-309.
2. **Budan S., Balaci Raveca, Petre L., 1997** – *Realizări în ameliorarea genetică la cireș și vișin*, în vol “Contribuții românești în ameliorarea genetică a soiurilor și portaltoilor de pomi, arbuști fructiferi și căpșuni (1951-1996)”, Pitești.
3. **Budan S., Grădinaru G., 2000** – *Cireșul*, Ed. Ion Ionescu de la Brad, Iași, 262 pag.
4. **Cociu V., Oprea Șt., 1989** – *Metode de cercetare în ameliorarea plantelor pomicole*, Editura Dacia, Cluj-Napoca, 172 pag.
5. **Cociu V., 1990** – *Soiurile noi factor de progres în pomicultură*, Editura Ceres, București.
6. **Petre L., 2006** – *Rezultate obținute în ameliorarea sortimentului de cireș, vișin și nuc la S.C.D.P. Iași*, Lucr. șt. ICDP Pitești-Mărăcineni, vol. XXII, Pitești, p. 45-49.
7. **Darbyshire R., Webb L., Goodwin I., Barlow E. W. R., 2012** - *Evaluation of recent trends in Australian pome fruit spring phenology*, International Journal of Biometeorology, available as abstract on <http://link.springer.com/article/1#>
8. **Fleckinger J., 1960** - *Phenologie et arboriculture fruitiere*, Rev. Bon Jardinier, tome 1, p. 362-372.
9. **Istrate M., Petre L., 2003** – *Îmbunătățirea sortimentelor pomicole și promovarea soiurilor valoroase în plantațiile pomicole din zona de NE a Moldovei*, Lucr. șt. UȘAMV, seria Horticultură, vol. 46, Iași.
10. **Kappel et al., 2000** – *Selecting for Firm Sweet Cherries*; Proc. EUCARPIA Symp. On Fruit Breed. And Genetics; Ed. M.Geibel, M. Fischer & C. Fischer, Acta Hort., nr. 538, vol. 1, ISHS, p. 355-358.
11. *****, 2006** - *Protocol for distinctness, uniformity and stability tests of sweet cherry (Prunus avium L.)* available at <http://www.cpv0.europa.eu>

OBSERVATIONS ON THE FROST RESISTANCE OF THE FERNOR WALNUT VARIETY DURING THE REST PERIOD (JANUARY-APRIL), UNDER THE PEDOCLIMATIC CONDITIONS IN SĂLCIOARA AREA, DÂMBOVIȚA COUNTY

OBSERVAȚII ASUPRA REZISTENȚEI LA ÎNGHEȚ A SOIULUI DE NUC FERNOR, ÎN TIMPUL PERIOADEI DE REPAUS (IANUARIE-APRILIE), ÎN CONDIȚIILE PEDOCLIMATICE DIN ZONA SĂLCIOARA, JUD. DÂMBOVIȚA

KISS I. K.¹, HOZA D.¹, ISTRATE M.²
e-mail: iosif.kiss@nucifere.com

Abstract. *It is well known that walnut varieties with lateral fructification have a lower resistance to temperature variations during relative rest and on the entering vegetation. In the first decade of January 2017, in Salcioara village, Dambovita county there was recorded extremely high variations in the negative temperatures, which could affect the viability of the male florids (men) and the small unisixed female buds. At the end of April (26-28 April) there were late spring frosts that caused massive tissue necrosis of young tissues in native walnut trees and partial frosts of male 'Fernor' sprouts found in the phenophase of swelling of the buds. If the autochthonous genotypes produced 80% of the production of walnuts in the year 2017, these late frosts did not affect the subsequent development of fruit buds in the 'Fernor' variety. Approximately 10% of male florid shoots (avenues) showed partial frostbite without having their total pollen emission capacity and 3% of small buds unisixed females were affected by frost.*

Key words: *Juglans regia L., late frosts, Fernor, frost resistance*

Rezumat. *Este cunoscut faptul că soiurile de nuc cu fructificație laterală prezintă o rezistență mai scăzută la variațiile de temperaturi din timpul repausului relativ și a celor de la intrarea în vegetație. În prima decadă a lunii ianuarie 2017, în Com. Sălcioara, jud. Dâmbovița s-au înregistrat variații extrem de mari a temperaturilor negative, fapt ce putea să afecteze viabilitatea mugurilor floriferi masculi (amenți) și a mugurilor micști unisexuați femeli. La sfârșitul lunii aprilie (perioada 26-28 IV) s-au înregistrat înghețuri târzii de primăvară ce au cauzat necrozări în masă ale țesuturilor tinere la pomii din populațiile de nuc autohtone și degerături parțiale ale unor muguri floriferi masculi din soiul Fernor aflați în fenofaza de umflare a mugurilor. Dacă la genotipurile autohtone producția de nuci a anului 2017 a fost compromisă în proporție de 80%, la soiul Fernor aceste înghețuri târzii de primăvară nu au afectat dezvoltarea ulterioară a mugurilor de rod. Aproximativ, 10% din mugurii floriferi masculi (amenți) au prezentat degerături parțiale, fără a fi*

¹University of Agronomical Sciences and Veterinary Medicine of Bucharest, Romania

²University of Agricultural Sciences and Veterinary Medicine of Iasi, Romania

afectată total capacitatea lor de a emite polen și 3% din mugurii micști unisexuați femeli au fost afectați de îngheț.

Cuvinte cheie: *Juglans regia* L., înghețuri târzii de primăvară, Fernor, rezistența la îngheț

INTRODUCTION

Because in the last 10 years, in the variety conveyor of walnut varieties cultivated in Romania have made places and walnut varieties with lateral fructification of foreign origin (American, Hungarian, French, Turkish, Moldavian), there is required research on their evolution under the pedoclimatic conditions of Romania.

All fruit trees are more or less affected by early autumn frosts and late spring frosts. The likelihood of frost loss increases when negative weather events overlap the frostiness of trees. Frost sensitivity is inversely proportional to frost resistance. During the annual cycle of vegetation and latency, the autumn and spring transition periods are risky in terms of frost resistance. Likelihood of autumn or spring frost is comparable (Spulak and Balcar, 2013).

The behavior of walnut varieties with lateral fructification and the results obtained depend on applied technologies and climatic conditions (Botu *et al.*, 2010).

Fertilized trees are more vulnerable to frost damage. Application of fertilizer with nitrogen in late summer or early autumn decreases frost resistance (Thomas and Blank, 1996). Phosphorus, which is involved in cell division, is important for the recovery of tissue damage. Potassium has a favorable effect on the regulation of water and plant photosynthesis, but its effect on frost protection is not clear (Snyder *et al.*, 2005).

In conclusion, from September to January, the dynamics of the acclimatization process was determined by the environment, mainly because since January, by the removal of the buds, the effect of genotype on the tolerance and avoidance of frost was identified. (Charrier *et al.*, 2011)

MATERIAL AND METHOD

The present study is conducted under the climatic conditions of Salcioara village, Dâmbovița county (10 km from the town of Titu). In the collection of varieties owned by Kiss Iosif Karoly.

The observations were made on 100 'Fernor' walnut trees, planted in 2010, using an 8 x 4 m planting scheme. The culture substrate was analyzed in the OSPA Cluj Napoca laboratory during 2013. The general climatic data specific to the area were provided by OSPA Cluj. Data on meteorological developments were provided by the National Meteorological and Hydrological Agency through its own website. In periods of interest, with negative national temperatures, data on temperature and snow cover were collected at intervals of up to 4-6 hours. The main meteorological feature was the cooling effect of the wind because it influences in the field the resistance of vegetative buds and flowering buds and, implicitly, the fructification capacity of the trees. During 2016 and 2017 no treatments with systemic and contact

fungicides were applied. In 2017, there were applied 10 doses of foliar vermicompost liquid extract, 2 liters / ha, diluted in 200 liters of water, from 1st of May until 15th of July. The agrochemical content of the vermicompost used was analyzed in the Laboratory of Physical and Chemical Analysis for Soil Science, Agrochemistry and Soil Protection at INCDPAPM-ICPA Bucharest. In the spring of 2017, the physiological status of female young buds, male florid buds, and whether total or partial frosts of annual increases were recorded. On 1st of July 2017, there was evaluated the increases in length and diameter and the quality of floral induction (of the atems) and the ratio of the spruce to the diameter of the shoots raised in 2017.

RESULTS AND DISCUSSIONS

Resistance to wintering is influenced by: the hereditary factor, the degree of hardening of the trees for winter; age of trees; temperature oscillations during winter; the land exhibition and the technology applied the previous year. This attribute is determined not only by the singular effect of the temperature (as low as possible), but also by the winter weather and the ability of the plant to adapt to higher temperature amplitudes combined with the existence or lack of snow.

In the spring of 2017, tree temperatures at the crown level were lower (by 3-4 °C) due to the cooling effect of the wind. Thus, on 04.04.2017, 8.00 hours, the air temperature in the Titu area was 0 °C and the cooling coefficient was -3 °C. (figures 1 and 2). Under these conditions, there was no evidence of dry annual growths caused by frostbite in the first year branches where the ratio of bone marrow to branch diameter was less than 1:3.

When the ratio between the bone marrow and the diameter of the branch was higher than 1:1.5, drying of the annual growth occurred. Also, partial and total frosts were recorded at 10% of the aphids and 3% of the small female buds on annual growths with a ratio between the bone marrow and the diameter greater than 1:3 and less than 1:2.

Temperature shocks and high amplitudes in February-March (temperature amplitudes may sometimes reach +15 °C, a phenomenon commonly found in the southern part of the country, can cause significant damage to walnuts by affecting fruit buds) (tab. 1)

At the end of April (26-28 IV) there were late spring frosts that caused massive necrosis of young tissues to the trees of indigenous walnut populations and partial frostbite of male 'Fernor' sprouts found in the phenophase of swelling of the buds.

If the autochthonous genotypes produced 80% of the production of walnuts in the year 2017, these late frosts did not affect the subsequent development of fruit buds in the 'Fernor' variety. Approximately 10% of the male florid buds (avenues) showed partial frostbite, without having their total pollen emission capacity and 3% of the small buds unisexed females were affected by frost (figures 3 and 4).

This period is characterized primarily by the intense increase in water content, which confirms the passage of the buds to a more pronounced or

elongation of the cells, which is connected with an influx of water higher than in the case of embryonic growth.

Table 1

Evolution of climatic elements measured in Sălcioara village, Dâmbovița county, in 2013 (Climate Atlas of Romania), OSPA Cluj 2013

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Monthly Median Monthly Air Quality (°C)	-5	-3	3	7	14	18	21	20	14	8	3	-2
Average daily minimum (°C)	-3	-1	6	12	17	20	23	22	16	12	5	-1
Maximum absolute air temperature (°C)	20	23.3	25	30.1	35.6	36.6	39.8	39.4	38.8	34.2	28	19.1
Absolute minimum air temperature (°C)	-30	-27	-19	-8	-1	4.2	8	5.6	-2.3	-3.6	-13.2	-22
Atmospheric precipitation (mm)	37	37	34	49	76	88	77	61	44	35	47	44

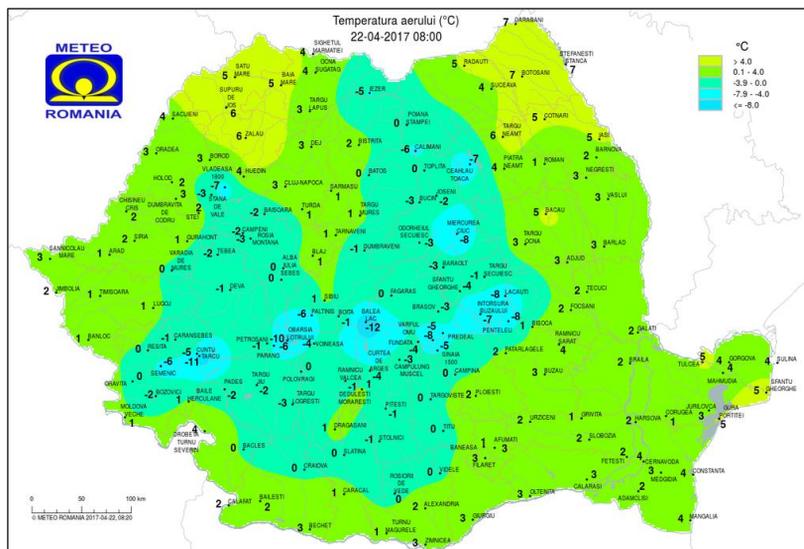


Fig. 1 The air temperature recorded at Romania level, on 22.04.2017

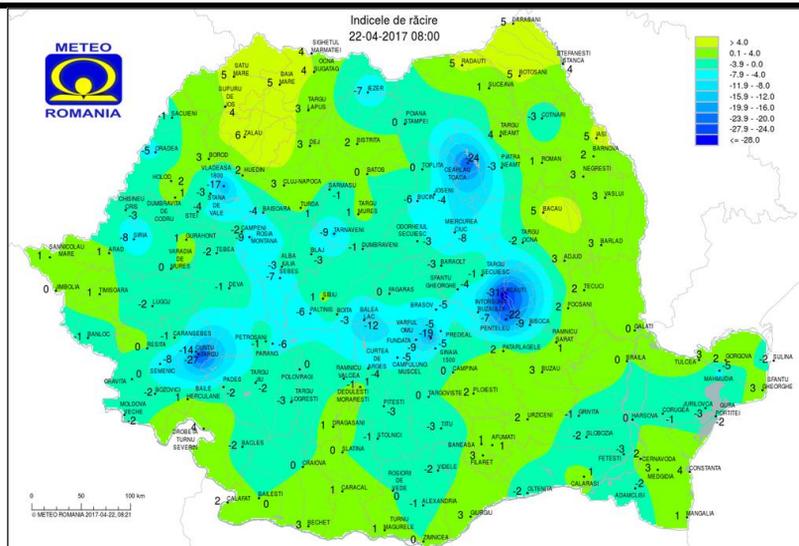


Fig. 2 Cooling index, recorded on 22.04.2017



Fig. 3 Aspects of damage as a consequence of the late spring frost in the walnut native varieties



Fig. 4 Aspects of damage as a consequence of the late spring frost in the 'Femor' Walnut variety

In 2017 there were no *Xantomonas campestris* and *Gnomonia leptostyla* attacks above the economic damage threshold, on the foliage of foliage treatments with vermicompost liquid extract.

CONCLUSIONS

In order to reduce the risk of frost caused by the cooling effect of the wind, it is advisable to create a protection curtain around the plantation, of rapidly growing species.

Nitrogen fertilization from the walnut orchard will stop at the latest on 15th of July. The optimal ratio of calcium to nitrogen in foliar and basal fertilization influences the frost resistance of walnut varieties with lateral fructification.

Applying foliar treatments with vermicompost liquid extract increases the resistance to walnut-specific pathogens.

To assess the frost resistance of indigenous and foreign walnut varieties, it is recommended to conduct a study in a controlled environment according to the standard practice defined by Diaz R. and Fernando Lopez (2005) for the *Juglans regia*, quoted by N. Aleta *et al.*, 2014.

The parameter to be followed is LT50 (the negative temperature at which a genotype has 50% loss of its cells) (Aleta *et al.*, 2014).

REFERENCES

1. Aletà N., Vilanova A., Tomàs E., Guàrdia M., 2014 - Frost resistance in seven commercial walnut cultivars. Acta Hort. 1050, 389-393, DOI: 10.17660/ActaHortic.2014.1050.54
2. Botu M., Botu I., Tudor M., Papachatzis A., 2010 - Advantages and disadvantages offered by growing lateral bearing walnut cultivars in the Sub-Carpathian area of Oltenia. Scientific Papers of the R.I.F.G. Pitesti, Vol. XXVI, 2010. <http://www.icdp.ro/publicatii/Lucrari%202010/063.pdf>
3. Bussler W., Epstein E., 1972 - Mineral Nutrition of Plants: Principles and ...Z. Pflanzenernaehr. Bodenk., 132: 158–159. doi:10.1002/jpln.19721320211.
4. Charrier G., Bonhomme M., Lacoïnte A. Améglio T., 2011 - Are budburst dates, dormancy and cold acclimation in walnut trees (*Juglans regia* L.) under mainly genotypic or environmental control? Int J Biometeorol 55(6): 763-774. <https://doi.org/10.1007/s00484-011-0470>.
5. Díaz R., Fernández-López J., 2005 - Genetic variation at early ages for several traits of interest for timber-production breeding of *Juglans regia*. Canadian Journal of Forest Research, 35(2): 235-243, <https://doi.org/10.1139/x04-162>
6. Snyder R. L., Melo-Abreu J. P., 2005 - Frost Protection: Fundamentals, Practice, and Economics, Vol. 1. London: Food and Agriculture Organization of the United Nations, XIV + 223 p. <http://journal.frontiersin.org/article/10.3389/fpls.2015.00259/full#h1>
7. Spulak O., Balcar V., 2013 - Temperatures at the margins of a young spruce stand in relation to aboveground height. I Forest 6, 302–309 10.3832/ifer0815-006
8. Thomas F. M., Blank R., 1996 - The effect of excess nitrogen and insect defoliation on the frost hardness of bark tissue of adult oaks. Ann. For. Sci. 53, 395–406 10.1051/forest:19960222

PRELIMINARY STUDY IN REGARDS TO THE CULTURE OF BLUEBERRY IN CONTAINERS

CERCETĂRI PRELIMINARE PRIVIND CULTURA AFINULUI ÎN CONTAINER

KOTROTSIOS I.¹, SLAV M.¹, HOZA D.¹

e-mail: dorel.hoza@gmail.com

Abstract. *The blueberry culture has presented a growing interest in the past years among fruit producers due to the constantly increasing demand on the market. However because of the specific pH requirements of the soil the culture can only be cropped where appropriate conditions are being met. To avoid restrictions of improper soil the focus has been shifted on containers. Thus, during a study of plant behaviour involving a 30 litres container and 4 blueberry varieties – Draper, Patriot, Brigitta and Elliot it has been observed that when they reach the age of 3 plants have a satisfactory growing response and start to form fruit. Among the four tested varieties differences have been registered in what regards the phenological progress of flowering, the growth and ramification capacity and the fruit forming capacity. The Patriot variety has been the most forward and Draper the most late flowering. Draper has presented a higher vigour represented by a higher growing and ramification capacity while Brigitta has had a lower vigour overall.*

Key words: culture substrate, growth, production,

Rezumat. *Cultura afinului este de mare interes în ultimii ani în rândul producătorilor de fructe, datorită cererii crescânde pe piață, dar din cauza pretențiilor desosebite față de pH-ul solului cultura nu poate fi înființată decât acolo unde solul permite. Pentru a evita restricțiile impuse de solul impropriu culturii, sunt încercări de cultură a afinului în conainer. Într-o experiență privind comportarea plantelor la cultura în container cu capacitatea de 30 litri, a 4 soiuri de afin: Draper, Patriot, Brigitta și Elliot s-a constatat că la vârsta de 3 ani plantele au avut o comportarea bună în ceea ce privește creșterea și au început să fructifice. Cele 4 soiuri testate au avut o comportare diferită din punct de vedere al derulării fenologiei înfloritului, a capacității de creștere și ramificare și a capacității de fructificare. Soiul Patriot a fost cel mai timpuriu, iar Draper cel mai târziu, Draper a avut o vigoare mai mare exprimată printr-o capacitate mai mare de creștere și ramificare, iar soiul Brigitta a avut o vigoare mai mică.*

Cuvinte cheie: creștere, producție, substrat de cultură

INTRODUCTION

The blueberry culture (*Vaccinium corymbosum L.*) has lately become more interesting for small fruit producers due to the nutraceutical and gustative quality

¹ University of Agronomical Science and Veterinary Medicine of Bucharest, Romania

of fruits (Giovanelli and Buratti, 2009; Wang *et al.*, 2017). Blueberries can be consumed fresh, they can be processed and frozen or they can be stored for a certain amount of time depending on variety and storing conditions (Yang *et al.*, 2014). During storing the quality of blueberry fruits can be affected by microbiological impairments caused by fungi (Chen *et al.*, 2015; Liato *et al.*, 2016). Although the specie is quite rustic it does require specific soil conditions especially an acid reaction and a good water-permeability as the pH is a limiting agent for the culture (Botez *et al.*, 1984). Because acid soils are limited, especially in the lower area of the culture, the possibility of container culture exists, through which the acidity of soil is better controlled. As a result, the blueberry can be cultivated in areas where soil conditions are not generally appropriate (Asanica *et al.*, 2017). The choice of area for blueberry culture is also determined by the minimum limit of winter temperature, -20°C and most of all by the late frosts during spring that can result in significant damage (Hoza, 2000). The present paper presents the reaction of some blueberry varieties cultivated in containers, highlighting growth and fructification capacity.

MATERIAL AND METHOD

The study was made in Kardits, Greece, in 2016, using 4 blueberry varieties: Draper, Patriot, Brigitta a (fig. 1). The containers were placed at 1 m distance from each other, in rows having 2 m in between them. The plants were conducted as a bush. The culture substratum was formed of: 40% black peat with a 5.5 pH, 40% blonde peat with a 3.5 pH and 20 % perlite. The culture was designed with a fertigation system, with 20 mm tubes and dripping devices with a capacity of watering 4l/hour. The irrigation was done daily with 2-3 l of water/plant depending on temperature and the fertigation was done with complex fertilizer, fortnightly, 20 g/plant until August. Measurements were made regarding: flowering phenology, growing capacity, ramification capacity, production capacity and the moment of fruit ripening.



Fig. 1 Aspect of experience

RESULTS AND DISCUSSIONS

The flowering phenology has shown the varieties studied are different in what regards the start of vegetation, flowering moments and ripening of fruits. Thus, the Draper variety budded on 25 of February, followed by Patriot 10 days later while Elliot only started the process a month after (tab. 1). The beginning of flowering was conditioned and dependent of bud sprouting and the differences between varieties maintained. Leaves formation took place roughly in the same time as flowering and the beginning of ripening happened in the last decade of May for the earliest variety, Patriot and a month later for the latest variety, Elliot. The duration of ripening was slightly different, 3 varieties: Draper, Patriot and Brigitta staggered on 20 days while Elliot on 25 days, the latter being also the latest.

Plant vigour was normal for 3 years old plants and the ramification capacity was dependent on variety. The bush height was slightly higher at the Draper variety, having 85 cm, followed by the Elliot variety with 75 cm and Brigitta and Patriot with roughly 62-65 cm (tab. 2).

Table 1

Development of flowering phenology of some blueberry varieties cultivated in containers Kardits, Greece, 2016

Variety	Bud sprouting	Start of flowering	First leave formation	Start of ripening	End of ripening
Elliot	25.03	5.04	5.04	20.06	15.07
Draper	25.02	5.03	7.03	20.05	10.06
Patriot	5.03	15.03	12.03	1.06	20.06
Brigitta	15.03	25.03	25.03	10.06	30.6

The best ramification capacity was noted at Draper, the bush had 13 ramifications and 3 new growths in the collet area. The weakest ramification capacity was registered at Brigitta and Patriot with approximately 10.5-10.8 ramifications and only 2 new growths in the collet area. The Elliot variety had intermediary values. The average length of annual growths was bigger at Draper, 26.5 cm, followed by Patriot with 24.3 cm, while the smallest values were observed at Brigitta, of only 21.2 cm. The sum of annual growths proved the difference in vigour for all varieties studied and it was influenced by the number of ramifications and the average length of fructification branches. The highest value was seen at Draper, 4.47 cm and the smallest at Brigitta 3.21 cm. The other two varieties had intermediary values.

Table 2

Biometrical parameters of plants for some blueberry varieties cultivated in containers Kardits, Greece, 2016

Variety	Height of the bush (m)	Number of ramifications in the bush (buc)	Number of annual stems in the collet (buc)	Average length of annual growths (cm)	Sum of annual growths (m)
Elliot	0.75	11.2	2.1	22.6	3.53
Draper	0.85	13.1	3.1	26.5	4.47
Patriot	0.65	10.8	2.0	24.3	4.12
Brigitta	0.62	10.5	1.9	21.2	3.21
Average	0.705	11.4	2.275	23.65	3.83

Although the plants were young they started to produce fruits and the results obtained registered differences in what regards the morphological parameters that influence the production. Thus, the number of inflorescences per plant was significantly influenced by variety, the values being of 11-11.5 at Elliot and Draper and 7.5-8 at Patriot and Brigitta (tab. 3, fig. 2). The number of fruits in one inflorescence is a characteristic of each variety and it was observed just from that year. Elliot produced an average of 8.1 fruits, registering the highest value and Brigitta produced 5 fruits having the lowest value. Patriot and Draper produced intermediary values, similar to each other.

Table 3

Productivity parameters of plants for some blueberry varieties cultivated in containers Kardits, Greece, 2016

Variety	Number of inflorescences per plant	Number of fruits per inflorescence	Average production per plant (g)	Production per hectare (kg)
Elliot	11.0	8.1	173.74	694.9
Draper	11.5	6.5	216.77	867.1
Patriot	7.5	5.5	86.62	346.5
Brigitta	8.0	5.0	80.00	320.0
Average	9.5	6.27	139.28	557.1

The average production per bush was different for all varieties but it is not a distinctiveness of them. It revealed however their precocity level. For the small fruit producer it is imperative to know the fructification capacity of plants grown in containers from when they are 3 years old. From the quantity point of view, Draper produced 216 g of fruits, 173 g roughly from Elliot and only half of this value was obtained from Patriot and Brigitta. If a calculus is made considering the area and the density of pots at 4000, the production resulted could be approximately 320-860 kg/ha for a culture in its third year of life.



Fig. 2 Detail of fructification, Draper variety

CONCLUSIONS

From this preliminary study that tackles the behaviour of some blueberry varieties cultivated in containers the following conclusions can be drawn:

1. The varieties studied reacted positively at container growth on peat substratum mixed with perlite. The plants grew normally considering their age;
2. The development of flowering phenology revealed a staggering of this process depending on variety. Draper was the earliest variety and Elliot the tardiest;
3. The ramification capacity and the length of fructification branches were different at each variety in part. Draper had the highest ramification capacity and Brigitta the lowest;
4. Fructification started in their third year of life and registered differences from one variety to the other. Draper proved to be more precocious and productive while Brigitta was registered as the less productive one.

REFERENCES

1. **Asănică A., Delian E., Tudor V., Teodorescu R.I., 2017** - *Physiological activity of some blueberry varieties in protected and out-side conditions*. Agrolife Scientific Journal, 6(1):31-39.
2. **Botez M., Bădescu Gh., Botar A., 1984** - *Cultura arbuștilor fructiferi*. Ceres Publishing, Bucharest.
3. **Chen H., Cao S., Fang X., Mu H., Yang H., Wang X., Xu Q., Gao H., 2015** - *Changes in fruit firmness cell wall composition and cell wall degrading enzymatic in postharvest blueberry during storage*. Scientia Horticulturae, 188:44-48.
4. **Giovanelli G., Buratti S., 2009** - Comparison of polyphenolic composition and antioxidant activity of wild Italian blueberries and some cultivated varieties. Food chemistry: 112, 4, pp 903-908.
5. **Hoza D., 2000** - *Cultura căpșunului, semiarbuștilor și arbuștilor fructiferi*. Elisavaros Publishing, Bucharest, pp 208-209.
6. **Liato V., Hammani R., Aider M., 2017** - *Influence of electro-actived solution o weak organic acid salts on microbial quality and overall appearance of blueberry during storage*. Food Microbiology 64, pp 56-64.
7. **Wang H, X. Guo, X. Hu, T. Li, X. Fu, R. H. Liu, 2017** - *Comparison of phytochemical profiles, antioxidant and cellular antioxidant activities of different varieties of blueberry (Vaccinium spp.)*. Food chemistry, Vol. 217, pp 773-781.
8. **Yang G., Yue J., Gong X., Qian B., Wang H., Deng Y., 2014** - *Blueberry leaf extracts incorporated chitosan coating for preserving postharvest quality of fresh blueberries*. Postharvest Biology and Technology, 92, pp 46-53.

BEHAVIOR OF SOME NEW APPLE VARIETIES ON THE FIREBLIGHT ATTACK

COMPORTAREA UNOR SOIURI NOI DE MĂR LA ATACUL FOCULUI BACTERIAN

MARIN F. C.¹, CĂLINESCU Mirela, MILITARU Mădălina,
SUMEDREA Mihaela, SUMEDREA D.
e-mail: c_marin69@yahoo.com

Abstract. Fireblight - *Erwinia amylovora* Burill. Winslow is one of the most damaging for the apple culture in the many apple producing countries. Under ideal microclimate conditions it can destroy a young apple orchard in a single growing season, and by consequence it is very devastating not only for the apple production growing industry but for nurseries sector as well. In order to restrain and control the disease spread and damages, intensive researches are carried out in many fruit growing countries. This work aim was to assess the infection risks and early warning possibilities for the fire blight infections, under specific climatic conditions, using modern computer software, to assess the behavior of some new released and introduced apple varieties and to establish their susceptibility to natural occurred infections on active growing lateral shoots, in the latest years. According to the software forecast model, in the latest years, the infection risk with *Erwinia amylovora* on apples was high and very high from May to October. Under the given natural and technological conditions, the most sensitive apple varieties to fireblight attack were: Auriu de Bistrita (ROM) DD%=45.0; Dalinco and Dalinred (FRA) DD%=30-45.0; Topaz (CEH) DD%=35.0; Crimson Crisp and Idared (USA) DD%=35.0; Red Jonaprince (NL), Fuji Kiku Clone 8 (JPN) DD%=15.0. During the identified risk periods the apple trees need special prunings and preventive treatments with plant protection products including copper hydroxide and fosetil-aluminium, to keep them in good phytosanitary status. In order to better manage the fireblight disease, breeding o new tolerant or resistant apple varieties is always actual and a constant request.

Key words: apple, varieties, fireblight, behavior, monitoring, early-warning

Rezumat. Focul bacterian al rozaceelor - *Erwinia amylovora* Burill. Winslow este una dintre cele mai pagubitoare maladii care afectează cultura mărului în numeroase țări ale lumii. În condiții ideale de microclimat poate distruge o plantație tânără în decursul unui sezon de vegetație, de aceea este pagubitoare nu numai pentru producția de mere ci și pentru sectorul pepinieristic. Pentru restrângerea și controlul răspândirii maladiei și a daunelor, se întreprind cercetări laborioase în multe țări cu tradiție în pomicultură. Scopul acestei lucrări a fost acela al investigării riscului infecțiilor cu focul bacterian, și al posibilităților de avertizare timpurie a atacului, în condiții climatice specifice, folosind software modern, evaluarea comportării unor soiuri de măr recent omologate sau introduse în țară și stabilirea susceptibilității la infecțiile

¹Research Institute for Fruit Growing Pitesti Romania, Orchard Technology and Plant Protection Lab

apărute în condiții naturale pe lăstarii laterali. Conform modelului software de avertizare timpurie, în ultimii ani riscul infecțiilor cu *Erwinia amylovora* a fost mare și foarte mare din Mai și până în Octombrie. În condițiile naturale și tehnologice de referință, cele mai susceptibile soiuri de măr s-au dovedit a fi : Auriu de Bistrita (ROM) GA%=45.0; Dalinco and Dalinred (FRA) GA%=30-45.0; Topaz (CEH) GA%=35.0; Crimson Crisp and Idared (USA) GA%=35.0; Red Jonaprince (NL), Fuji Kiku Clone 8 (JPN) GA%=15.0. Pe parcursul perioadelor de risc identificate, pomii au avut nevoie de tăieri speciale și tratamente preventive cu produse de protecție a plantelor pe bază de hidroxid de cupru și foseții de aluminiu pentru a putea fi menținuți în stare fitosanitară corespunzătoare. Pentru prevenirea și combaterea cu succes a focului bacterian, ameliorarea sortimentală și obținerea de soiuri de măr tolerante sau rezistente este o cerință și o activitate mereu actuală.

Cuvinte cheie: măr, soiuri, focul bacterian, comportare, monitoring, avertizare-timpurie

INTRODUCTION

Fireblight is one of the most damaging for the apple culture in many apples producing countries. Under ideal conditions it can destroy a young apple orchard in a single growing season, and by consequence it is very devastating not only for the apple production growing industry but for nurseries sector as well (Biggs *et al.*, 2008; Babadoost, 2005; Hartman and Hershman, 2002; Ritchie and Sutton, 2002; Branște and Amzăr, 2000; Amzăr and Ivașcu, 2003; Tomșa and Tomșa, 2003). The causal agent (*Erwinia amylovora* Burr Winslow, *Bacteriophyta*, *Enterobacteriaceae*) was spotted for the first in England in the 18th Century, but nowadays is present in many apple growing countries. More over the pathogen attacks 75 hosts plant species and genera, on many genus of fruit species (*Aronia*, *Fragaria*, *Cydonia*, *Cerasus*, *Malus*, *Pyrus*, *Rubus*, *Sorbus*), and many decorative species as well. In Romania the damaging agent was spotted first in 1991 (Amzăr *et al.*, 2003). The pathogen overwinters in diseased shoots and surrounding bark plagues, during the vegetation period the bacteria are spread on host plants by bees, insects, birds, winds, rains water and human interventions (Biggs and Steiner, 2000).

The symptoms can develop in an exponential manner, secondary infection symptoms can be worse than those in the primary infections. In the susceptible cultivars the amount of fire blight disease depends on: the number and distribution of sources from which inoculum is available; the genetic susceptibility of scion and rootstock cultivars; the rate at which new infections occur. Direct connection is between the primary sources for fire blight, the amount of disease in the previous year and the phytosanitary procedures applied in the previous year and the actual year (Biggs *et al.*, 2008).

In order to restrain and control the disease spread and damages intensive researches are carried out in many fruit growing countries like: USA, Canada, Australia, New Zealand, UK, Germany, Italy, Belarus and Romania in the fields of pathogen biology and epidemiology, early detection and risk assessment methods, monitoring of pathogen propagation into the ecosystems, agronomical

methods to reduce the varieties susceptibilities, use of adequate plant protection products, define behavior on the pathogen attack and breeding of tolerant or tolerant varieties.

This work aim was to assess the infection risks and early warning possibilities for the fire blight infections, under specific climatic conditions, using modern computer software Specware Pro 9, to assess the behavior of some new released and introduced apple varieties and to establish their susceptibility to natural infections occurred on active growing lateral shoots, in the latest years.

MATERIAL AND METHOD

The researches were conducted during 2016-2017, at Research Institute for Fruit Growing Pitesti Romania. The weather data were collected using the WatchDog Spectrum Technologies Inc. semi-automate weather station and were stored, processed and analyzed using the facilities of the MS Office Excel 2010 and with SpecWare Pro 9.0 software facilities for early warning. The studied biological material consisted in 42 apple varieties recently released or introduced in our Country, grafted on six different low vigor vegetative rootstocks, grown in an remote and isolated high density intensive orchard, with over 3000 trees/ha, trained as slender spindles and supplied with water and nutrients by fert-irrigation. The experimental device, was located on a plane terrain situated on the second terrace of the Argeș River, on a low to medium fertile illuvial-clay soil unit (over 30% clay; humus less than 1.7%; nitrogen index 0.33-1.43; PAL 1.3-2.5 mg/100g), but well supplied with potassium up to 40 mg /100g). Soil reaction is slightly acid (pH 5.8-6.8). The orchard floor was covered with grass between the trees rows and cleared with total herbicides on stripes of 1.0-1.2 m wide, along the trees rows. The fireblight infection risk was assessed using Cougar scale (where '0'=very low infection risk; '4'=very high infection risk), and the apple varieties behavior during the vegetation seasons was assessed using the Van der Zweet *et al.*, 1979, scale (where '1'=healthy tree; '9'=dead tree). The new apple varieties were characterized using both pomological descriptors and IPBGR descriptors for apple.

RESULTS AND DISCUSSIONS

On highly sensitive apple varieties, the malady can affect all the vegetative and generative organs of the apple trees, the inoculum surviving in diseased bark cankers.

The most vulnerable periods to the pathogen infections are the blooming time and the vegetative shoots elongation. The most sensitive organs are the flower clusters, on which, the infections may become visible after 5-6 up to 30 days with higher temperatures (103 degrees over the 12.7°C threshold). After the flowers clusters, the young vegetative shoots are the most sensitive. According Steiner, 2000, the carbohydrates reserves accumulated in the second part of June favorises the pathogen attack. The infections occurs, develops and became vizable very quick, less than 167 days with temperatures higher than 13.0 °C and ooze droplets might be seen.

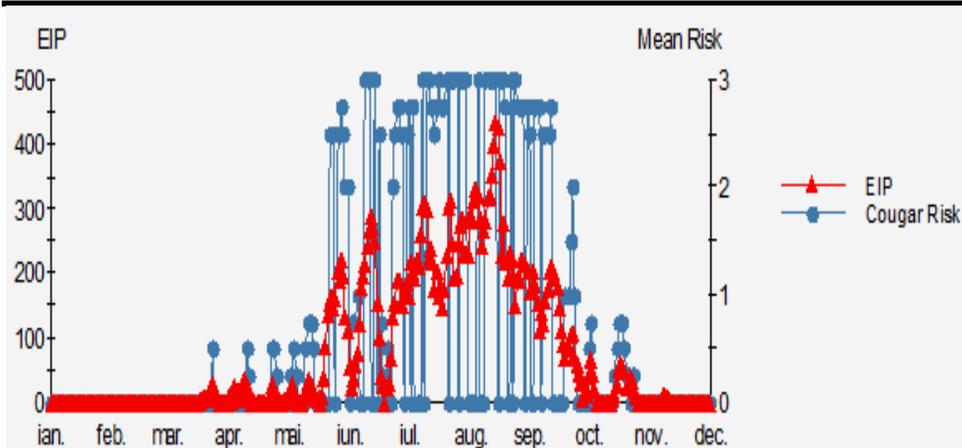


Fig. 1 Fireblight infections risk Pitesti-Maracineni, Romania, 2016

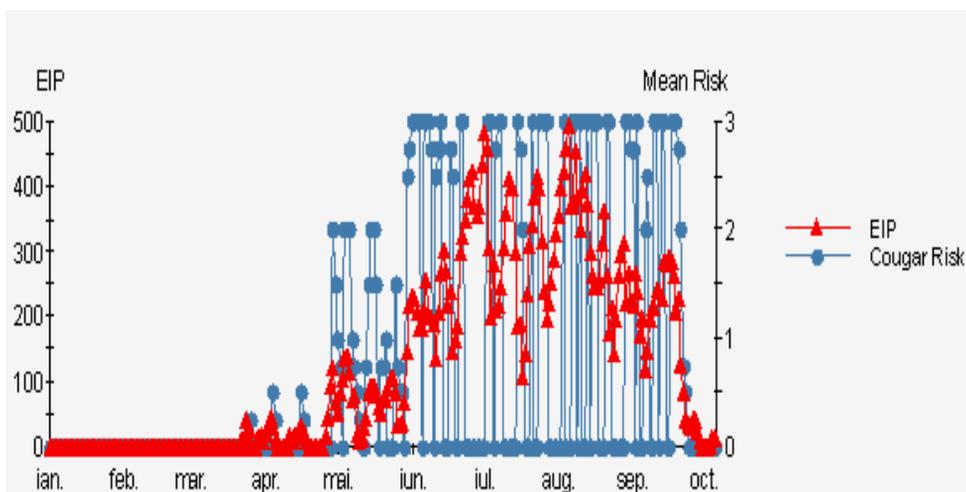


Fig. 2 Fireblight infections risk Pitesti-Maracineni, Romania 2017

Assessment of the figures 1 and 2 reveals that according to the forecast model, the infection risk with fireblight on apples was high and very high.

So, between May and October 2016, the epiphytic infection potential (EIP) was 200-300 and between May and October 2017 was 250-450.

Evaluation of Cougar infection risk shows that between May and October 2016, and between June and October 2017 the indicator was 2.0-3.0 (high and very high risk of infection).

Therefore special prunings and preventive treatments with plant protection products including copper hydroxide and fosetil-aluminium, to keep them in good phytosanitary status.

Behavior of some apples varieties on fireblight *Erwinia amylovora* Burill Winslow attack on shoots
Research Institute for Fruit Growing Pitesti Romania 2016-2017

No	Variety and rootstock	Origin	Age	Van der Zweet scale [1-9]	Disease severity [%]	Disease incidence [%]	Damages degree [%]
1	Aura / M9	ROM	10	1	0.0	0.0	0.00
2	Auriu de Bistrita / M9	ROM	12	7	5.0	9.0	45.00
3	Bistritean / M9	ROM	10	1	0.0	0.0	0.00
4	Ciprian / M9	ROM	10	1	0.0	0.0	0.00
5	Florina / M9	ROM	12	2	1.0	2.0	2.00
6	Goldprim / M9	ROM	10	1	0.0	0.0	0.00
7	Initial / M9	ROM	10	1	0.0	0.0	0.00
8	Jonaprim / M9	ROM	10	1	0.0	0.0	0.00
9	Rebra / M9	ROM	12	1	0.0	0.0	0.00
10	Redix / M106	ROM	12	1	0.0	0.0	0.00
11	Romus 3 / M9	ROM	10	1	0.0	0.0	0.00
12	Romus 4 / M9	ROM	10	1	0.0	0.0	0.00
13	Romus 5 / M9	ROM	10	3	3.0	2.0	6.00
14	Rustic / M9	ROM	10	1	0.0	0.0	0.00
15	Starkprim/M9	ROM	10	1	0.0	0.0	0.00
16	Dalinbel / EMLA	FRA	8	3	2.0	5.0	10.00
17	Dalince / EMLA	FRA	8	7	9.0	5.0	45.00
18	Dalinred / EMLA	FRA	8	6	8.0	5.0	40.00
19	Dalinred / PI 80	FRA	8	5	6.0	5.0	30.00
20	Dalinred / T337	FRA	8	6	0.0	5.0	0.00
21	Ariane / M9	GER	12	1	2.0	0.0	0.00
22	Ariwa / T337	GER	12	2	0.0	2.0	0.00
23	Pinova / M9	GER	12	1	0.0	0.0	0.00
24	Red Jonaprince / M9	NL	12	4	3.0	5.0	15.00
25	Topaz / M9	CEH	12	6	5.0	7.0	35.00
26	Golden Lassa / T337	ITA	12	1	0.0	0.0	0.00
27	Golden Orange / T337	ITA	12	3	2.0	3.0	6.00
28	Fuji Kiku Clone 8 / M9	JPN	12	4	5.0	3.0	15.00

29	Enterprise / M9	USA	12	1	0.0	0.0	0.00	
30	Crimson Crisp / Pajam 1	USA	8	4	3.0	5.0	15.00	
31	Crimson Crisp / PI 80	USA	8	5	5.0	4.0	20.00	
32	Golden Delicious / M9	USA	12	3	2.0	5.0	10.00	
33	Goldrush / Pajam	USA	8	1	0.0	0.0	0.00	
34	Goldrush / PI 80	USA	8	1	0.0	0.0	0.00	
35	Goldrush / EMLA	USA	8	3	2.0	5.0	10.00	
36	Idared / M9	USA	12	3	5.0	4.0	20.00	
37	Jonatan / M9	USA	12	3	2.0	5.0	10.00	
38	Nured Jonathan / M9	USA	12	2	5.0	1.0	5.00	
39	Prima / M9	USA	12	1	0.0	0.0	0.00	
40	Braeburn / M9	NZ	12	2	2.0	5.0	10.00	
41	Hillwell / M9	NZ	10	2	3.0	3.0	9.00	
42	Falstaff / M9	UK	10	1	0.0	0.0	0.00	
<i>Indicators</i>			AVG		2.5	1.90	2.26	8.52
			STDEV		1.8773	2.4376	2.5285	12.9544
			VAR		75.0934	127.9744	111.7849	151.9790

Evaluation of the table 1 brings new data on the behavior 42 apple cultivars on the lateral shoots to the fireblight attack during the study period 2016-2017.

The Romanian apple varieties displayed a good behavior to the pathogen attack on lateral shoots, only four of them (28.57%) being affected. The most damaged variety was Auriu de Bistrita / M9 with an average damage degree DD%=45.0, followed by Romus 5 with DD%=6.0.

During the two years of study sever affected were the French apple varieties Dalinco /EMLA and Dalinred / EMLA and Dalinred /PI 80, with the average damage degree DD%=45.0, 40.0 and respectively 30.0 followed by Czech variety Topaz / M9 with DD%=35.0.

Under the given conditions, the American eleven apple varieties had a good behavior to the pathogen attack, only two of them (18.18%) were affected Crimson Crisp / PI 80 and Idared / M9 with an average damage degree DD%=20.0.

Among the German and Dutch varieties, the most affected was Red Jonaprince / M9 variety with the average damage degree DD%=15.0. The same behavior had the Japanese variety Fuji Kiku Clone 8, with an average damage degree DD%=15.0 (fig.3, fig.4).



Fig. 3 Apple trees shoots attacked by fireblight *Erwinia amylovora* Burill. Winslow



Fig. 4 Fruits from well trained and healthy apple trees tolerant on *Erwinia amylovora* Burill. Winslow

CONCLUSIONS

1. The most vulnerable periods to the fireblight - *Erwinia amylovora* Burill Winslow infections are the blooming time and the young vegetative shoots elongation.

2. The facilities of the WatchDog semi-automate weather station and the dedicate software Specware Pro 9.0 are very useful tools for monitoring the risk with fireblight infections, early warning and precise positioning of the preventive phytosanitary treatments.

3. The biological material assessment under the orchard condition is very important for complete evaluation of the varieties, prior their extension into intensive fruit production system.

4. Under the given natural and technological conditions, the most sensitive apple varieties to fireblight attack were: Auriu de Bistrita (ROM), Dalinco and Dalinred (FRA), Topaz (CEH), Crimson Crisp and Idared (USA), Red Jonaprince (NL), Fuji Kiku Clone 8 (JPN). Therefore, during the risk periods they needed special prunings and preventive treatments with plant protection products including copper hydroxide and phosetil-aluminium, to keep them in good phytosanitary status.

5. In order to better manage the fireblight attack, breeding of new tolerant or resistant apple varieties is always actual and a constant request.

Acknowledgements: This research was possible with the support of the Agriculture Ministry, Research Program ADER and Research Institute for Fruit Growing Pitesti Romania.

REFERENCES

1. **Amzăr Valentina, Ivascu Antonia, 2003** - *Ghid de identificare al principalelor boli și dăunători la speciile pomicole*, Editura MEDRO, București, 200p., ISBN 973-8487-02-1
2. **Braniste N., Amzar V., 2000** - *Cultura mărului*, Editura Gee, ISBN973-99540-5-7, 92p
3. **Babadoost M., 2005** - *Fireblight of apples*, University of Illinois, College of Agricultural, Consumer and Environmental Sciences, Department of Crop Sciences, RPD n. 801, 8pp
4. **Biggs A.R., Turechek W.W., Gottwald T.R., 2008** - *Analysis of fire blight shoot infection epidemics on four apple cultivars*. *Plant Diseases*, 92:1349-1356
5. **Hartman J., Hershman D., 2002** - *Fire Blight*, University of Kentucky, College of Agriculture and Life Sciences, Plant Pathology Department, Extension, PP Information Note 34 (PPA 034);
6. **Ritchie D.F., Sutton T.B., 2002** - *Fire Blight of Apple and Pear*, North Carolina State University, College of Agriculture and Life Sciences, Plant Pathology Department, Extension, Fruit Disease Information Note 3 (FDIN 003);
7. **Tomșa M., Tomșa Elena, 2003** - *Protecția integrată a pomilor și arbuștilor fructiferi la început de Mileniu*, Editura Gee, București, 162 p., ISBN 973-85232-9-X;
8. **Van der Zwet T., Keil L. H., 1979** - *Fire blight. A bacterial disease of Rosaceus plants*, USDA, ARS Beltsville MD, Agriculture Handboock N. 510, Washington, DC, 001-000-03724-2;
9. *****SpecWare 9 User Guide (Pro & Basic)** - Product manual, SpecWare Software © 1997-2012 Spectrum Technologies, Inc., IL, USA, 52 pp.;
10. *****SpecWare 8 Quick Start Guide** - Product manual, SpecWare Software © 1997-2012 Spectrum Technologies, Inc., IL, USA, 12pp.;

NEW SWEET CHERRY CULTIVARS FOR ROMANIAN ORCHARDS

NOI SOIURI DE CIREȘ PENTRU PLANTAȚIILE POMICOLE DIN ROMÂNIA

*SÎRBU Sorina*¹, *IUREA Elena*¹, *CORNEANU Margareta*¹
e-mail: sorinas66@yahoo.com

Abstract. *In the last ten years was been introduced into the orchards of Romania new autochthonous sweet cherry cultivars or from the foreign assortment. Research was conducted during 2014-2016 at three Romanian new obtained cultivars as 'Andreias', 'Alexus' and 'Mihailis' and two introduced sweet cherry cultivars as 'Kordia' (Czech Republic) and 'Van' (Canada). An other cultivar, 'Boambe de Cotnari' (Romania) was evaluated. 'Boambe de Cotnari' is an old cultivar very spread in Romania but still demanded by producers. Some parameters related to phenological stages and fruit characteristics were determined. Sweet cherry cultivars taken into study registered fruit weight value as 7.72 g (as average 2014-2016) and soluble solids content as 14.53 Brix.*

Keywords: sweet cherry, cultivar, phenology, fruit, soluble solids content

Rezumat. *În ultimii zece ani, au fost introduse în livezile românești noi soiuri autohtone de cireș sau provenite din sortimentul internațional. Cercetările a fost realizate în perioada 2014-2016 la trei noi soiuri românești 'Andreias', 'Alexus' și 'Mihailis' și două soiuri de cireș introduse 'Kordia și 'Van (Canada). A fost evaluat și soiul 'Boambe de Cotnari' (România) care este un soi vechi foarte răspândit în România și cerut în continuare de producători. S-au determinat parametri privind stadiile fenologice și caracteristicile fructului. Soiurile de cireș luate în studiu au înregistrat o valoare a greutateii fructelor de 7,72 g (media 2014-2016) și conținut în substanță uscată solubilă de 14,53 Brix.*

Cuvintecheie: cireș, soi, fenologie, fruct, substanță uscată solubilă.

INTRODUCTION

In Romania sweet cherry tree (*Prunus avium* L.) is a wild or cultivated species (Ciocârlan, 2000). In 2014 in Romania the harvest area was 6,446 ha with 12.8 tonnes/ha fruits production (FAOSTAT data). Of total orchards 44% are in decline and just seven percent are young plantations (Chitu and Coman, 2014). The main cultivars in orchards are still 'Stella', 'Van', 'Germersdorf', 'Boambe de Cotnari' and 'Hedelfinger' grafted on seedlings rootstocks *Prunus mahaleb* L. or *Prunus avium* L. In the last ten years by a National Programme for renewing local fruit growing, new cultivars were introduced in plantations but also grafted on vegetative rootstocks, especially on Gisela 5, these being suitable

¹Research Station for Fruit Growing Iasi, Romania

for high density orchards (Usenik *et al.*, 2017; Radunić *et al.*, 2011). This paper aims to assess six sweet cherry cultivars which are preferred by growers and that can be planted in orchards.

MATERIAL AND METHOD

Research was conducted during 2014-2016 at three Romanian new obtained cultivars as 'Andreiaș', 'Alexus' and 'Mihailis' and two introduced sweet cherry cultivars as 'Kordia' (Czech Republic) and 'Van' (Canada). An other cultivar, 'Boambe de Cotnari' (Romania) was evaluated these being an old cultivar very spread in Romania but still demanded by producers and produced in nurseries. The fruit growing trees can be found in the experimental plot, grafted on *P. mahaleb* as seedlings rootstock and planted at a distance of 5 x 4 m, with free flattened palmette crown on the direction of the trees row, without a sustaining system and without irrigation system. On the row with trees, the cultivar was worked with the lateral disk with feeler and between the trees rows the soil was heated.

Some parameters related to phenological stages, tree and fruit characteristics were determined. Phenological data were determined through the Fleckinger system (Fleckinger, 1960): F₁ - the beginning of the flowering: the flowers are open for 5%; G - the end of the flowering: the petal of flowers have fallen for 90%. Characteristics of fruit, stone and stalk were determined on a sample of 30 fruits for each cultivar using a digital caliper Loomytools for dimensions determinations and an high precision balance (Radwag, 0.01 sensivity) for weight determinations. Index of the fruit and stone shape was calculated by formula: $\text{length}^2/\text{width} \times \text{thickness}$ (Stojanovic, 2012). Soluble solids content was determined using a refractometer Zeiss on samples of 15 fruits in three repetitions.

The statistical analysis was performed with the XLSTAT programme, the differences between cultivars being determined by the Duncan's test ($p \leq 0.05$).

RESULTS AND DISCUSSIONS

During 2014 - 2016 it has been observed a great variability of the number of days from end of flowering to the harvesting time according to the sweet cherry tree cultivars and climatic conditions of the year. During the study the values ranged between 47 days at 'Andreiaș' and 61 days at 'Boambe de Cotnari' (tab. 1). Beginning flowering (stage B₁) started at April 4 at 'Van' in 2016 these data being the earliest from entire study and range until April 21 at 'Alexus' and 'Mihailis' in 2015. For stage G 'Boambe de Cotnari' registered April 12 in 2016 but were recorded until April 28 at 'Alexus' in 2018 conditions.

Fruit ripening time at sweet cherry cultivars during between June 5 ('Mihailis' in 2016) to June 23 ('Alexus' in 2016) (tab. 1).

As period from the end of flowering to the harvesting time 'Mihailis' was the earliest with 47 days in 2016 but 'Boambe de Cotnari' recorded 61 days in 2016. Radicevic *et al.*, 2011 studied 23 sweet cherry cultivars for combination in commercial orchards and recorded flowering onset time at April 4 at 'Van' and

April 5 for 'Kordia' as average between 1999 to 2006, that being in according with our data (tab. 1).

Table 1

**Phenological data of sweet cherry cultivars
(average 2014 – 2016, RSFG Iasi, Romania)**

Cultivar	The beginning of the flowering (stage B ₁)	The end of the flowering (stage G)	Fruit ripening time	Duration from end of flowering to harvesting period (days)
Andreias	6-19.04	14-23.04	6-11.06	49-53
Alexus	8-21.04	14-28.04	11-23.06	53-58
Boambe de Cotnari	5-17.04	12-22.04	12-22.06	60-61
Mihailis	5-21.04	13-26.04	5-12.06	47-53
Kordia	8-20.04	14-24.04	12-21.06	58-59
Van	4-16.04	14-26.04	11-16.06	51-58

Stojanovic *et al.* (2012) find flowering time of 'Kordia' between April 17 to April 30 besides ripening time was at June 21 in Sarajevo climate conditions, these data being almost like ours results.

Some fruit characteristics are presented in table 2. As fruit mass the bigger was 'Alexus' with 9.56 g as average of all three years of study. Also good size recorded 'Andreias', 'Mihailis' and 'Van' with 8.86 g, 7.44 g and 7.62 g respectively.

Fruit width is a value with great importance for evaluated the sweet cherry quality. Great dimensions recorded 'Alexus' with 26.35 mm and 'Andreias' with 25.32 mm as average during 2014 to 2016, but with great variability year by year.

Table 2

**The fruits characteristics at six sweet cherry cultivars
(average 2014-2016, RSFG Iasi, Romania)**

Cultivar	Fruit weight (g)*	Fruit dimensions (mm)			Fruit shape index
		Width D	Thickness d	Length H	
Andreias	8.86 ^{ab}	25.32 ^c	22.11 ^a	24.11 ^a	1.04 ^{ab}
Alexus	9.56 ^a	26.35 ^{ab}	22.33 ^a	24.25 ^a	1.00 ^{ab}
Boambe de Cotnari	6.79 ^{bc}	22.62 ^{abc}	21.98 ^{ab}	21.26 ^b	0.93 ^b
Mihailis	7.44 ^{abc}	23.24 ^{abc}	20.26 ^{ab}	22.51 ^{ab}	1.08 ^a
Kordia	6.03 ^c	22.39 ^a	19.55 ^b	22.43 ^{ab}	1.11 ^a
Van	7.62 ^{abc}	24.67 ^{bc}	21.35 ^{ab}	20.64 ^b	0.78 ^b

* - Different letters after the number corresponds with statistically significant differences for P 5% - Duncan test.

Maglakelidze *et al.* (2017) showed data of nine sweet cherry cultivars for the same period 2014 to 2016 and 'Van' recorded average width value as 25.9 mm being similar with our data (24.67 mm) as fruit characteristics. Fruit shape index range between 0.78 ('Van') to 1.11 ('Kordia'). Differences in the fruit form are important and seems to be more tempting a flattened sweet cherry than a lengthened one (Perez-Sanchez *et al.*, 2010). 'Kordia' and 'Mihailis' were lengthened since all others sweet cherry cultivars studied were flattened heart shape.

Table 3

**The stone characteristics of six sweet cherry cultivars
(average 2014-2016, RSFG Iași, Romania)**

Cultivar	Stone weight (g)	Stone dimension (mm)			Stone shape index
		Width D	Thickness d	Length H	
Andreias	0.34 ^{ab}	9.08 ^{ab}	7.07 ^b	10.79 ^{ab}	1.83 ^{bc}
Alexus	0.36 ^{ab}	9.42 ^a	7.79 ^a	10.67 ^{ab}	1.55 ^d
Boambe de Cotnari	0.43 ^a	9.01 ^{ab}	7.27 ^{bc}	10.29 ^b	1.62 ^{cd}
Mihailis	0.33 ^{ab}	8.91 ^{ab}	7.20 ^{bc}	11.10 ^{ab}	1.92 ^b
Kordia	0.31 ^c	8.68 ^b	6.63 ^c	11.75 ^a	2.40 ^a
Van	0.32 ^{bc}	9.18 ^{ab}	7.49 ^{ab}	9.27 ^b	1.26 ^e

* - Different letters after the number corresponds with statistically significant differences for P 5% - Duncan test.

The stone characteristics were showed in table 3. The greatest size of stone recorded 'Boambe de Cotnari' that being the most reason for replace the cultivar in orchards in the future.

Table 4

The fruit stalk characteristics and soluble solids content of six sweet cherry cultivars (average 2014-2016, RSFG Iași, Romania)

Cultivar	Stalk length (mm)	Stalk weight (g)	Soluble solids content (%)
Andreias	31.33 ^d	0.09 ^b	16.57 ^a
Alexus	35.6 ^c	0.11 ^{ab}	17.03 ^a
Boambe de Cotnari	39.53 ^b	0.10 ^{ab}	17.93 ^a
Mihailis	43.47 ^a	0.11 ^{ab}	17.64 ^a
Kordia	41.67 ^{ab}	0.12 ^a	17.3 ^a
Van	26.67 ^e	0.10 ^{ab}	17.5 ^a

* - Different letters after the number corresponds with statistically significant differences for P 5% - Duncan test.

But no significant statistically differences between them and ‘Andreias’, ‘Alexus’ or ‘Mihailis’ recorded (tab. 3). As stone shape index at ‘Kordia’ and ‘Van’ were observed statistically significant differences than all sweet cherry cultivars taken in the study (tab. 3).

The fruit stalk characteristics are presented in table 4. Fruit stalk length is an important parameter in cultivar determination, the longer being better for easier picking (Stojanovic *et al.*, 2012). In our study were recorded longer stalk at ‘Mihailis’ and ‘Kordia’ with values 43.47 mm and respectively 41.67 mm. Stalk weight range between 0.09 g (‘Andreias’) to 0.12 g (‘Kordia’). Soluble solids content range between 16.57% to 17.93% at sweet cherry cultivars taken in study. ‘Boambe de Cotnari’ recorded greatest value (17.93%) of soluble solids content but no significant statistically differences recorded between them and all sweet cherry cultivars taken in study.

CONCLUSIONS

1. The climate conditions have influenced the duration of the phenological stages of different cultivars of sweet cherry.

2. ‘Alexus’ and ‘Andreias’ showed great fruit size being suitable for establishing new commercial orchards.

3. ‘Boambe de Cotnari’ showed greatest values of soluble solids content being a very good choice for production fruits destined processing as compote but also for fresh consumption.

Acknowledgements: *This study has been partially financed by the Ministry of Agriculture and Rural Development, Grant No. ADER 3.1.2./2015, with title ‘Management of in situ and ex situ fruit crop resources’.*

REFERENCES

1. Ciocârlan V., 2000 - *Flora ilustrată a României. Pteridophyta et Spermatophyta*. Editura Ceres, București, 1139 pp.
2. Coman M., Chitu E., 2014 - *Zonarea speciilor pomicole în funcție de condițiile pedoclimatice și socio-economice ale României*. Editura Invel Mutimedia, 288 pp.
3. Fleckinger J., 1960 - *Phenologie et arboriculture fruitiere*. Bon Jardinier. Tome 1: 362-372.
4. Maglakelidze E., Bobokasvili Z., Kakashvili V., Tsigriasvili L., 2017 - *Biological and agricultural properties of sweet cherry (Prunus avium L.) cultivars in Georgia*. International Journal of Science and Research (IJSR), Volume 6, Issue 9, p. 796-803, DOI: 10.21275/ART20176036.
5. Perez-Sanchez R., Gómez-Sánchez M., Morales-Corts M., 2010 - *Description and quality evaluation of sweet cherry culture in Spain*. Journal of Food Quality. 33. pp 490–506.
6. Radičević S., Cerović R., Marić S., Đorđević M., 2011 - *Flowering time and incompatibility groups – cultivar combination in commercial sweet cherry*. Genetika, Vol. 43, No. 2, 397-406.

7. **Radunić M., Jazbec A., Pecina M., Čosić T., Pavičić N., 2011** - *Growth and yield of the sweet cherry (Prunus avium L.) as affected by training system*. African Journal of Biotechnology Vol. 10 (24), pp. 4901-4906.
8. **Stojanovic M., Milatovic D., Kulina M., Alic Z., 2012** – *Pomological properties of sweet cherry cultivars on Gisela 5 rootstock in the region of Sarajevo*. Third International Scientific Symposium "Agrosym Jahorina 2012", p. 183-187.
9. **Usenik, V., DonikPurgaj, B., Fajt, N., 2017** - *Evaluation of five rootstocks with cherry cultivars 'Kordia' and 'Regina' at two locations in Slovenia*. ActaHortic. 1161, p. 261-266.
10. ***, www.fao.org/faostat/en/#data/QC

PRELIMINARY RESULTS REGARDING MAINTAINING OF THE QUALITY AFTER HARVESTING OF THE APRICOTS

REZULTATE PRELIMINARE PRIVIND MENȚINEREA CALITĂȚII CAISELOR DUPĂ RECOLTARE

VERINGĂ Daniela¹, MOHORA Angela¹, LĂMUREANU Gh.²
e-mail: veringa.daniela@yahoo.com

Abstract. *The aim of this paper is to establish the influence of variety and storage conditions on the preserving capacity after harvesting of the apricots. The paper presents the results obtained in 2016 on quality maintaining of the apricots. There were studied two Romanian varieties of apricots, created from Research Station for Fruit Growing (R.S.F.G) Constanta - Mamaia and Olimp. Apricots were kept at Research and Development Institute for Processing and Marketing of the Horticultural Products Bucharest, in different technological conditions: ambient temperature (20-22°C); temperature of 10-12° C (refrigerated conditions), with and without modified atmosphere and temperature of 3-5°C (cold storage). The initial level and the evolution during storage of the firmness of the fruits and of the main biochemical components: soluble dry matter, soluble carbohydrates, titratable acidity and vitamin C were determined. After storage determinations were performed on the total losses, quantitative losses (expressed by evaporate-transpiration) and qualitative depreciations. The results revealed the fact that, in general the apricots were sensitive to storage, the maximum storage duration being 5-20 days, depending on the storage conditions. The two main problems were represented by the mass losses, which caused the wrinkle of the fruit and the injuries, which mostly affected the appearance and the consumption quality. The losses by impairment were between 0 to 22.5%, depending on the variety, conditions and duration of storage. The depreciation of the apricots during storage was caused in most cases by the attack and the development of diseases (Botrytis, Penicillium, Phytophthora etc), which have spread rapidly in the fruit mass. The apricots of Mamaia variety were more resistant to storing than Olimp variety, which degraded faster and more than the others. The most favorable conditions for the maintaining of the quality have been shown to be temperature of 10-12° C (refrigerated conditions), with modified atmosphere (5% CO₂-enriched), in which apricots have recorded, after 20 days of storage, quantitative losses of less than 0.5% and losses by impairment of 0-2.78%, depending on variety.*

Key words: storage conditions, biochemical components, quantitative and the qualitative losses

Rezumat. *Scopul acestei lucrări este stabilirea influenței soiului și condițiilor din timpul păstrării asupra capacității de păstrare a calității după recoltare a caiselor. Lucrarea prezintă rezultate obținute în anul 2016 cu două soiuri de caise românești, Mamaia și Olimp, create la SCD Constanța. Caisele au fost păstrate la Institutul de Cercetare și Dezvoltare pentru Industrializarea și Marketingul Produselor Horticole*

¹Research and Development Institute for Processing and Marketing of the Horticultural Products Bucharest, Romania

²Research Station for Fruit Growing Constanta, Romania

*București, în diferite condiții tehnologice: temperatura mediului ambiant (20-22°C); temperatura de 10-12°C (condiții de refrigerare), cu sau fără atmosferă modificată și temperatura de 3-5°C (la frig). A fost determinat nivelul inițial și evoluția pe durata păstrării a fermițății fructelor și a principalelor componente biochimice a caiselor: substanța uscată solubilă, glucide solubile, aciditatea titrabilă și vitamina C. După scoaterea de la păstrare au fost stabilite pierderile totale, pierderile de masă și pierderile prin stricare ale fructelor. Rezultatele au scos în evidență faptul că, în general, caisele au fost sensibile la păstrare, durata maximă de păstrare fiind de 5-20 zile, în funcție de condițiile de păstrare. Principalele două probleme le-au reprezentat pierderile de masă, care au determinat zbarcirea fructelor la exterior și cele prin stricare, care au afectat în cea mai mare măsură aspectul și calitatea de consum. Pierderile prin stricare au fost între 0-22,5%, în funcție de soi, condițiile și durata de păstrare. Deprecierea caiselor în timpul păstrării a fost cauzată în majoritatea cazurilor de atacul și dezvoltarea unor boli (*Botrytis*, *Penicillium*, *Phytophthora* etc.) care s-au răspândit rapid în masa de fructe. Caisele din soiul Mamaia au fost mai rezistente la păstrare decât ale soiului Olimp, care s-au depreciat mai repede și mai mult decât celelalte. Condițiile cele mai favorabile menținerii calității s-au dovedit a fi spațiile refrigerate și cu atmosferă modificată îmbogățită în CO₂ (5%), în care caisele au înregistrat, după 20 zile de păstrare, pierderi de masă de sub 0,5% și pierderi prin stricare de 0-2,78%, în funcție de soi.*

Cuvinte cheie: condiții de păstrare, componente biochimice, pierderi cantitative și calitative

INTRODUCTION

Apricots are very popular with consumers, both as a dessert fruit and as well as processed in various ways. The high demand for fruits is determined by their qualitative and technological attributes, by the complex biochemical composition and by the very pleasant taste and specific flavor etc (Akin *et al.*, 2008; Alexe, 2017)

There are many apricot consumption benefits that are also supported by scientific studies. Firstly, they are a real and rich source of vitamin A, B and C, along with beta carotene (due to which the color is yellow-orange) helps maintain eyesight and nerves and tissue regeneration (www.pro-sanatate.com/caisele-beneficii...).

But in the biochemical composition of fruits there are several other important components for the human nutrition. High nutritional value of apricots and apricot-based finished products, led specialists in the scientific research domain to diversify the assortment by creating or placing cultivars in the tillage that behave well in the climatic conditions from Romania.

Apricots are extremely perishable, which raises serious problems concerning the maintaining of their quality during the valorisation process, from the moment they are harvested until they reach the consumer. Being highly perishable, apricots are typically consumed or canned within two weeks of harvest.

In our country not many data on the storage of apricots in refrigerated and controlled atmosphere (CA) are available in the literature, especially concerning the effect of CO₂ level in CA. In Italy, Europe's main producer of apricots, Andrich and Fiorentin (1986) studied two varieties of apricots to determine their storability and to examine the effect of the CO₂ level on weight decrease,

firmness, total titratable acidity, pH, refractometric degree and physiological and pathological changes. In other countries the researchers determined effects of controlled atmosphere storage and ethylene on specific biochemical changes in apricot fruits (Brecht *et al.*, 1982; Bartley, 1970; Palou and Crisosto, 2003).

The aim of this work is to establish the influence of variety and storage conditions on the preserving capacity after harvesting of the apricots belonging to two of the selected cultivars: Mamaia and Olimp.

MATERIAL AND METHOD

The experience includes a total of 8 experimental variants. The factors of the storage experience were the variety and storage conditions. Apricots were harvested and introduced in experimentation in 2016, coming from Research Station for Fruit Growing (R.S.F.G) Constanta. The scheme of the organization of experience with the apricots storage is shown in table 1.

Table 1

Experimental scheme for preserving of the apricot

Variant	Variety	Storage conditions *
V1	MAMAIA	20-22°C
V2	-idem-	10-12 °C
V3	-idem-	10-12 °C+MA
V4	-idem-	3-5 °C
V5	OLIMP	20-22°C
V6	-idem-	10-12 °C
V7	-idem-	10-12 °C+MA
V8	-idem-	3-5 °C

* Legend: MA= modified atmosphere

Aspects regarding the organization of the experiment are presented in figure 1.



Fig. 1 Aspects of the organization of the experiment

Before placing the storage, biometric measurements were made, having regard to: average fruit weight, height, diameter and index form.

There have been determined the initial level and the evolution during storage of some biochemical components: soluble dry matter, total sugar, titratable acidity and vitamin C. Aspects of the varieties are shown in figure 2.

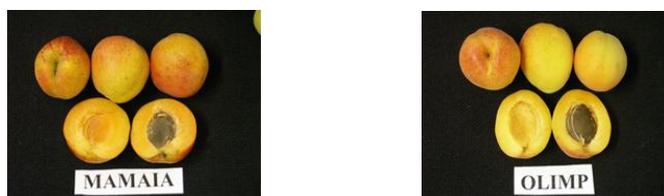


Fig. 2 Appearance of apricot varieties

RESULTS AND DISCUSSIONS

The results regarding the biometric data of the apricots are presented in Table 2, which shows that they are relatively close, as size, shape and weight of the fruits, average weight, the fruits of variety Mamaia being however larger with 3,52 g compare with those of variety Olimp.

Table 2

Biometric data of the apricots					
No.	Variety	Height (mm)	Diameter (mm)	Shape index	Average weight (g/fruit)
1	MAMAIA	46.3	42.9	0.93	51.12
2	OLIMP	43.6	40.2	0.92	47.60

The data on the evolution of apricots losses during storage are presented in table 3. The storage duration of the apricots was: 5 days when they stored at a temperature of 20-22° C, 15 days for storage at 10- 12° C and 20 days when the temperature was 3-5° C.

Table 3

Losses of the apricots during storage (%)						
Variant	Variety	Storage conditions (°C)	Storage duration (days)	Mass losses (%)	Depreciation losses (%)	Total losses (%)
V1	MAMAIA	20-22°	5	17.91	5.00	22.91
V2	- idem-	10-12 °C	15	12.10	12.50	24.60
V3	- idem-	10-12 °C+MA	15	0.26	0	0.26
V4	- idem-	3-5 °C	20	19.26	5.55	24.81
V5	OLIMP	20-22°	5	18.23	20.00	38.23
V6	-idem-	10-12 °C	15	14.23	22.50	36.73
V7	-idem-	10-12 °C+MA	15	0.32	2.78	3.10
V8	-idem-	3-5 °C	20	22.46	7.50	29.96
Average		20-22°	5	18.07	12.50	30.57
		10-12 °C	15	13.17	17.50	30.67
		10-12 °C+MA	15	0.29	1.39	1.68
		3-5 °C	20	20.86	6.53	27.39

Apricots stored at ambient temperature were recorded, after 5 days, mass losses from 17.91% for the variety Mamaia, up to 18.23% for the variety Olimp, qualitative losses of 5.00% for Mamaia variety, to 20.00% for Olimp variety and total losses from 22.91% (Mamaia) to 38.23% (Olimp). Variant V5 of Olimp variety kept warmed presented the lowest values of the weight losses, depreciation and total losses, of all the experimented variants. The difference between the two varieties consist mainly in the level of losses due to spoilage, which was 4 times lower in the Mamaia variety.

The aspect of the apricot of Mamaia variety kept for 5 days at ambient temperature is shown in figure 3.



Fig. 3 Aspect of the apricot kept at ambient temperature

The general appearance of apricot Mamaia variety kept for 15 days under refrigeration conditions is shown in figure 4.



Fig. 4. Appearance of apricots kept under refrigeration conditions

At temperature of 10-12°C the tomatoes were recorded, after 15 days of storing, from 12.10% (Mamaia variety), till 14.23% (Olimp variety) mass losses, from 12.50% for the variety Mamaia till 22.50% for Olimp variety depreciation losses, and from 24.26% (Mamaia variety) to 36.73% (Olimp variety) total losses. The level of loss due to damage, which was almost double in the Olimp variety, made mainly the difference between the two varieties in terms of storage resistance under given conditions.

The accumulation of an increased concentration of CO₂ in modified atmosphere conditions carried out in the sealed containers located in room with a temperature of 10-12°C, resulted in registration after 15 days of storage of the apricots to: mass losses of 0.26 (Mamaia variety) to 0.32% (Olimp variety), losses by impairment of 0 for the variety Mamaia and 2.78% to variety Olimp and total losses of 0.26% for the variety Mamaia and of 3.10% to Olimp variety.

The CO₂ concentration of the air in the storage container was maintained around 5% over the entire duration of the tomatoes storage. In these conditions both variants with modified atmosphere (V3 and V7) were recorded, after a storage period of 15 days, the mass losses extremely low (below 1%) due to the air tight volume in special containers. Also the depreciation losses were among the lowest, which is below the level of other variant of work. The fruits of Mamaia variety, being completely free of mass losses and with only 0.26% depreciation represented a real technological revelation, the V3 variant offering the best storage results of the whole apricot experience.

The appearance of Mamaia apricots variety kept for 15 days under

refrigeration conditions and modified atmosphere is shown in figure 5.



Fig. 5 Appearance of apricots kept under refrigeration and modified atmosphere conditions

At a temperature of 3-5° C the apricots preserved for 20 days were recorded, from 19.26% for Mamaia variety up to 20.86% for Olimp variety mass losses, from 5.55% (Mamaia variety) up to 7.50% (variety Olimp) depreciation losses and from 24.81% for Mamaia variety, to 29.96% for Olimp variety, total losses. And in these cold conditions, Mamaia variety, by V4 variant, presented lower losses than V8 variants of the Olimp variety, which had higher rates of mass, spoilage and total losses.

If under given refrigeration conditions, the level of impairment losses it was a reasonable one, that of the mass losses was highest in the whole experience, representing about 1/5 of the initial mass of the stored product. It entailed mostly on the level of total losses, which thus increased to 25-30% depending on the variety.

The results regarding the initial level and evolution of some chemical components during storage of the apricots are shown in table 4.

Table 4

Initial level and evolution of chemical components during storage of the apricots

Variant	Variety	Storage conditions (°C)	Soluble solids (%)	Acidity (%)	Total sugar (%)	Vit.C mg/100g
	MAMAIA	initial	12.2	0.39	5.48	12.40
V1	- idem-	20-22°	14.6	0.33	6.40	10.72
V2	- idem-	10-12 °C	14.2	0.30	6.21	12.14
V3	- idem-	10-12 °C+MA	13.7	0.33	5.86	12.74
V4	-idem-	3-5 °C	15.1	0.22	6.50	12.24
	OLIMP	initial	13.9	0.49	6.21	16.96
V5	-idem-	20-22°	15.3	0.29	7.14	13.30
V6	-idem-	10-12 °C	14.7	0.36	6.40	15.39
V7	-idem-	10-12 °C+MA	11.2	0.52	4.34	13.18
V8	- idem-	3-5 °C	15.6	0.26	6.86	15.46
Average		initial	13.05	0.44	5.85	14.68
		20-22°	14.95	0.31	6.77	12.01
		10-12 °C	14.45	0.33	6.31	13.77
		10-12 °C+MA	12.45	0.43	5.10	12.96
		3-5 °C	15.35	0.24	6.68	13.85

The data presented in table, shows that initially, in placing in storage, the apricots had a content of 12.2 to 13.9% soluble solids, titratable acidity from 0.39 to 0.49%, from 5.48 to 6.21% total sugar and 12.40-16.96 mg / 100g vitamin C, depending on the variety. Olimp variety had the higher content of soluble dry

substance, titratable acidity, total sugar and vitamin C than Mamaia variety.

The content of the soluble dry substance presented, during storage, especially, increases. They were smaller or larger, depending on variant. The highest increases occurred in varieties V4 and V8 (cold storage), when values of 15.1-15.6% were determined, according to the variant of the storage. The lowest soluble dry substance content was determined for variants V3 and V7, for refrigerated conditions, with modified atmosphere.

The acidity of apricots decreased to the majority of variants of preservation compared to initial values, but in varying proportions, depending on variety, duration and storage conditions. The highest decrease in acidity was recorded in the V4 and V8 variants - apricot kept under refrigeration conditions, the level of acidity being of 0.22-0.26% depending on the variety. The higher values of acidity were identified in the variants V3 and V7 - refrigeration storage with modified atmosphere. The apricots of Mamaia variety maintained better the level of the acidity during storage, compared to the Olimp variety.

Total sugar content increased during apricot preservation in most cases, the volume of these increases being different depending on the variant of storage. The higher increases in total sugar content occurred, in both varieties, either in V1 and V6 variants - apricots stored at ambient temperature or in V4 and V8 variants- refrigeration storage, the smallest increase or even a decrease being recorded to variants V3 and V7 - refrigeration storage with modified atmosphere. In the other variants of storage, the increases in sugar content were at average values very close to each other.

Evolution of vitamin C content was different, showing in particular decreases in content and a slight increase in V3 variant - refrigeration storage with modified atmosphere. The two varieties generally had similar developments under similar storage conditions. The results of the initial level and evolution of apricot firmness during storage are shown in table 5.

Table 5.

Level and evolution of apricot firmness during retention

Variant	Variety	Storage conditions (°C)	Firmness (PU)*	Decrease of firmness (%)
	MAMAIA	initial	70.13	-
V1	- idem-	20-22°	111.80	-59
V2	- idem-	10-12°	113.45	-62
V3	- idem-	10-12 °C+MA	93.05	-33
V4	- idem-	3-5°	103.03	-47
	OLIMP	initial	68.35	-
V5	- idem-	20-22°	110.90	-64
V6	- idem-	10-12°	118.40	-73
V7	- idem-	10-12 °C+MA	111.45	-63
V8	- idem-	3-5°	99.90	-46
Average		initial	69.24	-
		20-22°	111.35	-61
		10-12°	115.93	-67
		10-12 °C+MA	102.25	-48
		3-5°	101.47	-47

* PU-Penetrometer Unit = 0.1mm

The data in the table shows that the initial firmness of apricots in the two varieties showed close values, suggesting also similar degrees of fruit maturity. During storage, a reduction in firmness was found in all variants, but in different proportions depending on the storage variant, from 33% to 73%. The highest reduction in firmness occurred in V2 and V6 variants of fruit - storage under refrigeration conditions and the lowest decrease occurred to variant V3, followed by V4 and V6 variants – refrigeration storage. The data also show that in Olimp variety the decrease in firmness was more pronounced than in Mamaia variety in most variants, confirming the better conservation results recorded by the apricots of Mamaia variety.

CONCLUSIONS

The results revealed the fact that, in general the apricots were sensitive to storage, the maximum storage duration being 5-20 days, depending on the storage conditions.

The two main problems were represented by the mass losses, which caused the wrinkle of the fruit and the injuries, which mostly affected the appearance and the consumption quality.

The losses by impairment were between 0 to 22.5%, depending on the variety, conditions and duration of storage. The depreciation of the apricots during storage was caused in most cases by the attack and the development of diseases (*Botrytis*, *Penicillium*, *Phytophthora* etc), which have spread rapidly in the fruit mass.

The apricots of Mamaia variety were more resistant to storing than Olimp variety, which degraded faster and more than the others.

The most favorable conditions for the maintaining of the quality have been shown to be the temperature of 10-12° C (refrigerated conditions), with modified atmosphere (5% CO₂-enriched), in which apricots have recorded, after 20 days of storage, quantitative losses of less than 0.5% and losses by impairment of 0-2.78%, depending on variety.

REFERENCES

1. Akin EB, Karabulut I, Topcu A., 2008 - *Some compositional properties of main Maltaya apricot (Prunus armeniaca L.) varieties*. Food Chem, 2008; 10: 1016-1026.
2. Alexe Constanta, Vintila M., Caplan I., Lamureanu GH., Chira Lenuța, 2017. *Comparative study of processed products from cultivars of the native apricot*. Scientific papers, series b. Horticulture, vol. LVIVII 2017, USAMV Bucuresti: 96-102
3. Andrich G., R, 1986 - *Effects of controlled atmosphere on the storage of new apricot cultivars*. J. Sci. Food Agr. 37:1203-1208
4. Brecht J.K., Kader A.A., Heintz C.M., Norona C.M., 1982 - *Controlled atmosphere and ethylene effects on quality of California canning apricots and clingstone peaches*. J. Food Sci. 47:432-436.
5. Bartley N.W., 1970 - *Effects of Controlled Atmosphere Storage on Specific Biochemical Changes in Apricot and Peach Fruits*, J. Amer. Soc. Hort. Sci. 97:636-638
6. Palou, L. Crisosto CH., 2003 - *Postharvest treatments to reduce the harmful effects of ethylene on apricots*. Acta Hort, 2003; 599: 31-38.
7. ***, www.pro-sanatate.com/caisele-beneficii

STUDIES REGARDING SOME GRAPE VARIETIES IN DEALU BUJOR VINEYARD DURING 2015-2016

STUDII ASUPRA UNOR SOIURI DE STRUGURI DIN PODGORIA DEALU BUJOR ÎN CONDIȚIILE ANILOR 2015 ȘI 2016

*COLIBABA Cintia*¹, *ROTARU Liliana*¹

email: cintia_colibaba@yahoo.co.uk

Abstract. *As a result of different climatic influence, the characteristic phenophases of vines are constantly changing. Their evolution is extremely important for obtaining a qualitative final product, be it wine or table grapes. The present article follows the maturation period of some grape varieties (Fetească albă, Fetească regală, Băbească gri, Fetească neagră and Băbească neagră) in the Dealu Bujor vineyards. The obtained results from the maturation dynamics can be used for the creation of specific viticultural databases, to represent in a clear and concise way the region's oenological potential in the current climate.*

Keywords: Dealu Bujor vineyard, local grape varieties, maturation dynamics, maturation period

Rezumat. *Ca urmare a schimbărilor climatice la care suntem martori în ultimii ani, fenofazele caracteristice plantei de viței-de-vie se schimbă în mod constant. Evoluția lor este extrem de importantă pentru obținerea unui produs finit calitativ, fie el vin sau struguri de masă. Prezentul articol analizează perioada de maturare a anumitor soiuri de struguri (Fetească albă, Fetească regală, Băbească gri, Fetească neagră și Băbească neagră) în podgoria Dealu Bujor. Rezultatele obținute din analiza dinamicii maturării strugurilor pot fi utilizate pentru crearea unor baze de date viticole specifice, care să reprezinte într-un mod clar și concis potențialul oenologic al regiunii în climatul actual.*

Cuvinte cheie: podgoria Dealu Bujor, soiuri autohtone de struguri, dinamica maturării, perioada de maturare

INTRODUCTION

The optimum time for harvesting grapes is determined according to their state of physiological, full, technological and commercial maturity. It is believed that a certain varieties hve reached full maturity when the berries have reached the maximum weight, when acidity and sugar content are stagnating or developing very slow (Ciubucă *et al.*, 1999).

The temperate-continental climate of the Dealu Bujor vineyard is characterized by dry and very warm summers, very cold winters, the average annual temperature being 9.5 °C in the north and 10 °C in the south. The amount of precipitation is insufficient (approximately 450 mm annual average), with the

¹ University of Agricultural Sciences and Veterinary Medicine Iasi, Romania

addition of high evapotranspiration (680 mm/year) and arid wind, which explains the high deficiency of aero-edaphic humidity during the extended drought periods in July –August (Teodorescu *et al.*, 1987, Teodorescu, 1954).

MATERIAL AND METHOD

Five grape varieties (Feteasca albă, Fetească regală, Băbească gri, Băbească neagră, Fetească neagră) specific to the Dealu Bujor vineyard were studied and during the two years we aimed to determine the characteristic indices of grape maturity and technological maturity.

The annual and vegetation rainfall values, as well as average temperature were recorded during the two years, using the meteorological station from SCDVV Bujor.

The dynamics of grape maturation are followed by the determination, from time to time, after the grapes enter veraison, of the following indices: the mass of 100 berries; sugar content and acidity content, according to OIV standards.

RESULTS AND DISCUSSIONS

In the two years the study was conducted (2015-2016), the rainfall had values that approached the multiannual average (448 mm) and during the vegetation period: 454 mm.

Temperature-wise, during this period (July-September), the average temperature was 28.3 °C in July, 25.8 °C in August and 20.4 °C in September. Very close temperatures were reported in May, June and August, being a thermally balanced year.

It has been noticed, following the analyses (tab. 1), that at Fetească albă the evolution of the parameters (sugar content, acidity and the mass of 100 berries) stops after 14th of September, the values remaining relatively constant until harvest. The mass of 100 berries has a maximum value on 31st of August (148 g), so it can be concluded that full maturity occurs around this date. After full maturity, the weight decreases, reaching 139 g, the berries lose a portion of the accumulated water, the sugars' concentration increases, the value rising from 194 g/L to 215 g/L and the acidity dropping from 4.7 g/L to 3.8 g/L tartaric acid.

Table 1

Maturation dynamics of grapes in 2015

Date	Grape variety	Mass of 100 berries	Concentration of sugars g/L	Total Acidity g/L tartaric acid
17.08	Feteasca Albă	141	183	6.1
	Fetească Regală	142	148	7.9
	Băbească Gri	192	122	11.1
	Băbească Neagră	170	124	12.7
	Fetească Neagră	122	188	9.1

LUCRĂRI ȘTIINȚIFICE SERIA HORTICULTURĂ, 60 (2) / 2017, USAMV IAȘI

24.08	Fetească Albă	143	188	5.4
	Fetească Regală	149	161	6.9
	Băbească Gri	206	134	10.8
	Băbească Neagră	180	148	11.9
	Fetească Neagră	128	196	7.2
31.08	Fetească Albă	148	194	4.7
	Fetească Regală	157	180	6.5
	Băbească Gri	239	154	7.6
	Băbească Neagră	192	170	9.8
	Fetească Neagră	133	212	6.8
07.09	Fetească Albă	146	210	4.4
	Fetească Regală	159	196	6.1
	Băbească Gri	240	188	6.5
	Băbească Neagră	198	189	9.1
	Fetească Neagră	126	252	5.5
14.09	Fetească Albă	139	215	3.8
	Fetească Regală	157	199	5.8
	Băbească Gri	238	196	6.1
	Băbească Neagră	197	202	7.6
	Fetească Neagră	-	-	-
21.09	Fetească Albă	-	-	-
	Fetească Regală	154	210	5.1
	Băbească Gri	230	202	5.2
	Băbească Neagră	195	210	6.8
	Fetească Neagră	-	-	-
28.09	Fetească Albă	-	-	-
	Fetească Regală	-	-	-
	Băbească Gri	228	220	4.1
	Băbească Neagră	193	222	5.3
	Fetească Neagră	-	-	-

For Feteasca regală, full maturity takes place around 7th of September, when the mass of 100 berries reaches 159 g, then drops very little, to 154 g, a value observed on 21st of September, when the sugars' concentration increased,

compared to the full maturity value, from 196 g/L, to 210 g/L and the acidity decreased from 6.1 g/L to 5.1 g/L.

Băbească gri records maximum value of the mass of 100 berries in the same period as Feteasca regală, respectively 240 g. It decreases to 228 g, sugar concentration increases from 188 g/L to 220 g/L, and acidity drops from 6.5 g/L to 4.1 g/L tartaric acid by 28th September, for harvest.

Băbească neagră reaches full maturity over the same period, reaching a maximum mass of 100 berries (198 g) on 7th of September, then decreases to 193g until 28th of September, when the sugars increase from 189 g/L to 222 g/L and the acidity decreases from 9.1 g/L to 5.3 g/L tartaric acid.

Fetească neagră reaches maturity around 31st of September, just like Fetească albă. It reaches a mass of 100 berries of 133 g, then by overmaturation it decreases to 126 g and the variety reaches 252 g/L sugars, 5.5 g/L tartaric acid, being the variety with the highest sugar concentration in year 2015.

In 2016, samples were taken on 16th, 22nd and 29th of August, 5th, 12th, 19th and 26th of September.

Table 2

Maturation dynamics of grapes in 2016

Date	Grape variety	Mass of 100 berries	Concentration of sugars g/L	Total Acidity g/L tartaric acid
16.08	Feteasca Albă	121	172	8.9
	Fetească Regală	125	154	11.2
	Băbească Gri	163	119	18.4
	Băbească Neagră	148	119	22.7
	Fetească Neagră	120	160	13.4
22.08	Feteasca Albă	129	186	6.6
	Fetească Regală	131	160	10.7
	Băbească Gri	186	143	13.7
	Băbească Neagră	170	138	16.8
	Fetească Neagră	132	197	10.2
29.08	Feteasca Albă	134	199	5.9
	Fetească Regală	146	168	8.2
	Băbească Gri	188	148	12.6
	Băbească Neagră	180	152	12.1
	Fetească Neagră	130	220	9.6
05.09	Feteasca Albă	130	210	4.8
	Fetească Regală	151	176	7.1

	Băbească Gri	191	164	9.6
	Băbească Neagră	182	174	10.5
	Fetească Neagră	-	-	-
12.09	Fetească Albă	129	218	4.5
	Fetească Regală	154	188	6.5
	Băbească Gri	194	180	8.1
	Băbească Neagră	189	187	7.2
	Fetească Neagră	-	-	-
19.09	Fetească Albă	127	220	4.4
	Fetească Regală	152	202	5.9
	Băbească Gri	192	188	7.6
	Băbească Neagră	185	204	6.8
	Fetească Neagră	-	-	-
26.09	Fetească Albă	-	-	-
	Fetească Regală	-	-	-
	Băbească Gri	190	202	7.1
	Băbească Neagră	-	-	-
	Fetească Neagră	-	-	-

In Fetească albă variety, maturity occurs approximately in the same period as the previous year, but it recorded a decrease in the mass of 100 berries, from 148 g to 134 g, reaching up to 127 g at harvest. The sugar concentration reaches from 220 g/L (19th of September), a value close to that recorded in 2015. Acidity is slightly more pronounced, reaching 5.9 g/L at maturity, then decreasing to 4.4 g/L at harvest.

At Fetească regală, the ripening and harvesting period and the values of the three parameters remain very close to those of the previous year. Thus, the maturity is recorded on 12th of September, harvesting takes place with a one week difference, on 19th of September. Concentration of sugars increases from 188 g/L to 202 g/L, acidity drops from 6.5 g/L to 5.9 g/L tartaric acid, and the mass of 100 berries drops from 154 g to 152 g.

In the case of Băbească gri variety, we noticed significant differences in acidity and berry mass values. The acidity at maturity is very high, 8.1 g/L tartaric acid and until harvest it reaches 7.1 g/L tartaric acid, higher than the one recorded in the previous year. The mass of 100 berries is lower, 194 g at maturity and 190 g at harvest, and the sugars reach a maximum concentration of 202 g/L.

Băbească neagră grapes no longer have any variations after 19th of September and reaches full maturity a week earlier on 12th of September.

Compared to the previous year, even higher acidity values were obtained, while, for 100 berries and sugars, they decreased. With a mass of 189 g, sugars of 187 g/L and an acidity of 7.2 g/L tartaric acid, overmaturation leads to a mass of 185 g, sugars of 204 g/L and acidity of 6.8 g/L tartaric acid.

Fetească neagră progresses faster in 2016 than in 2015, full maturity takes place on 22nd of September and after the 29th, it does not record any variation. As with the other black varieties analyzed, we noticed a lower mass of 100 berries, fewer sugars and more pronounced acidity. Thus, at maturity it reaches 10.2 g/L tartaric acid, then this value decreases to 9.6 g/L tartaric acid. The maximum sugar value is 220 g/L at harvest time.

CONCLUSIONS

Generally, comparing the values obtained from analyzes carried out on samples collected in the two years, we noticed higher acidity values in 2016, while in 2015, sugar concentrations were higher. As for the mass of 100 berries, it had lower values in 2016, as rainfall was scarce during the growing season.

In the conditions of the Dealu Bujorului vineyard, during the two years in which the study was conducted, technological maturity was reached after the full maturity. It is also very important to follow acidity in order to make possible corrections of the acidity of musts and even of wines that are poorer in acids or of too high acidity and to appreciate the quality of the wines to be obtained: lower acidity wines are flat, unpleasant to taste, and the too acid ones are perceived as harder to drink.

REFERENCES

1. Ciubucă A., Birliga N., Postolache E., Indreica E., 1999- *Evolution of grape maturity in the Dealurile Bujorului vineyard*. Lucrări științifice vol. 1(42), Seria Horticultură, Universitatea Agronomică și Medicină Veterinară Iași.p. 154-160.
2. Teodorescu Șt., Popa A., Sandu Gh., 1987 - *Oenoclimatul României*, Editura Științifică și Enciclopedică, București.
3. Teodorescu I. C., 1954- *Metode de interpretare a elementelor climatice, cu aplicarea lor la cultura viței de vie*, București.
4. *** OIV, 2016 - *Recueil des methodes internationales d'analyse des vins et des mouts*, Office International de la Vigne et du Vin, Editura O.I.V., Edition Officielle, Paris.

DYNAMICS OF SOIL MOISTURE IN VINEYARDS UNDER WATER AND THERMAL STRESS CONDITIONS

DINAMICA UMIDITĂȚII SOLULUI ÎN PLANTAȚIILE VITICOLE ÎN CONDIȚII DE STRES HIDRIC ȘI TERMIC

ZALDEA Gabi¹, NECHITA Ancuța¹, DAMIAN Doina¹,
ALEXANDRU L. C.¹

e-mail: gabizaldea@yahoo.com

Abstract. At the Copou - Iasi viticulture center, in recent years we witnessed a decrease in the multi - annual average rainfall regime, this being of 579.6 mm and of 398.1 mm (1981-2010) during the vegetation period. Between 1992 - 2014, the driest years were 2000, 2007, 2009 and 2012. Drought conditions were also in 2015 and 2016, having different characteristics. In 2015, there were few precipitations accompanied by high temperatures, often above 30°C. The amounts of rainfall recorded in 2016 were very unevenly distributed, thus there were recorded months with very low quantities, well below the normal values and months when quantities were higher than the normal values. Low rainfall and high temperatures have led to a sharp decline in accessible soil moisture values, well below optimal humidity levels for the vine, and to increased deficit.

Key words: temperatures, low rainfall, soil moisture, vineyard

Rezumat. În centrul viticol Copou - Iași, în ultimii ani, asistăm la o scădere a regimului de precipitații media multianuală fiind de 579,6 mm, iar în perioada de vegetație de 398,1 mm (1981-2010). În perioada 1992 - 2014, cei mai secetoși ani au fost 2000, 2007, 2009 și 2012. Condiții de secetă au fost și în ani 2015 și 2016, cu caracteristici diferite. În 2015 au fost precipitații puține coroborate cu temperaturi ridicate, frecvent peste 30°C. Cantitățile de precipitații înregistrate în anul 2016 au fost foarte neuniform repartizate, astfel au fost luni în care s-au înregistrat cantități foarte mici, cu mult sub valorile normale și luni în care s-au înregistrat cantități mai mari decât cele normale. Cantitățile mici de precipitații, și temperaturile mari înregistrate au dus la scăderea accentuată a valorilor umidității accesibile din sol, cu mult sub valorile optime de umiditate ale viței de vie și creșterea deficitului.

Cuvinte cheie: temperaturi, precipitații scăzute, umiditate sol, plantații viticole

INTRODUCTION

The vine is a great water-consuming, and if in some dry years suffer less than annual plants, this is due to the fact that it has a deep root system that explores a large volume of soil in the deep layers, where there is a large reservoir of water. In the long periods of drought of 2-3 years, when the water reserve in

¹Viticulture and Oenology Research and Development Station in Iasi, Romania

the deep layers of soil decreases, the vine suffers the same as the annual plants (Alexandrescu *et al.*, 1998).

The optimum soil moisture content for vineyards is between 50-80% of the useful soil water capacity (UWC), with higher values being favorable for the growth of smaller shoots and for grain maturation (Moțoc, 1968). In the dry years, high temperature values in conjunction with soil deficiency have led to the accentuation of atmospheric and pedological drought with adverse effects on the vegetation status of the vines by overcoming the phenophases of growth and fructification, wart hunting, prematurely yellowing of the leaves, the grapes remained small with small and wilted berries and decreasing the available moisture from the soil to the depths deep at 100-150 cm deep (Zaldea *et al.*, 2013; Enache *et al.*, 2016). Drought affects primarily young vines (1st and 2nd year), aging, less vigorous vines and those with large eye loads left to cut. The stems and cords are dehydrated, deep longitudinal cracks appear, causing the vines to dry.

MATERIAL AND METHOD

For the analysis of rainfall and temperatures were used the data recorded by automatic station Agroexpert of Research and Development Station for Viticulture and Vinification Iași and from Moldova Regional Meteorological Center. To determine soil moisture, the samples were taken in layers from 10 to 10 cm up to 150 cm depth for each month during the growing season. Results were expressed first in percentage compared to dry soil weight, then into percent by volume. With hydrophysical indices values were calculated the accessible moisture existing in soil at a time (Uacc) expressed in mm and the deficit in mc/ha and %. To establish the insurance degree with available water supply for plants was reported the momentary humidity (Uacc) to useful water capacity (AUC), previously calculated for Iași Copou viticultural center

RESULTS AND DISCUSSIONS

Drought periods of 2-3 years are those with serious consequences for vineyards, because the disastrous effects of the drought are recorded in the second or third year of the drought, and the restoration of plantations lasts for another two to three years, which means that over a period of about six years no grape production can be obtained to cover the expenses incurred. Such a situation has been recorded over the last three years, each year with different characteristics.

The year 2015 was characterized as *excessively dry* with a warmer spring than normal, with few and uneven rainfall distributed and a very dry summer, with few precipitations combined with very high temperatures, often above 30°C. Almost all months were recorded smaller amounts of precipitation than normal. Thus, during the vegetation period, only 180.6 mm was accumulated, well below the multiannual average, which is 398.1 mm in the Copou Iasi wine center, representing only 45% of the necessary, and the annual rainfall was 365,5 mm compared to 579.5 mm (tab. 1).

The statistics show that between 1972 and 2014, only in one year was recorded a quantity of less than 200 mm, namely in 1973 by 156.3 mm. It is also

noteworthy that even in the months of the vegetative repose period very few precipitations were recorded, for example in December it was only 1.6 mm compared to the normal month of 31.0 mm being the most drought December for the last 40 years. A similar amount of precipitation was recorded in December 1989, namely 1.8 mm.

Table1

The pluviometric regime in the period 2015-2016

Month	Multiannual values	Raifalls 2015 (mm)			Raifalls 2016 (mm)				
		2015	>0.1	>5	>10	2016	>0.1	>5	>10
I	26.7	14.7	10	-	-	16.0	13	-	-
II	24.9	23.2	8	-	1	25.0	10	1	-
III	29.2	66.4	10	2	2	31.8	6	1	1
IV	46.6	31.6	9	1	1	77.6	4	1	2
V	61.4	13.8	7	-	-	90.2	8	3	3
VI	82.5	46.8	4	3	2	107.0	4	3	4
VII	83.8	40.8	7	1	1	15.4	3	2	-
VIII	62.7	28.0	-	-	2	31.4	4	2	1
IX	61.1	19.6	7	1	-	12.2	5	1	-
X	38.9	54.4	3	1	2	182.8	12	-	6
XI	30.8	24.6	9	1	-	50.2	5	2	2
XII	31.0	1.6	5	-	-	7.2	6	-	-
Annual	579.5	365.5	79	10	11	646.8	80	16	19
Vegetation	398.1	180.6	34	6	6	333.8	28	12	10

Low rainfall, as well as high temperatures, have led to a sharp decline in soil moisture (9 to 30%), well below optimal moisture levels (50 - 80%) and increased deficit (fig. 1).

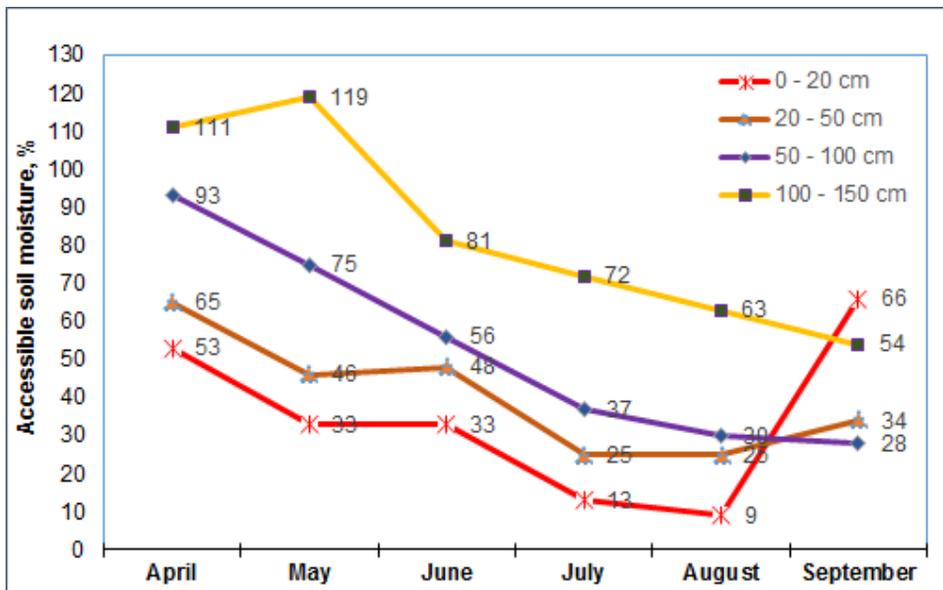


Fig.1 Grade of water available in the soil during the vegetation period of 2015

At the end of August, water deficit in the soil, up to a depth of 100 cm, ranged between 70-91% (tab. 2).

Table 2

Water deficit of soil during vegetation period of 2015

Depth, cm	Month											
	IV		V		VI		VII		VIII		IX	
	m ³ /ha	%										
0 – 20	221	47	319	67	318	67	412	87	434	91	163	34
20 – 50	257	35	398	54	382	52	554	75	556	75	486	66
50 - 100	78	7	265	25	471	44	675	63	746	70	768	72
100 - 150	-	-	-	-	124	19	181	28	237	37	296	46

The rainfall amounts recorded in 2016 were very unevenly distributed, so months were very small, well below normal values, such as January, July, August, September, December, and months when - they recorded higher quantities than normal, such as April, May, June, October and November.

The annual rainfall regime was greater than normal, 646.8 mm versus 579.5 mm, but during the vegetation period (April to September) it was only 333.8 mm from the normal of 398.1 mm in the Copou Iasi wine center. These conditions led to the year being characterized as a *little more dry*.

As a result of the small rainfall from July to September and the high temperatures there was a sharp decrease of the soil humidity values, well below the optimum moisture values of the vine and the increase of the deficit, with a negative influence on the growth and maturation of the grapes (fig. 2, tab. 3).

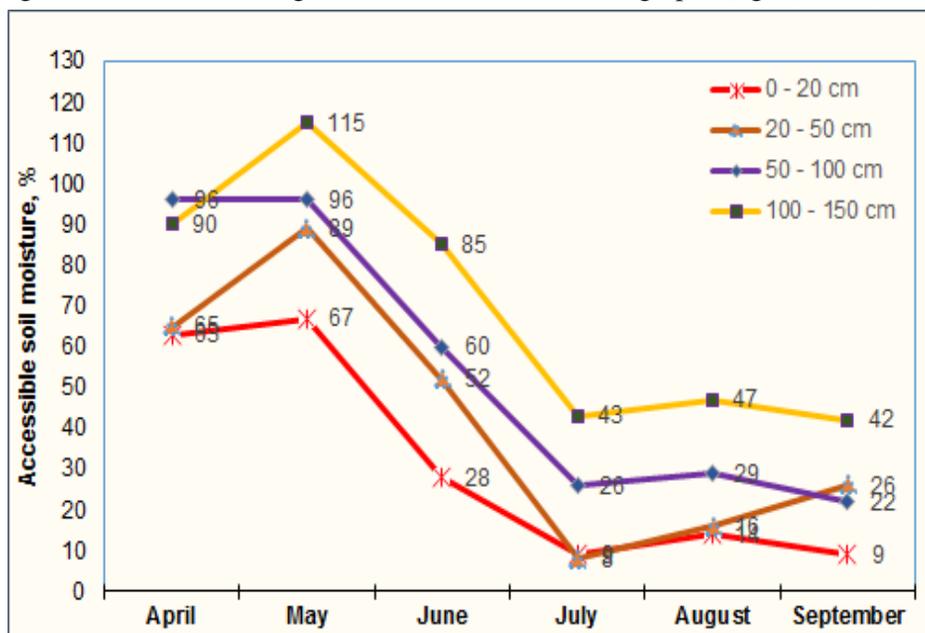


Fig. 2 Grade of water available in the soil during the vegetation period of 2016

At the end of September, the available humidity values, in the first layer 0-20 cm, were below the wilting coefficient, and from 20 to 150 cm deep they were well below the optimum values for the vine. Soil water deficiency ranged from 58 - 78% (tab. 3).

Table 3

Water deficit of soil during vegetation period of 2016

Depth, cm	Month											
	IV		V		VI		VII		VIII		IX	
	m ³ /ha	%										
0 - 20	174	37	158	33	341	72	433	91	408	86	432	91
20 - 50	258	35	82	11	358	48	680	92	619	84	548	74
50 - 100	41	4	47	4	432	40	795	74	758	71	832	78
100 - 150	62	10	-	-	97	15	365	57	341	53	377	58

Year 2017, is the third consecutive year of drought, with precipitation below normal and high temperatures, often above 30°C. The precipitation deficit was recorded in the winter months: January (18.1 mm compared to 26.7) and February (22.7 mm compared to 24.9 mm) and in the months of the vegetation period: May (47.8 mm compared to 61.4 mm), June (49.0 mm compared to 82.5 mm), July (67.6 mm compared to 83.8 mm), August (24.0 mm compared to 62.7 mm) and September (26.6 mm compared to 61.1 mm).

Small rainfall and high temperatures have led to a sharp decline in available soil moisture across the soil depth (0 - 150 cm), from one month to the next, reaching the end of the vegetation period at values ranging from 8 and 45% (fig. 3).

In these conditions, the deficit of water in the soil showed values between 55 and 92% (tab. 4).

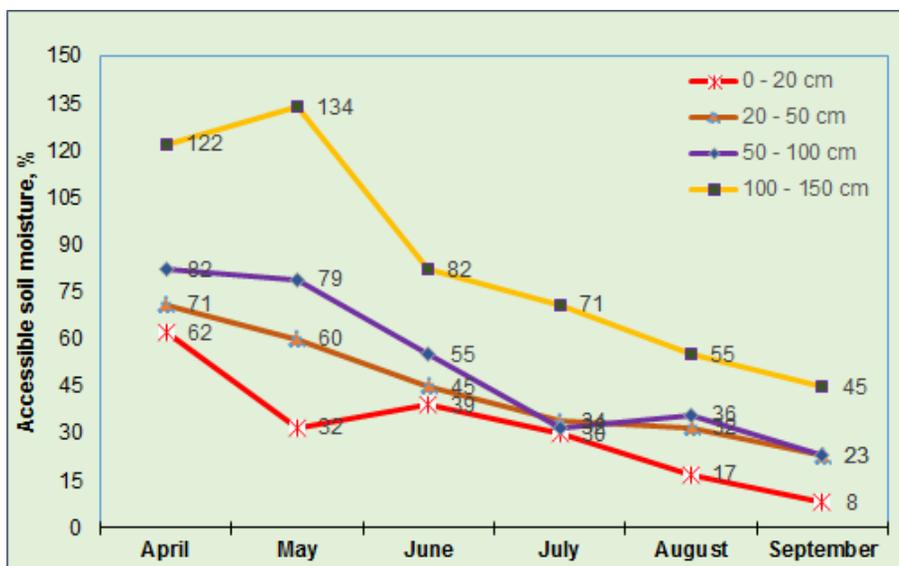


Fig. 3 Grade of water available in the soil during the vegetation period of 2017

Table 4

Water deficit of soil during vegetation period of 2017

Depth cm	Month											
	IV		V		VI		VII		VIII		IX	
	m ³ /ha	%										
0 – 20	179	38	324	68	289	61	333	70	395	83	440	92
20 – 50	217	29	297	40	409	55	486	66	504	68	567	77
50 – 100	194	18	224	21	484	45	725	68	687	64	830	77
100 - 150	-	-	-	-	116	18	186	29	293	45	356	55

CONCLUSIONS

1. Drought can be a destructive phenomenon for vineyards when there is a rainfall in the autumn and winter of the previous year, and the quantities recorded in the spring fail to restore the water reserve from the deep layers of soil from which vine vines are fed. Periods of 2-3 consecutive years with precipitation deficiency have the most serious consequences, with disastrous effects occurring, especially in the second or third year of drought.

2. From the recorded data, in recent years there is an increase in the frequency of the drought phenomenon, which greatly affects the vineyards. In these conditions, it is increasingly necessary to create Vinifera varieties and drought resistant rootstocks, as well as to generalize and extend the irrigation system at national level.

Acknowledgments: The paper was developed in the project within the Sectoral Plan, ADER 3.3.8 “Adaptation of vine cultivation technologies to the ecological system by maximizing the use of biotic and abiotic resources of the viticultural ecosystem in order to preserve its biodiversity”

REFERENCES

1. **Alexandrescu I., Pițuc P., Băbușanu V., Chivu D., 1998** – *Viticultura practică sezonieră*. Editura Danaster, Iași.
2. **Enache Viorica, Tăbăranu G., 2016** - *Assessing of the termic and hydric risk in Dealul Bujorului vineyard under likely climate change*. *Lucrări Științifice Seria Horticultură* Vol. 59, no.1., U.S.A.M.V. Iași. Editura “Ion Ionescu de la Brad” ISSN 1454-7376, p. 121 - 126.
3. **Moțoc M., 1968** – *Estimarea deficitului de umiditate a solului în plantațiile viticole*. *Centrul de documentare agricolă București*.
4. **Zaldea Gabi, Măntăluță Alina, Damian Doina, Savin C., Alexandru C., 2013** - *The hidric and thermic stress in the agricultural year 2011-2012 and this influence on SCDVV-Iasi vineyards*. *Lucrări Științifice Seria Horticultură* Vol. 56, no.1., U.S.A.M.V. Iași. Editura “Ion Ionescu de la Brad” ISSN 1454-7376, p. 319 - 324.

EXPERIMENTAL ASPECTS REGARDING THE MALOLACTIC FERMENTATION USING THE FREEZE-DRIED CULTURE OF *OENOCOCCUS OENI* FOR RED WINES

ASPECTE EXPERIMENTALE PRIVIND FOLOSIREA UNUI PREPARAT DE *OENOCOCCUS OENI* LA FERMENTAȚIA MALOLACTICĂ A UNOR VINURI ROȘII

ANDRIEȘ M. T.¹, ODĂGERIU G.², VĂRARU F.³,
ZAMFIR C. I.², COTEA V. V.¹
e-mail: andriestibi@yahoo.com

Abstract. *This paper presents some typical aspects of the malolactic fermentation process, respectively, the variation of total acidity, real acidity (pH) and volatile acidity, malic acid metabolization and formation of lactic acid. Also, other composition characteristics like tartaric and citric acids, potassium, calcium, reducing sugars and phenolic compounds were studied. The experiment was conducted both in laboratory conditions as well as in industrial conditions, on Feteasca neagra and Cabernet sauvignon wines. In order to start the malolactic fermentation, after 7-15 from the end of alcoholic fermentation, a freeze-dried culture of Oenococcus oeni (commercialized under the name of FD-DVS Viniflora CH11) were inoculated directly into wine. In all samples except the control sample we found a decrease of total acidity and malic acid content, correlated to an increase of the pH and lactic acid content. Regarding the potassium and calcium cations, there was a decrease. Also, the content of phenolic compounds, showed differences from the control sample.*

Key words: red wines, composition characteristics, malolactic fermentation, *Oenococcus oeni* FD-DVS Viniflora CH11.

Rezumat. *Lucrarea prezintă o serie de aspecte caracteristice procesului de fermentație malolactică, respectiv modificarea acidității totale, a acidității reale (pH) și volatile, precum și metabolizarea acidului malic și formarea acidului lactic. Totodată, s-a urmărit și modificarea unor caracteristici de compoziție, precum acizii tartric și citric, cationii de potasiu și calciu, respectiv zaharuri reducătoare și compuși fenolici. Experimentele s-au realizat atât în condiții de laborator cât și în condiții industriale, pe vinuri obținute din soiurile Feteasca neagră și Cabernet Sauvignon. Pentru a declanșa fermentația malolactică, la 7-15 zile după sfârșitul fermentației alcoolice, vinurile au fost însămânțate cu preparatul pe baza de Oenococcus oeni comercializat sub denumirea de FD-DVS Viniflora CH11, administrat sub formă de granule, direct în vin. La toate probele analizate, cu excepția probei martor, s-a*

¹University of Agricultural Sciences and Veterinary Medicine, Iași, Romania

²Research Centre for Oenology, Romanian Academy - Iași, Romania

³S.C. Agroindustrială Bucium S.A. – Iași, Romania

constatat o scădere diferențiată a concentrației acidului malic, corelată cu creșterea conținutului de acid lactic. Realizarea fermentației malolactice a fost concretizată și prin scăderea pronunțată a acidității totale și creșterea valorii pH-ului. În ce privește cationii de potasiu și calciu, s-a constatat o diminuare a acestora. De asemenea, conținutul de compuși fenolici a înregistrat diferențe față de proba martor.

Cuvinte cheie: vinuri roșii, caracteristici de compoziție, fermentație malolactică, preparat FD-DVS Viniflora CH11.

INTRODUCTION

Malolactic fermentation is a beneficial biological process, especially for red wines, for the following reasons: it leads to convenient deacidification, which gives the red wines qualities of suppleness, diminishing their astringency, often intensifies the color of the wines, although there are decreases of content in anthocyanins and tannins; provides biological stability to lactic bacteria (Cotea, 1985; Delfini, 1995; Vodošek Vrščaj *et al.*, 2008).

In a previous paper (Odăgeriu *et al.*, 2009), aspects of malolactic fermentation of red and white wines, the variation of some compositional characteristics and physical-chemical indices, depending on the modification of their total and actual acidity, were presented. Continuing the previous research, the present paper presents a series of new aspects characteristic of the malolactic fermentation process of some red wines, explicitly the use of a lactic bacteria preparation which allowed to be added directly in to the wine in the form of grains, much more accessible to the oenologist in its preoccupations to initiate this biochemical process. At the same time, changes in total acidity, volatile and real (pH), metabolism of malic acid and lactic acid formation, as well as modification of other compositional characteristics (tartaric and citric, potassium, calcium) during the studied process were followed.

MATERIAL AND METHOD

The experiments were carried out both under laboratory and industrial conditions, between October and December 2016, on wines obtained from the Fetească Neagră and Cabernet Sauvignon varieties cultivated in the Bohotin zone of the Husi vineyard. Thus, the above mentioned wines were obtained from the grapes harvested in the 2016 at the S.C. Agroindustrială Bucium Iași Winery and were analyzed in the laboratory of the Research Center for Oenology Iași.

To activate the malolactic fermentation, 7-15 days after the end of the alcoholic fermentation, the wines were seeded with the FD-DVS Viniflora® CH11 (a pure lyophilized culture of *Oenococcus oeni*). This is a heterofermentative malolactic bacterium that ensures rapid and safe malolactic fermentation after inoculation directly into the wine. It is especially suited for inoculation of low pH and high levels of alcohol and does not produce biogenic amines (histamine, tyramine, putrescine, phenylethylamine, isoamilamine, cadaverine) as opposed to indigenous bacteria of wine.

The wine samples from the two studied varieties consisted of several experimental variants. For the Fetească neagră variety, three variants were

differentiated between them as follows: V1 divided into V1.1. (the initial control wine), i.e. wine (1000 L) before malolactic fermentation and V1.2. (final) representing the wine (1000 L) seeded with malolactic bacteria at the end of malolactic fermentation; V2 divided into V2.1. (initially), i.e. wine (1000 L) prior to malolactic fermentation, and previously malic acid at 1 g / L and V2.2 was added. (final) wine sample (1000 L) similar to V2.1. (seeded with malolactic bacteria) at the end of malolactic fermentation; V3 divided into V3.1. (initially), i.e., wine (500 L) before malolactic fermentation, and previously malic acid was added at 2 g / L and V3.2. (final) similar to V3.1. i.e. wine (500 L) seeded with malolactic bacteria at the end of malolactic fermentation.

The wine samples obtained from the Cabernet Sauvignon variety, three other variants were differentiated between them as follows: V4 divided into V4.1. (the initial control wine), i.e. wine (1000 L) before malolactic fermentation and V4.2. (final) representing wine (1000 L) seeded with malolactic bacteria at the end of malolactic fermentation; V5 divided into V5.1. (initially), i.e. wine (1000 L) before malolactic fermentation and in which malic acid was previously added at a dose of 1 g / L and V5.2. (final) wine (1000 L) similar to V5.1. (seeded with malolactic bacteria) at the end of malolactic fermentation; V6 divided into V3.1. (initially), i.e. wine (500 L) before malolactic fermentation, and previously malic acid was added at a dose of 2 g / L and V6.2. (final) similar to V6.1. i.e. wine (500 L) seeded with malolactic bacteria at the end of malolactic fermentation.

The addition of malic acid was conditioned by the fact that wines from the 2 varieties with a content of about 2.10 g / L (but which required strictly malolactic fermentation) did not cover a larger range of malic acid (3-4 g / L) needed to verify the specific predilection of the bacteria studied for this acid.

Thus, the content of a packet (for 25 hL) for the wines of each variety was given as granules directly into the wine (initially in 5 L of wine and then 2.0 L of it in 1000 L and 1.0 L respectively in 500 L vessels).

At the start and the end of the malolactic fermentation process, the samples were collected for each distinct wine. Thus, from samples of the Fetească Neagră variety, the samples were: V1.1, V1.2, V2.1, V2.2, V3.1, V3.2, and samples from the Cabernet Sauvignon wine were: V4 .1, V4.2, V5.1, V5.2, V6.1, V6.2. The wine samples were stored in a area where the temperature ranged between 14 and 18 ° C. These were mixed by hand 4-5 times a day.

At the end of the malolactic fermentation, when it was found that the expected quantities of malic acid had been reached, the bacterial activity of the wines was stopped by removing from the deposit and treating them with sulfur dioxide and gelatin, with established doses based on laboratory microprobes.

For each sample taken after filtration and decarbonation, the physico-chemical analyzes were performed. Analyzes of the main compositional characteristics (total acidity, volatile acidity, pH, tartaric, malic, lactic, citric, free and total sulfur dioxide, potassium, calcium, total phenolic compounds, reducing sugars) during and after the malolactic fermentation acquired between October and December 2016. These were done according to the current standard methods (** 2012; *** 2015) and the specialized literature (Bauer *et al.*, 2004; Bartowsky, 2005; Croitoru, 2005; Flanzky, 1998; Lepădatu *et al.*, 1975; Odăgeriu *et al.*, 2008; Ribereau-Gayon *et al.*, 1972; Țârdea, 2007; Vodošek Vrščaj *et al.*, 2008; Würdig and Woller, 1989).

RESULTS AND DISCUSSIONS

The main compositional characteristics of the tested wines (eight samples per wine) are shown in tables 1 and 2.

Thus, the alcoholic strength (expressed in % vol.) of the control wines studied had the following values, between 12.85 and 12.95 for Fetească Neagră and between 13.42 and 13.50 for Cabernet Sauvignon.

Other values of the control samples, less modified, refers to succinic acid (which had values from 0.58 and 0.67 g / L respectively) and free (total) sulfur dioxide content, which was between 2.9 (39.1) and 8.3 (49.5) mg / L.

The main compositional characteristics (total and volatile acidity, pH, malic, lactic, citric acids) involved in specific malolactic fermentation processes depending on the type of wine, are presented in the abovementioned tables.

Table 1

Variation of main compositional characteristics during malolactic fermentation - Fetească neagră

Element/ Parameters	U.M.	Sample 1		Sample 2		Sample 3	
		initially sample $V_{1.1}$	final sample $V_{1.2}$	initially sample $V_{2.1}$	final sample $V_{2.2}$	initially sample $V_{3.1}$	final sample $V_{3.2}$
Alcohol	% vol.	12.85	12.95	12.85	12.90	12.85	12.85
TA	g/L $C_4H_6O_6$	6.40	5.28	7.55	5.63	8.55	5.93
	δ_r (%)	0.00	- 17.50	0.00	- 25.43	0.00	- 30.48
VA	g/L $C_2H_4O_2$	0.46	0.62	0.49	0.65	0.48	0.69
pH		3.58	3.80	3.37	3.81	3.23	3.78
	δ_r (%)	0.00	6.11	0.00	13.01	0.00	17.16
Malic acid	g/L	2.18	0.34	3.08	0.43	3.91	0.48
	δ_r (%)	0.00	- 84.40	0.00	- 86.04	0.00	- 87.72
Lactic acid	g/L	0.46	1.75	0.43	2.14	0.44	2.43
	$\delta_r \times 10^{-1}$ (%)	0.00	28.04	0.00	39.76	0.00	45.22
Malic acid / Lactic acid		6.37	0.27	9.62	0.27	11.94	0.27
Citric acid	g/L	0.33	0.28	0.31	0.22	0.32	0.25
Tartaric acid	g/L	2.12	1.96	2.10	1.88	2.12	1.78
Potassium	mg/L	1031	997	1030	986	1028	963
Calcium	mg/L	95	91	95	88	95	83
Phenolic compounds	g/L	2.05	2.00	2.05	1.97	2.05	1.23
Sugars	g/L	3.51	3.29	3.51	3.32	3.51	3.51
NE	g/L	22.71	21.86	23.70	22.31	24.64	22.59

Table 2

Variation of main compositional characteristics during malolactic fermentation - Cabernet Sauvignon

Element/ Parameters	U.M.	Sample 4		Sample 5		Sample 6	
		initially sample V _{4.1}	final sample V _{4.2}	initially sample V _{5.1}	final sample V _{5.2}	initially sample V _{6.1}	final sample V _{6.2}
Alcohol	% vol.	13.42	13.46	13.42	13.50	13.42	13.47
TA	g/L C ₄ H ₆ O ₆	6.79	5.68	7.99	6.04	8.96	6.31
	δ _r (%)	0.00	- 16.35	0.00	- 24.41	0.00	- 29.58
VA	g/L C ₂ H ₄ O ₂	0.51	0.65	0.53	0.64	0.52	0.70
pH		3.52	3.80	3.33	3.73	3.20	3.69
	δ _r (%)	0.00	8.01	0.00	12.09	0.00	15.31
Malic acid	g/L	2.07	0.34	3.01	0.39	3.83	0.54
	δ _r (%)	0.00	- 83.57	0.00	- 87.04	0.00	- 85.90
Lactic acid	g/L	0.57	1.88	0.56	2.25	0.58	2.31
	δ _r × 10 ⁻¹ (%)	0.00	22.98	0.00	30.18	0.00	29.83
Malic acid / Lactic acid		4.88	0.24	7.22	0.23	8.87	0.321
Citric acid	g/L	0.39	0.34	0.38	0.32	0.38	0.35
Tartaric acid	g/L	2.31	2.06	2.34	2.15	2.31	2.01
Potassium	mg/L	1202	1148	1200	1158	1202	1140
Calcium	mg/L	104	98	104	100	104	96
Phenolic compounds	g/L	2.62	2.58	2.62	2.54	2.62	2.50
Sugars	g/L	3.82	3.78	3.82	3.74	3.82	3.76
NE	g/L	25.22	24.39	26.12	24.80	27.20	25.11

VA - (volatile acidity); TA – (total acidity); NE- (non-reducing extract)

CONCLUSIONS

Spreading with Selected Malolactic Bacteria (BMS) of the biolact acclimatee series (*Oenococcus oeni* class), used in the maize form is recommended in oenological practice as it provides optimum conditions for the biological deacidification of wines. From this point of view, there is an effective metabolism of malic acid to lactic acid, which gives appreciable organoleptic qualities to the wines undergoing this process.

Changes in other compositional features support an optimal evolution of malolactic fermentation, resulting in increased pH and a pronounced decrease in total acidity over a period of time (approximately 20-34 days).

Malolactic fermentation is a beneficial process for red wines because it ensures their biological stability against lactic bacteria. In connection with this

aspect it is appreciated that this leads to a convenient deacidification, which gives the red wines the qualities of suppleness by reducing astringency (decreasing the tannin content) and, at the same time, increasing their color.

REFERENCES

1. Bauer R., Dicks L. M. T., 2004 - *Control of Malolactic Fermentation in Wine. A Review*. S. Afr. J. Enol. Vitic., Vol. 25, No. 2. p. 74-88.
2. Bartowsky E. J., 2005 - *Oenococcus oeni and malolactic fermentation - moving into the molecular arena*. Austral. J. grape and wine res., vol. 2, no. 11, p. 174-187.
3. Cotea D. V., 1985 - *Tratat de Oenologie, vol. 1*. Bucuresti: Ed. Ceres, p. 533-546.
4. Croitoru C., 2005 - *Reducerea acidității musturilor și vinurilor, Metode și procedee fizice, fizico-chimice, chimice și biologice*. Editura Agir, București, p. 241-307.
5. Delfini Cl., 1995 - *Scienza e tecnica di microbiologia enologica*. Edizioni "IL LIEVITO", Asti, Italia, p. 238-247.
6. Flanzly Cl., 1998 - *Oenologie, Fondements scientifiques et technologiques*. Édition Lavoisier, Techniques & Documentation, Paris, France, p. 498-525.
7. Lepădatu V., Sandu-Ville G., Sandu-Ville Gabriela., Sauciu J., 1975 - *Studiul unor factori care influențează desfășurarea fermentației malolactice la vinurile din podgoria Iași*, An. Inst. Vitic., Vinif., vol. VI, p. 431-441.
8. Odăgeriu G., Neacșu I., Niculaua M., Zamfir C., Buzilă I., 2008 - *Aspecte privind variația unor indici fizico-chimici în timpul fermentației malolactice la unele vinuri roșii*. Simpozion INVV "Realizări inovative în domeniul viti-vinicol", Chișinău, 18-19 septembrie, p. 186-188.
9. Odăgeriu G., Bălănuță A., Cotea V. V., Rusu E., Vacarciuc L., 2009 - *Experimental Aspects regarding the Malolactic Fermentation of Some Red and White Wines*. Cercet. Agron. în Moldova, vol. XLII, nr 2 (138), p. 55-70.
10. Ribereau-Gayon J., Peynaud E., Sudraud P., Ribereau-Gayon P., 1972 - *Traité d'oenologie. Sciences et techniques du vin, tome 1. Analyse et contrôle des vins*. Dunod-Paris, France.
11. Țârdea C., 2007 - *Chimia și analiza vinurilor*. Editura "Ion Ionescu de la Brad", Iași.
12. Vodošek Vrščaj T., Cigic Kralj I., Strlič M., Košmerl T., 2008, *The utilization of free amino acids during malolactic fermentation of Malvasia wine*. Riv. Vitic. Enol., n. 2-3-4, 2008, Italia, p. 243-254.
13. Würdig G., Woller R., 1989 - *Chemie des wines*. Ed. Ulmer, Stuttgart, Germany.
14. ***, 2012 - *Colectie de standarde pentru industria vinului si bauturilor alcoolice*. Ministerul Industriei Alimentare, Bucuresti.
15. ***, 2015 - *Recueil des méthodes internationales d'analyse des vins et de moûts*. Office International de la Vigne et du Vin, Édition Officielle, juin, Paris

STUDY OF VOLATILE AROMA COMPOUNDS OF SOME ROSÉ WINES FROM IAȘI COPOU VINEYARD

STUDII PRIVIND COMPUȘII VOLATILI DE AROMĂ DIN UNELE VINURI ROZE OBȚINUTE ÎN PODGORIA IAȘI COPOU

ANDRIEȘ M. T.¹, TUDOSE-SANDU-VILLE Ș.¹, ZAMFIR C.I.²,
VARARU F.³, NICULAU M.², COLIBABA Cintia¹,
ODĂGERIU G.², COTEA V.V.¹

e-mail: andriestibi@yahoo.com

Abstract. *The main objective of the present study is to identify volatile aroma compounds of some rosé wines obtained from black grapes, in Iași Copou vineyard. Fetească Neagră, Băbească Neagră and Merlot grapes were manually harvested in 2016 and vinified in rose wine. After 14 days fermentation at 15°C, the wine samples were filtered, bottled and subjected to analyses. The wine aroma compounds were analysed by a Shimadzu GC-2010, coupled with a QP2010 Plus mass spectrometer. Many terpenic compounds, alcohols and esters were identified in the studied samples. The wine obtained from the Fetească neagră variety was found to have the highest content in terpenic compounds from all the studied samples.*

Key words: vinified in rose, aroma compounds

Rezumat. *Scopul acestei lucrări este de a identifica compușii volatili de aromă din vinurile roze obținute din soiuri de struguri negri, în podgoria Iași Copou. Struguri din soiurile Fetească Neagră, Băbească Neagră și Merlot din recolta anului 2016 au fost recoltați manual și vinificați în rose. După 14 zile de fermentare la 15°C vinul a fost filtrat, îmbuteliat și supus analizelor. Compușii de aromă au fost identificați utilizând ansamblul format din gaz cromatograf Shimadzu GC-2010 cuplat cu spectrometru de masă QP2010 Plus. Au fost identificați compuși terpenici, alcoolii și esterii în cantități diferite. În urma acestui studiu s-a evidențiat cu un conținut mai ridicat în compuși terpenici vinul obținut din soiul Fetească neagră.*

Cuvinte cheie: vinificați în rose, compuși de aromă

INTRODUCTION

The name of the rose wine be attributed to the product obtained from the black grapes which are poorly pigmented due to their biological nature or which do not achieve sufficient pigmentation to produce red wines due to unfavorable conditions of maturation. There are also rosé wines that can be obtained from the rosé grape varieties (Cotea, 1985).

¹The University of Agricultural Sciences and Veterinary Medicine, Iași, Romania

²Research Centre for Oenology, Romanian Academy - Iași, Romania

³S.C. Agroindustrială Bucium S.A. – Iași, Romania

In the process of obtaining rosé wines it is possible to lack maceration or to be short-lived. Flavor is one of the most important factors related to the quality of a wine and to characterize the flavor, volatile compounds play an important role. The volatile fraction of wine determines to a great extent the flavor, which is one of the most important characteristics that influence wine quality and consumer preferences. Volatile compounds are able to stimulate the sensory organs responsible for olfaction.

These compounds correspond to small molecules of medium hydrophobicity and molecular weight generally between 30 g / mol and 300 g / mol (Morrot and Brochet, 2000).

Depending on the origin and considering the technological stage of winemaking, the wine flavor can be classified into four different groups (Bayonove *et al.*, 1998): *varietal flavor*, typical of the grape variety; *pre-fermentative flavor*, from grape processing and subsequent operations; *fermentative aroma* produced by yeast during alcoholic fermentation and lactic acid producing bacteria during malolactic fermentation; *post-fermentative aroma* resulting from the transformations that occurred during wine preservation and aging of wine (Vilanova and Oliveira 2012).

These flavors are mostly attributed to classes of compounds such as higher alcohols, aldehydes, ethyl esters of fatty acids, fatty acids, ketones, monoterpenes and volatile phenols (Andujar-Ortiz *et al.*, 2009).

The organoleptic characteristics of rosé wines are intermediate between the macerated red wines and the white wines ones without maceration.

MATERIAL AND METHOD

The purpose of this study was to obtain data on volatile flavor compounds composition from some rosé wines obtained from black grapes in the Iasi Copou vineyard to verify that the wines obtained retained their typical variety.

The raw material was Fetească Neagră, Băbească Neagră, Merlot, harvested at the technological maturity of the Copou vineyard in 2016.

The grapes were harvested manually, after that, the complete transport of the raw material to the wine-making center was ensured. Once they get there, the grapes are subjected to qualitative and quantitative reception. After the destemming and crushing of the grapes, the short-term maceration-fermentation takes place. The must has been pressed with a hydraulic press. The must obtained without pressing the grapes, and the resulting press must, was placed in 50L glass containers where it was left for fermentation process.

After completion of the alcoholic fermentation, the wine is filtered through sterile plates. Following these operations, 22 L of wine were obtained and it was sulfated with a 1 mL / 0.75 L vial, 6% SO₂ solution and 220 mL of benonite was added (fig. 1).

The acquisition of these wine samples lasted 14 days, obtaining three variants of study.

For each sample taken after filtration and decarbonation of the sample, physicochemical analyzes (***) (2015), determination of flavor compounds and organoleptic analysis were performed.

The flavor compounds in these wines were identified using the Shimadzu GC-2010 equipment coupled with the QP2010 Plus spectrophotometer.

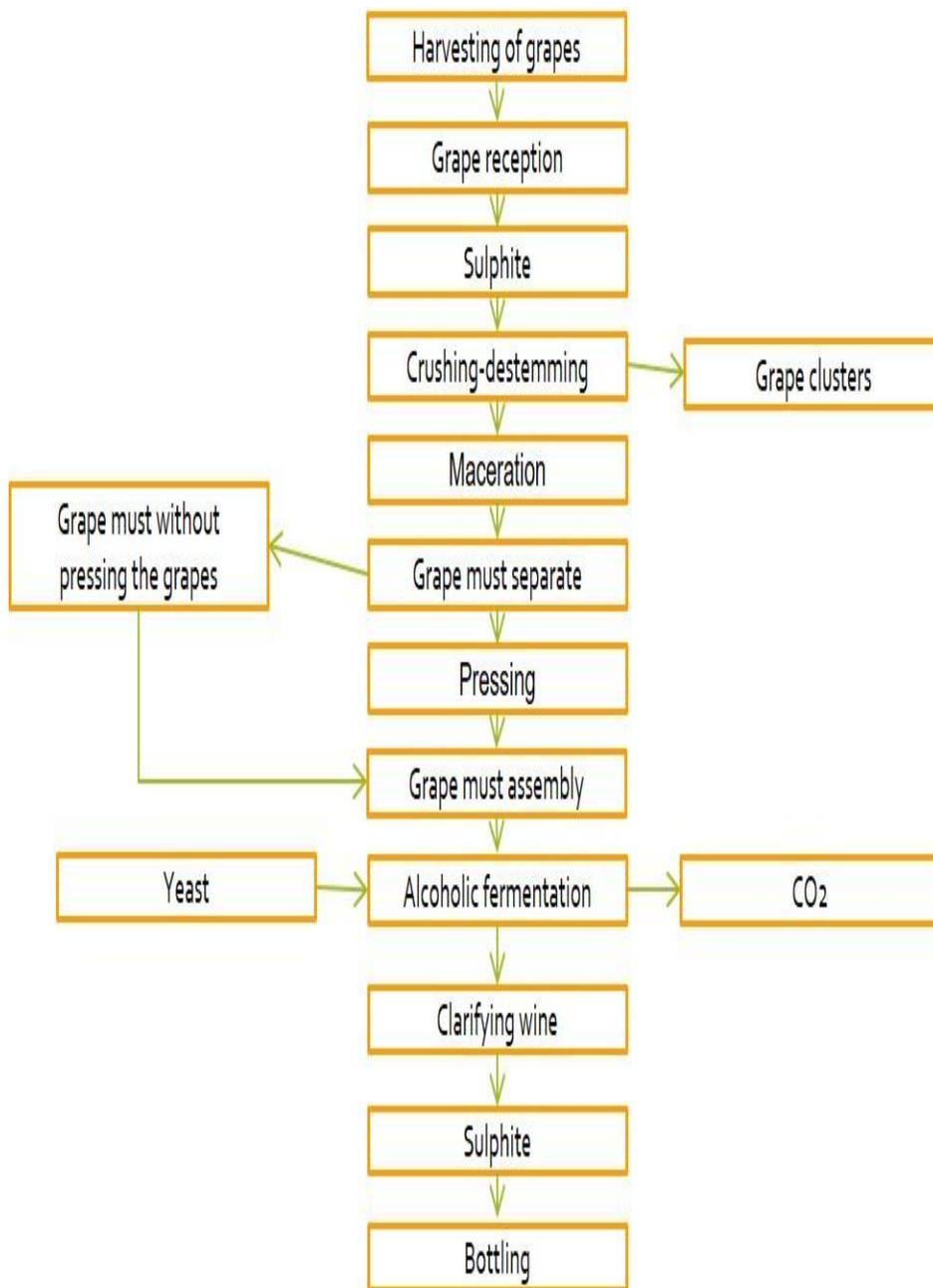


Fig.1 Flow diagram

RESULTS AND DISCUSSIONS

By analyzing the studies on the evolution of the chemical composition of the grapes, the winemakers have precisely established the time of harvesting the grapes, respectively the technological maturity.

The raw material used in the study comes from the Iași-Copou vineyard and belongs to the varieties: Fetească Neagră, Băbească Neagră and Merlot.

Even if grapes intended for winemaking had homogeneous composition characteristics, the composition of the wines is different due to the different varieties used.

The main physical-chemical parameters of the analyzed wine samples are shown in table 1.

Following these analyzes, terpenic compounds, alcohols (1-propanol, 3-methyl-1-butanol, etc.) and esters (ethyl caprylate, ethyl laurate, etc.) were identified in different amounts (tab. 2).

Terpenic compounds, alcohols and esters have been identified in varying amounts. Following this study, the wine obtained from the Fetească Neagră variety was found to have a higher content in terpenic compounds

Organoleptic analyzes highlighted the following:

- citrus flavor has been identified in all samples
- raw berry notes are more impressive than exotic fruits
- the most predominant flavor of the olfactory sensation, on the rosé wines that have been tasted, is the mineral.

From a taste standpoint, rosé wines that have been analyzed from this point of view have been well structured, have a strong acidity and significant persistence.

Table 1

The physico-chemical characteristics of the rosé wines analyzed

Sample	Alcohol (% vol.)	T.A. (g/L acid tartic)	V.A. (g/L acid acetic)	Density (g/cm ³)	pH	Malic acid (g/L)	Lactic acid (g/L)	Fructose (g/L)	Glucose (g/L)	Sugar (g/L)
BN	12.7	6.8	0.47	0.9951	3.25	2.3	0	9.7	1.2	11.9
M	13.1	5.7	0.31	0.9937	3.39	1.6	0	8.4	0.2	9.2
FN	13.9	6.2	0.3	0.9908	3.52	2.3	0	1.4	0.5	3.3

VA - (volatile acidity); TA – (total acidity)

Table 2

Aroma compounds identified in rosé wines

Flavor	Aroma compound	BN	M	FN
smell of alcohol	1-Propanol, 2-methyl- (CAS) Isobutyl alcohol	X	X	/
	2-Pentanol, 4-methyl- (CAS) 4-Methyl-2-pentanol	X	X	X
	2-Pentanol, 4-methyl	X	X	X
	1-Butanol, 3-methyl	X	X	X
	4-Heptanol, 2,6-dimethyl	X	X	/
fruity, fresh	Octanoic acid, ethyl ester	X	X	X
	1-Hexanol	/	/	X
	Propanoic acid, 2-hydroxy-, ethyl ester	X	/	/
fruity	Ethyl butyrate	X	X	X
	Propanoic acid, 2-hydroxy-, ethyl ester	/	X	/
animal smell	ETHYL CAPRATE	X	X	/
swety, cheesy	HEXANOIC ACID	X	/	/
lemon	LINALOL	/	/	X
lime, roses	NEROL	/	X	X
citrus	GERANIOL	/	/	X
	Hexadecanoic acid, ethyl ester (CAS) Ethyl palmitate	X	X	X

BN-Băbească Neagră; M-Merlot; FN-Fetească Neagră

CONCLUSIONS

Experimental variants that have been studied have different physico-chemical properties because wine samples obtained from different varieties have been used.

From a chemical point of view, these wines come closer to white wines with a lower alcoholic strength, lower irreducible extract and adequate total acidity.

In the case of the Fetească de Neagră, there were identified aroma compounds from the terpene group (linalool, nerol, geraniol).

The aromatic profile of the wines was influenced by the vine variety, the maturity of grapes at harvest, the activity of yeasts, the preference and aging procedures. Through this study, it was observed that all analyzed wine samples showed a high degree of acidity, with a well-developed structure and a high level of persistence.

REFERENCES

1. **Andujar-Ortiz et al., 2009** - *Analytical performance of three commonly used extraction methods for the gas chromatography-mass spectrometry analysis of wine volatile compounds*. Journal of Chromatography A, Volume 1216, pp 7351-7357.
2. **Bayonove C.L., Baumes R.L., Crouzet J., Günata Y.Z., 1998** - *Arômes*. In: Œnologie - Fondements Scientifiques et Technologiques, Chap. n° 5, Lavoisier Tec & Doc (Eds.), Paris, 163–235
3. **Cotea V. D., 1985** - *Tratat de oenologie vol. I*. Editura Ceres, București.
4. **Morrot G., Brochet F., 2000** - *Ce que le nez peut dire*. In: *La Dégustation*. Journal International des Sciences de la Vigne et du Vin, n° Hors Série, 15–18
5. **Vilanova M., Oliveira J.M., 2012** - *Application of Gas Chromatography on the Evaluation of Grape and Wine Aroma in Atlantic Viticulture (NW Iberian Peninsula)*.
6. *****, 2015** - *Recueil des méthodes internationales d'analyse des vins et de moûts*. Office International de la Vigne et du Vin, Édition Officielle, juin, Paris.

DETERMINATION OF LEVURIEN BIOMASS IN BIOREACTOR

DETERMINAREA BIOMASEI LEVURIENE ÎN BIOREACTOR

CIUBUCĂ A.¹, DONICI Alina¹, POSTOLACHE Elena¹,
BORA D. F.¹, BÎRLIGA N.¹, DONICI I.¹
e-mail: aurel.ciubuca@gmail.com

Abstract. In the bioreactor, optimal growth and multiplication conditions were created by applying growth and aeration factors, reaching a multiplication rate of 32×10^6 cells/mL in the bioreactor versus 12×10^6 cells/mL at the control. The amount of yeast biomass obtained in the bioreactor was 78,6% higher than in the control by the aerobic stimulation effect of the synthesis of cellular precursors of biomass multiplication. In the bioreactor, the conditions of respiratory multiplication of the yeast have been established, as evidenced by the reduced alcohol content of 7.5% alcohol and the large amount of biosynthesis obtained by biosynthesis compared to the control where the fermentative processes are at the expense of the respiratory.

Key words: biomasă, yeast, bioreactor

Rezumat. În bioreactor s-a creat condiții optime de creștere și multiplicare levuriană prin aplicarea factorilor de creștere și aerare, ajungându-se la o rată de multiplicare de 32×10^6 celule/mL în bioreactor comparativ cu 12×10^6 celule/mL la martor. Cantitatea de biomasă levuriană obținută în bioreactor a fost cu 78,6% mai mare decât la martor prin efectul de stimulare aerobică a sintezei precursorilor celulari ai multiplicării biomasei. În bioreactor s-au creat condițiile de multiplicare levuriană pe cale respiratorie dovadă sta concentrația redusă în alcool de 7,5% vol alcool și cantitatea mare de biomasă obținută prin biosinteză comparativ cu martorul unde domină procesele fermentative în detrimentul celor respiratorii.

Cuvinte cheie: biomasă, drojii, bioreactor

INTRODUCTION

The use of bioreactors in the production of protein biomass with a high nutritional value is common practice in the industrialised countries for a long period of time.

In our country there are experimental trials for monitoring and overseeing of bioreactors (Cascaval and Ungureanu, 2000; Selișteanu, 2001), but we need a new scientific approach in the sense that we need to move pass the experimental stage to the pilot stage and finally to the industrial production stage if we want to put these biotechnologies to work in development according to A. Sasson (Sasson, 1993).

V. Magearu and S. Jurcoane worked on the analytical control of biotechnological processes and foundations in the bioreactors (Magearu, 1988; Jurcoane, 1999-2000).

¹ Research - Development Station for Viticulture and Winemaking Bujoru, Romania

In our experiment we wanted to increase the return of levurian biomass in the bioreactor versus a control of traditional fermentation without shaking, more nutrients or a change in pH value, the factors which have been used in the bioreactor.

The fermentation process was shorter in the bioreactor (9 days until dry) due to the above mentioned factors compared to the control (14 days) when the fermentation process had to be stopped as proven by the rezidual amount of sugar of 26 g/L.

Aeration is known as a physical factor of levurian multiplication as well as the separated influence of some B complex vitamins on the growth of yeasts.

MATERIAL AND PROCEDURE

The grape must is introduced in the bioreactor-5. It (236g/L sugars; 6.6g/L tartic acid; pH-3.35) and after that 60mg/L of SO₂ must (sterilized at 105°C for 15 min.) was added to provide antioxidant protection together with the pH sensors, DO, foaming sensor; cooling, air and temperature. All the entrances and exits in the fermentation tank were covered with cotton-wool and aluminium foil to avoid contamination.

At the same time 1lt of must was introduced in a UV sterilized plastic bottle to obtain a control sample without the imposed parameters from the bioreactor.

The transfer of the must in the control sample and in the reactor was followed by sterilization at 105°C for 15 min.

Sacharomyes cerevisiae -Killer strand 10701 USAMV Bucharest was added in 500 mL starter must and thermostated 3 days at 28°C/72 h.

Parameters settings in the bioreactor:

- stirring speed was set to 50 rot./min.;
- Nutrient dosage, in a dose of 31mL/day;
- pH-4.06;
- fermentation temperature 22°C;
- level of aeration-10;
- Basic Pump; (NaOH 1 N pH-13)

The pH, the metabolism of sugars in the must, numerical evaluation of yeasts in fermentation, foaming and the colour of the medium , quantitative evaluation of yeast biomass at the end of fermentation and physical-chemical analysis of the resulting wine were monitored.

Peristaltic pumping additives in Bioreactor

Nutrients:-B complex vitamins forte (5 tablets la %);

1. Essential nutrients for the yeasts:

- Pantothenic acid: 45 mg (9 mg/tablet)-ideal for the yeasts -250 µg;
- Vitamin B1: 8,250mg (1,65 mg/tablet)-ideal for the yeasts -250 µg;
- Biotin: 375 µg (75 µg/tablet)-ideal for yeasts 250 µg;

2. Glutation Activator Nutrient:

- 30g/hL (cell walls, scteroli vitamins, growth factors)
- Basic Pump Na OH 1N, pH 13

RESULTS AND DISCUSSIONS

The fermentation process was stopped through exposure to cold air (12°C) and sulfiting at 100mg/L SO₂.

The bioreactor was disconnected and the fermented liquid, 5 L, was taken from the bioreactor and was left to decant in the cold so the yeast sets and the crude wine decants; the control sample continued to ferment until 17.07.2017 when it was put in the cold to obtain the yeast and the crude wine;

During the multiplication of yeasts and the showing of alcohol fermentation we proceeded to the monitorisation of the alcoholic fermentation through the daily metabolism of sugars, numerical evaluation of the yeasts in fermentation, and the pH, the quantitative assesment of the levurian biomass at the end of fermentation according to table 1.

Table 1

The multiplication of yeasts

Data	Procedures/ obs.	Yeast no. Bioreactor /Control	Residual sugars g/L Bioreact./ Control	pH Bioreact. / Control
5.07.	The yeast dose is inoculated /Lag stage	5x10 ⁶ /5x 10 ⁶	236/236	4.06/3.24
6.07.	Multiplication/Exponential Stage	10x 10 ⁶ /6x 10 ⁶	205/220	4.03/3.25
7.07.	Exponential Stage	22x10 ⁶ /8x10 ⁶	175/190	4.00/3.26
8.07.	Exponential Stage	25x10 ⁶ /10x10 ⁶	150/170	4.00/3.26
9.07.	Exponential Stage	28x10 ⁶ /11x10 ⁶	100/135	3.99/3.27
10.07.	Exponential Stage/Stationary	32x10 ⁶ /12x10 ⁶	60/105	3.98/3.27
11.07.	Final Stage	16x10 ⁶ /8x10 ⁶	30/70	4.03/3.37
12.07.	Final Stage	10x10 ⁶ /8x10 ⁶	15/50	4.03/3.37
13.07.	Decanting and racking (Bioreactor)	8x10 ⁶ /8x10 ⁶	7/40	4.02/3/39

The rate of multiplication of yeasts in the bioreactor reached a maximum of 32x10⁶/ml after six days compared to the control sample where the multiplication rate was of only 12x10⁶/mL for the same period of time. The metabolism of sugars happens at the same speed in the bioreactor when after 8 days all the sugars are metabolised while in the control sample there are still 26g/L sugars even after 13 days. The appearance of the fermentation process represents the Gaussian bell.

Physico-chemical analysis of the resulting raw wines 236 g sugar=13.8% vol. alcohol

Why is there more biomass in the bioreactor?

Why is the wine from the bioreactor of lower alcoholic concentration (7.5% vol. alcohol) while in the control sample the concentration is higher (13.7% vol. alcohol)? (tab. 2)

The kinetics of biosynthesis processes

No	Sample	Alcohol % vol.	Total acidity g/L ac. tartaric	Acidity vol. g/L ac. acetic	SO ₂ total mg/L	SO ₂ free mg/L	Sugars red. g/L	Non-reductive extract. g/L	pH	Polyphenols g/L	Turbidity NTU
1	Wine control	13.7	7.4	1.11	151	10	26	26	3,25	0.380	0.64
2	Wine bioreactor	7.5	7.4	0.87	130	6	4	30	3,88	0.409	1.52

The answer comes from the the repression and enzymatic stimulation of some biochemical processes of glycolysis and breathing. Through `the Pasteur effect` the fermentation is inhibited by aeration and the aerobic (respiratory) pathway of sugar degradation is intensified. The modification of the Pasteur effect is called `the Crabtree` and represents the repression of breathing and the stimulation of fermentation through which the yeast strand *Saccharomyces cerevisiae* produces ethanol (alcohol) in anaerobic conditions and high concentrations of glucose while the pyruvate is transformed in ethanol and carbon dioxide and the energy production is lowered to 2 moles ATP/mole of glucose.

Of course in the bioreactor only a small amount of sugars were used in glycolysis to obtain ethyl alcohol (7.5 % vol. alcohol), the rest was used in the respiratory processes and oxidative phosphorylation of yeast mitochondria with the production of a large amount of energy required in the aerobic biosynthesis of levurian mass and nucleotide and nucleic acids via the hexose monophosphate pathway for the synthesis of biomass-forming cellular precursors according to figure 1.

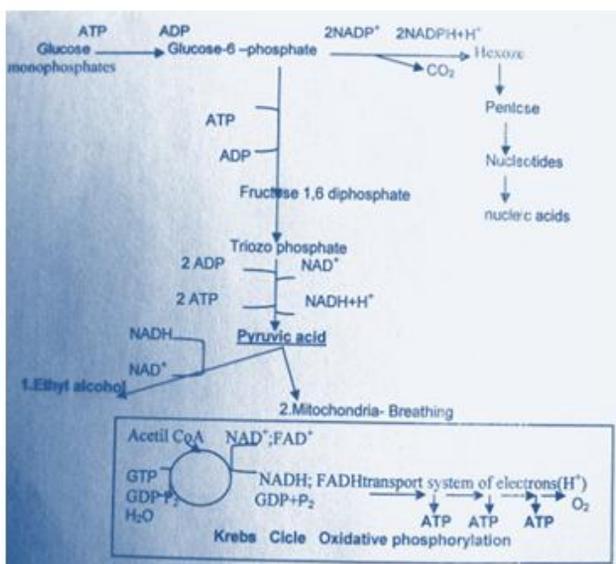


Fig.1 Sugar metabolism in the yeast cell

Wet yeasts mass:

In the control sample through the must fermentation of 1200 mL raw wine 16g of wet yeast were obtained.

In the bioreactor through the must fermentation of 5000 mL raw wine 119g of wet yeast were obtained.

The calculation of yield in the bioreactor:

If the control sample we have 1200 ml raw wine.....16.0 yeast
 Related to the bioreactor`s 5000 ml raw wine, we have..... 66.6 g yeast;
 66,6 g drojdie.....100%
 119 g drojdie.....x; **X =78,6 %**

The yield of levurian biomass in the bioreactor is 78.6% higher than in the control sample (fig.2, fig.3).

The factors that have led to increased yields in biomass

1. Aeration by air dosing at a dose of 10;
1. Rhythmic addition of nutritional factors of 31 mL / day for 5 days;
2. The change of pH in the bioreactor to 4.06;
3. Temperature: 22°C. Stirring to 50 rot/min.



Fig. 2 The Bioreactor working



Fig. 3 Sampling of the product

CONCLUSIONS

In the bioreactor optimal conditions of growth and levurian multiplication were created by applying aeration and growth factors, reaching a multiplication rate of 32×10^6 cells/mL versus 12×10^6 cells/mL in the control sample.

The obtained amount of levurian biomass in the bioreactor was with 78.6% higher than the amount obtained in the control sample due to the effect of aerobic stimulation of the synthesis of cellular precursors of biomass multiplication.

REFERENCES

1. Cascaval, D. Ungureanu F., 2000 - *Bioreactoare. Monitorizare*, Ed. UMF, Iași.
2. Jurcoane Ș., Vintilă T., 1999 - *Biotehnologia enzimelor*, Ed. Tehnică, București.
3. Jurcoane S., 2000 - *Biotehnologii. Fundamente. Bioreactoare. Enzime*, Ed. Tehnică, București.
4. Magearu V., 1988 - *Controlul analitic al proceselor biotehnologice*, Ed. Tehnică, București.
5. Sasson A., 1993 - *Biotehnologii și dezvoltare*, Ed. Tehnică, București.
6. Selișteanu D., 2001 - *Modelarea și conducerea bioreactoarelor*, Ed. Universitaria, Craiova.

ORGANOLEPTIC CHARACTERISTICS OF EXPERIMENTAL SPARKLING WINES

CARACTERISTICI ORGANOLEPTICE ALE UNOR VINURI SPUMANTE EXPERIMENTALE

FOCEA M.C.¹, LUCHIAN Camelia¹, ZAMFIR C.², NICULAU M.²,
MOROȘANU Ana Maria¹, NISTOR Alina¹, ANDRIEȘ T.¹,
LACUREANU G.¹, COTEA V.V.¹

e-mail: kamelia_luchian@yahoo.com

Abstract. *There are two main production processes for the quality sparkling wines: traditional and „charmate“ methods. In the traditional procedure, the second alcoholic fermentation of the base wine is carried out in sealed bottles. Some of the most popular sparkling wines, such as Champagne and Cava, are produced by the traditional method. Sensory and organoleptic characteristics are one of the most important indicators of sparkling wine quality for the acceptability of a product by consumers. So, this research is focused on the study of the influence of different yeast strains on the organoleptic profile of the experimental sparkling white wines produced by traditional method. Therefore, a Muscat Ottonel grape must was used and passed by a reverse osmosis process. The obtained permeate was mixed with a calculated amount of the concentrate to generate a must with a potential of 10.5% (v/v) alcohol, in order to obtain the base wine for the second fermentation. The obtained, stabilized, sparkling wine was analyzed for oenological parameters and to determine the organoleptic characteristics. Following the organoleptic analysis, the significant differences in the sensory profile for the analyzed wine samples were confirmed.*

Key words: Muscat Ottonel grape, reverse osmosis, champenoise method, yeast strains, organoleptic profile

Rezumat. *Există două metode de producere pentru vinurile spumante de calitate: prin metoda tradițională și prin metoda „charmate“. În procedura tradițională, cea de-a doua fermentație alcoolică a vinului se efectuează în sticle sigilate în prezența unor levuri speciale. Unele dintre cele mai populare vinuri spumante, cum ar fi Champagne și Cava, sunt produse prin metoda tradițională. Caracteristicile senzoriale și organoleptice sunt indicatori importanți ai calității vinurilor spumante în sensul acceptării unui produs de către consumatori. Prin urmare, această cercetare se concentrează pe studiul influenței diferitelor tulpini de drojzii asupra profilului organoleptic al unor vinuri spumante experimentale produse prin metoda tradițională. Pentru experimente a fost utilizat must de struguri Muscat Ottonel ce a fost trecut printr-o instalație de osmoză inversă. Permeatul obținut a fost amestecat cu o cantitate calculată de produs concentrat pentru a genera un must cu un potențial alcoolic de aproximativ 10,5% (v/v), pentru a obține vinul de bază pentru a doua fermentație. Vinul spumant obținut, stabilizat, a fost analizat pentru a se stabili principalii parametri oenologici și pentru a determina caracteristicile*

¹University of Agricultural Sciences and Veterinary Medicine Iasi, Romania

²Oenological Research Center - Romanian Academy, Iasi, Romania

organoleptice. În urma analizei organoleptice, au fost confirmate diferențe semnificative în profilul senzorial pentru probele de vin analizate.

Cuvinte cheie: Muscat Ottonel, osmoză inversă, metoda champenoise, levuri selectionate, profil organoleptic

INTRODUCTION

Sparkling wine are by definition wines (usually white) that are naturally carbonated by a second fermentation and can be obtained using two main production methods, namely: the traditional method and the charmant method, differentiated by the second fermentation process (bottle fermentation and the fermentation in large, stainless steel tanks).

Aroma is one of the most important factors determine the character and quality of a wine (Villanova *et al.*, 2007). Some of aroma compounds are released directly from the grape berries while others are formed during the fermentation and aging (Rapp, 1998).

Generally, the aroma of the wine depends on many factors such as: environmental and management practices, grape varieties, wine-making technique, etc (Falque *et al.*, 2001). In the case of sparkling wines the majority of flavor compounds are arising from the fermentation process and a determinant factor in developing the sensorial profile are the selected yeasts used in the process.

Wine aroma can be perceived by nose or in the mouth via postnasal way (Francis and Newton, 2005) and is a direct function of the chemical composition of the wine. Perceived flavor is the result of complex interactions between all the volatile and non-volatile compounds present in wine (Fairbairn *et al.*, 2014). The diversity of aromatic compounds in wine is immense and ranges in concentrations from mg/L to a few µg/L (Zhang *et al.*, 2011).

Wine quality is closely related to microbial ecology of fermentation and especially to the yeasts that are producing volatile metabolites with different flavor profiles. The yeasts are responsible for the biotransformation process of the grape juice constituents into aroma or flavor-impacting components, for bringing enzymes that transform neutral grape compounds into flavor-active compounds and lastly for the novo synthesis of many flavor active primarily and secondary metabolites (Styger *et al.*, 2011).

In the winemaking industry it is desired to obtain a wine from extremely ripe grapes in order to create a wine with a developed sensory palette, but in this case occurs the problem of obtaining wines with a high alcoholic strength. Thus, in order to avoid this type of situations reverse osmosis is applied and in this way the level of alcohol is reduced without major changes on the fruit flavors and other elements in the wine.

Reverse osmosis (RO) is a technology that uses a semi permeable membrane to remove ions, molecules and larger particles from different liquids. In reverse osmosis, an applied pressure is used to overcome osmotic pressure a

colligative property that is driven by chemical potential differences of the solvent, a thermodynamic parameter (Ribereau-Gayon *et al.*, 2006; Tessier, 2003).

The main objective of the present study is to evaluate the influence of different type of yeasts on the sensorial features of the sparkling wines. The originality of the study consists in applying the reverse osmosis (RO) in order to obtain a base wine for the second fermentation with standard characteristics.

MATERIAL AND METHOD

Must and wine samples

The present study was carried out on five samples of sparkling wines obtained from Muscat Ottonel juice/must. The raw material-the must/ juice was obtained from grapes of Muscat Ottonel that were harvest in 2015 at full maturity from Iași vineyard.

Wine samples

The sparkling wine samples taken in the experiment were produced in the micro-winery belonging to the Oenological department of the University of Agricultural Sciences and Veterinary Medicine of Iasi.

It is a must to emphasize the fact that the samples covered by this scientific study were obtained by applying the classical method *champenoise*. This method consists of a secondary bottle fermentation of the wine raw material, followed by the removal of impurities by riddling and disgorgement operations.

The harvests of grapes along with the primary fermentation proceeds as with any still wine. The still wine produced becomes in this way the base-wine to be used in the next step. It is necessary to mention the fact that a reverse osmosis process mixing in a variable ratio of the permeate and concentrate was applied followed by the usual fermentation process.

After primary fermentation and bottling of the base wine, a second alcoholic fermentation occurs in the bottle. The second fermentation is induced by adding yeast and sugar (*liqueur de tirage*). The sugar added with the *liqueur de tirage* provides food for the yeast and is entirely consumed during the secondary fermentation and has no effect on the "sweetness" of the finished product. At this time the bottle is capped with a crown cap and stored in a cellar in the horizontal position to age.

After the completion of the aging process the bottle is submitted to removing the dead yeast, this process being known as riddling. At this stage the bottles are placed on special racks at a 45° angle with the cork pointed down. After six to eight months the position of the bottles are changed being pointed straight down with the sediment in the neck of the bottle.

The disgorging operation consists in a freezing process of the neck bottles that are still pointed down and after that the bottles are turned upright and the cap is removed. In this way the pressure in the bottle will eliminate the lees.

Immediately after disgorging and before corking, the wine levels from the bottles is completed with the "liqueur d'expédition". Usually in this stage it is add a little quantity of sugar a practice known as dosage. The amount of sugar added in this step will determine the sweetness of the sparkling wine and in the end the cork is inserted.

Reagents for the fermentation process

For the fermentation process the most important factor is the type of the yeasts that were used. Thus, the yeasts are becoming the experimental factor helping to differentiate samples concerning the quality of the wine samples obtained such as:

aromatic compounds, metal content, acid content, color and the determination of the amino acids. The samples are: V0- the blank sample (no yeast used), V1- Ioc FIZZ yeast, V2- IOC DIVINE yeast, V3- IOC 18-2007, V4- LEVULIA CRISTAL. It is also necessarily to emphasize the fact that the yeasts that were used for this experiment are selected and recommended by the Oenological Institute of Champagne.

After the decarbonisation operation, each sample of wine was submitted to the following analyses: sulfur dioxide, volatile acidity, total acidity, alcoholic strength, reducing substances, total dry matter and non-reducing substances. The analyses were done according to OIV methods and the specific literature.

RESULTS AND DISCUSSIONS

The general physical-chemical parameters of the analyzed sparkling wine samples are presented in table 1. It is necessarily to mention the fact that in the obtaining process of sparkling wines was used the same raw-material-wine and possible differences could result from using different types of fermentation yeasts.

Table 1

Quality parameters of the wine raw-material and of the sparkling wines obtained

Samples	1	2	3	4	5	6	7	8	9
Control sample	0.9921	6.2	0.33	10.3	17.2	70.7	3.2	15.2	2.8
Sample V1	0.9905	6.7	0.32	11.6	5.12	56.3	0.7	14.5	3.1
Sample V2	0.9908	6.9	0.29	11.3	5.12	48.6	1.9	13.3	3.0
Sample V3	0.9906	6.9	0.26	11.6	5.12	51.2	1.9	13.5	3.0
Sample V4	0.9907	6.6	0.31	11.3	7.68	64.0	0.7	14.3	3.0

1- density; 2- total acidity (g tartaric acid/L); 3- volatile acidity (g acetic acid/L); 4- alcohol strength (%); 5- free SO₂ (mg/L); 6- total SO₂ (mg/L); 7- reductive substances (g/L); 8- Non-reductive extract (g/L); 9- pH.

Visible differences can be observed between the control samples and the samples treated with specific yeasts. Thus, in the case of alcoholic strength the values of the analyzed samples ranged between a minimum of 10.34 % vol. for the control sample and a maximum of 11.6 % vol. for the sample V1 and V3. This variation pattern could be explained by the inoculation with specific yeasts in the second fermentation stage.

The volatile acidity didn't vary in large limits: from a minimum of 0.26 g/L acetic acid for the sample V3 to a maximum of 0.33 g/L acetic acid for the control sample. Low values of the total acidity were determined for the control sample and the sample V4.

The charts of organoleptic features are presented in figure 1 and in figure 2. These two charts describe the evolution of the sensorial profile of the analyzed sparkling wines since the analysis was conducted at six months and at twelve months.

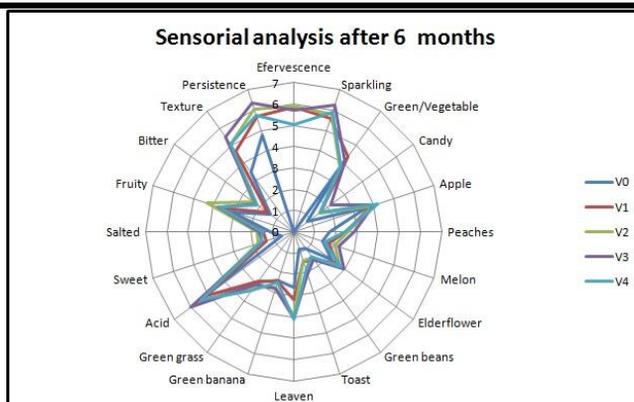


Fig.1 Organoleptic chart of the analysed sparkling wines after 6 months

The wines are equilibrated from the sensorial point of view. For example at six months in the case of the control sample, differences regarding the persistence, apple flavors and green-vegetable flavors were observed. So, in this case the organoleptic features were less developed. In addition, it is necessary to mention the fact that sparkling is very low by comparison with the other samples.

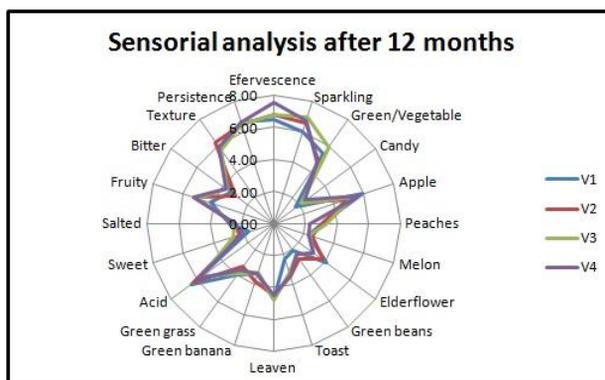


Fig. 2 Organoleptic chart of the analysed sparkling wines after 12 months

Concerning the samples treated with different types of yeasts the sample treated with IOC-18 2007 yeast revealed higher persistence and acidity and the sparkling phenomenon and the texture was better distinguished.

The sample V2 treated with IOC DIVINE yeast expressed better the fruity flavors and the sample V4 treated with LEVULIA CRISTAL yeast revealed more intense apple flavors and leaven flavors.

After twelve months another organoleptic chart was developed with notable differences by comparison with the sensorial analysis obtained at six months. So, it can be observed from figure 2 that the effervescence and the sparkling phenomenon were better expressed.

The acidity level of the samples maintained constant and the green-vegetable flavors developed more. For V2, the texture was more elaborated after twelve months and the fruity flavors were better expressed. Nevertheless, for the same sample, the persistence and the effervescence suffered an important decrease.

CONCLUSIONS

1. Following the results of the physico-chemical characteristics, the considered samples could be included in the category of 'brut' sparkling wines.

2. The use of specific yeasts influenced the physico-chemical features especially the alcoholic strength (%).

3. Concerning the influence of the yeasts on the sensorial features of the wine samples important differences were observed. So, the employment of yeast determined the increase of the persistence, of the effervescence and the occurrence of the sparkling phenomenon.

4. The aging process influenced positively the sensorial profile of the samples by the development of the green-vegetable and the fruitiness flavor.

REFERENCES

1. Fairbairn SC, Smit AY, Jacobson D, Prior BA, Bauer FF., 2014 - *Environmental stress and aroma production during wine fermentation*. South African Journal for Enology & Viticulture, 35, p. 168–177.
2. Falqué E., Fernández E., Dubourdiou D., 2001 - *Differentiation of white wines by their aromatic index*. Talanta, 54(2), p. 271-281.
3. Francis I.L., Newton J.L., 2005 - *Determining wine aroma from compositional data*. Australian Journal of Grape and Wine Research, 11(2), p. 114–126.
4. Rapp A., 1998 - *Volatile flavour of wine: correlation between instrumental analysis and sensory perception*. Die Nahrung, 42(6), p. 351-363.
5. Ribereau-Gayon P., Glories Y., Maujeanand A., Dubourdiou D., 2006 - *Handbook of enology. The chemistry of wine: Stabilization and treatments*, 2nd ed. – Chichester: Wiley, U.K., vol. 2.
6. Styger G., Prior B., Bauer F.F., 2011 - *Wine flavor and aroma*. Journal of Industrial Microbiology & Biotechnology, 38(9), p. 1145–1159.
7. Vilanova M., Zamuz S., Vilariño F., Sieiro C., 2007- *Effect of terroir on the volatiles of Vitis vinifera cv. Albariño*. Journal of the Science of Food and Agriculture, 87(7), p. 1252-1256.
8. Zhang M., Pan Q., Yan G., Duan C., 2011 - *Using headspace solid phase micro-extraction for analysis of aromatic compounds during alcoholic fermentation of red wine*. Food Chemistry, 25(2), p. 743–749.
9. Tessier B., 2003 - *Reviews about Reverse Osmosis System*. Blog. Retrieved 10 August 2017.

STUDIES ON SOME ALIGOTÉ WINES OBTAINED THROUGH DIFFERENT WINE-MAKING TECHNOLOGIES

STUDII ASUPRA UNOR VINURI DE ALIGOTÉ OBTINUT PRIN DIFERITE TEHNOLOGII DE VINIFICAȚIE

TELIBAN I.-V.¹, COLIBABA Cintia¹, ZAMFIR C.², NICULAU M.²,
ODAGERIU G.², TUDOSE SANDU-VILLE S.¹,
COSTEA-SAVIN Zenaida¹, COTEA V.V.¹

e-mail: telibaniulian@yahoo.com

Abstract. *The influence the fermentation volumes have on the sensory profile of the final product is very important. Aligoté grapes from Bucium viticultural center, Iasi vineyard were used. After crushing, destemming and pressing, the marc was divided into containers of various volumes, from 25 L demijohns to 1000 L tanks. Various selected yeasts was inoculated. For the organoleptic analysis of wines obtained by the fermenting Aligoté musts, a sensory analysis was organized for each wine assortment. The wines obtained in the industrial system show notes of fresh cut grass and hay and more pronounced notes of green fruits, with a stronger minerality. The texture and persistence of the wines obtained at small scale production are more obvious.*

Key words: Aligoté, wine fermentation; yeast, winemaking

Rezumat. *Gradul de influență al volumelor de fermentare asupra profilului senzorial al produsului final a fost studiat. Strugurii din soiul Aligoté au provenit din centrul viticol Bucium, podgoria Iași. După zdrobire, desciorchinare și presare, mustul a fost divizat în recipiente de diverse volume, de la damigene de 25 L la cisterne de 1000 L. S-a făcut incolul de diverse sușe de levuri selecționate. Pentru aprecierea organoleptică a vinurilor s-a organizat o analiză senzorială pentru fiecare sortiment de vinuri. Vinurile obținute în sistem industrial prezintă note de fân cosit și fructe verzi mai pronunțate, iar mineralitatea acestuia este mai pronunțată. Textura și persistența vinului obținut la capacități mici de producție sunt mai evidente.*

Cuvinte cheie: Aligoté, fermentarea vin, levuri, vinificație

INTRODUCTION

Aligoté grape variety originates from the wine region of France Auxere-Chablis-Bourgogne. The first written references on it appeared in 1780; in our country it was brought after 1900 and it adapted very well to the climatic conditions encountered in Moldova's vineyards. The oldest records refer to one of its synonyms, Plant de Trois. *Trois* is the French word for three, and refers to the

¹ University of Agricultural Sciences and Veterinary Medicine Iasi, Romania

² Oenological Research center – Iasi Branch of Romanian Academy

three grapes we predominantly find on each shoot. Aligoté is said to have found its second homeland in Romania, more precisely in Iași, thus obtaining wines specific to the area.

MATERIAL AND METHOD

The Aligoté grapes were harvested in 2015, from Bucium vineyard (Vișani center), near Iași, the trials being done at S.C. "HOUSE OLTEANU" S.R.L., which produces wines known under the 'Gramma' brand. The grapes have the potential to obtain wines with a denomination of controlled origin (D.O.C.). The wine was obtained by preferential maceration for two hours, after which the must was collected in two separate vessels (free run must and press must), each of which was fermented separately. After these operations, the must was divided into containers of various volumes, ranging from 25 L demijohns to 1000 L tanks. Musts were fermented using both selected yeasts as well as native yeasts. During the alcoholic fermentation, the same nutrients and activators were administered in the same concentrations to all samples. Wine samples were subjected to physical-chemical analyzes (alcoholic strength, total and volatile acidity, pH, reductive sugars) and organoleptic assessment in the U.S.A.M.V. Oenology Laboratory Iasi, using specific methods (Cotea and Sauciu, 1988; Țârdea, 2007). The tasting was attended by 11 specialists, each evaluating the samples with points from 1 to 9.

RESULTS AND DISCUSSIONS

The main compositional characteristics of the Aligoté wines are shown in table 1.

Table 1

Main compositional characteristics of the wine samples

No.	Sample	Alcoholic concentration (% vol.)	Reductive sugars (g/L)	Total acidity (g/L C ₄ H ₆ O ₆)	Volatile acidity (g/L)	pH
1	A-D-FN	10.60	12.00	6.8	0.29	2.99
2	A-D-LE	11.20	2.40	6.8	0.29	3.09
3	A-T-LE	11.50	3.50	6.7	0.04	3.02

The 2015 wines obtained had the following compositional characteristics: the alcoholic strength registered between 10.6 %vol. for Aligoté sample spontaneous fermentation in demijohn (AD-FN) (No.1) and 11.50 %vol. for Aligoté wine fermented with selected yeast *Levulia Esperide* in tank (AT-LE) (No. 3). In general, the variants obtained with selected yeast inoculum, both in tanks and in demijohns, are within the quality category of D.O.C. wines. The samples where the fermentation took place with the help of spontaneous yeasts obtained values under the minimum for D.O.C wines. The total acidity ranged from 6.8 g/L in Aligoté wines fermented with *Levulia Esperide* in demijohns (A-D-LE) (No 2) and A-D-FN, and 6.7 g/L for A-T -LE samples. The sugar content

had values between 3.5 g/L at A-T-LE and 12.0 at A-D-FN (selected yeast inoculant (*Levulia Esperide*)), allowed fermentation of sugars so the resulting wines fall into category of dry wines with a sugar content of 2.4 or 3.5 g/L sugars, the variant with spontaneous yeast having a content of 12 g/L of sugars. Volatile acidity ranged from 0.04 g/L for A-T-LE wine and 0.29 g/L for A-D-LE and A-D-FN wines.

The comparative sensory diagram of Aligoté fermented in demijohns, with spontaneous and selected yeasts and in bigger volumes with selected yeasts is presented in figure 1. The wine obtained in tanks shows more pronounced notes of hay and green fruits, due to the secondary fermentation flavor resulting from the used yeast. Minerality is more pronounced in the samples produced with selected yeast inoculum in tank, this characteristic specific to Aligoté. The hue of dried fruit and ripe fruit perceived in large-scale fermentation is diminished. The texture and persistence of wine obtained in small capacities in the case of fermented must without commercial yeast inoculum are more obvious, this could be attributed to different genus of yeasts participating throughout the alcoholic fermentation. Fermentation aroma of non-*Saccharomyces* yeasts is much studied nowadays, as it can bring new notes to the wines.

The hue of honey and blossom flowers was felt the most in the case of wine fermented with inoculum in small recipients.

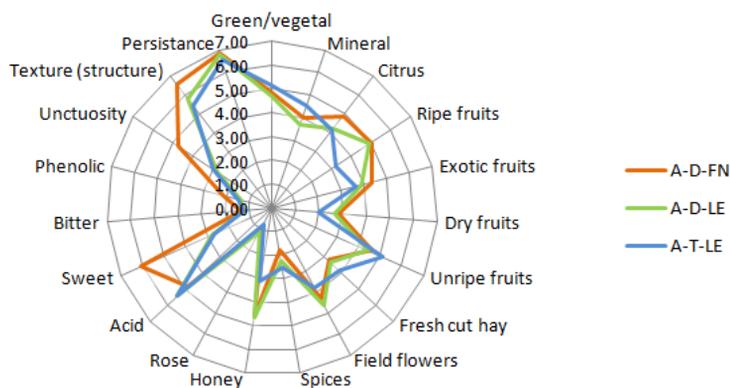


Fig. 1 Comparative Sensory Diagram for Aligoté wines fermented in demijohns and tanks, with selected and spontaneous yeasts

CONCLUSIONS

1. From the point of view of the alcoholic strength, the best ratio of sugar transformation is found in the variant where the inoculum was made with selected yeasts in the tank.

2. The spontaneous flora failed to fully ferment the sugars, the resulting wines being at the limit of the dry and semi-dry compared to the wines obtained with yeast inoculum.

3. As regards total acidity, all the wines obtained have similar values.

4. The type of used yeasts and the greater fermentation capacity allowed obtaining wines with lower volatile acidity values.

5. In the case of fermentating with the yeast brand Levulia Esperide in tanks, the wine has a more pronounced minerality.

6. The wine samples where spontaneous yeast were used, a better specificity of the variety and vineyard was observed.

REFERENCES

1. **Colibaba Cintia, 2010** - *Studii privind optimizarea tehnologiei de obținere a vinurilor aromate în podgoriile Cotnari și Iași*, Teză de doctorat, USAMV Iași.
2. **Cotea V.V., Cotea V.D., 2006** - *Tehnologii de producere a vinurilor*, Ed. Academiei Române.
3. **Cotea, V.D., Sauciuc, J., 1988** - *Tratat de oenologie*, vol. 2, Ed. Ceres, București.
4. **Musteață G., Furtuna N., 2014** - *Similitudini ale analizei senzoriale și olfactive a vinurilor obținute din soiuri de struguri de selecție autohtonă*, Știința Agricolă, no. 1, p. 47-51
5. **Pomohaci N., Stoian V., Gheorghită M., Sirghi C., Cotea V.V., Nămoșanu I., 2000** - *Oenologie. Volumul 1: Prelucrarea strugurilor și producerea vinurilor*. Editura Ceres.
6. **Țârdea C., 2007** - *Chimia și analiza vinului*, Ed. Ion Ionescu de la Brad, Iași.

STUDIES OF THE INFLUENCE OF THE DIFFERENT SELECTED YEAST ON THE AROMATIC COMPOUNDS FROM CIDER

STUDIUL PRIVIND INFLUENȚA DIFERITELOR PREPARATE LEVURIENE FOLOSITE ÎN TEHNOLOGIA DE PRODUCERE A CIDRULUI ASUPRA COMPUȘILOR DE AROMĂ

TUĐOȘE-SANDU-VILLE Ș.,¹ NICULAU M.²,
COLIBABA Cintia¹, ANDRIEȘ M. T.¹, ZAMFIR C.I.²,
LUCHIAN Camelia Elena¹, COTEA V. V.¹
e-mail: andriestibi@yahoo.com

Abstract. Cider is an alcoholic beverage made from the fermented juice of apples and whose production technology does not differ greatly from that of wine. This study wants to identify the influence of selected yeast to aroma compounds from cider. The cider samples were obtained by 110L of apple juice after classic fermentation. It was divided into seven glass containers of 15 liters of juice and subjected to fermentation. It was used seven types of selected yeast: V1-Fermativ Blanc Aromatique Sodinal®, V2-Lalvin Rhone 2056 Yseo Lallemand®, V3-Maurivin AB®, V4-Yseo Cross Evolution Lallemand®, V5-Fermactive Thyol Sodinal®, V6-Afinity ECA5 Levure-Yeast®, V7-Fermactive RBR®. The primary fermentation lasted for two weeks at a constant temperature of 18 ° C. The secondary fermentation happened after bottling. The cider aroma compounds were analysed by gas chromatography. It should be noted that it is not possible to carry out the quantitative analysis of the flavor compounds, so that the areas of the peaks corresponding to the identified compounds were used. It has been studied how the area increases depending on the yeast strains used. The results show a high content of flavor compounds of the group of alcohols, esters and acids in all seven variants. Of all seven variants of levurian preparations, it was noted in the experiment with a high number of aromatic compounds in V3-Maurivin AB®.

Key words: cider, aromatic compounds, selected yeast

Rezumat. Cidrul este o băutură slab alcoolică ce se obține prin fermentarea sucului de mere și a cărei tehnologie de obținere nu diferă foarte mult de cea a vinului. Scopul acestei lucrări este de a identifica influența diferitelor preparate levuriene asupra compușilor de aromă din cidru. Variantele experimentale supuse studiului s-au obținut prin tehnologia clasică de fermentație la sec în damigeană utilizându-se aproximativ 110 L suc de mere pasteurizat, împărțit în mod corespunzător în șapte damigene, a câte 15 L de suc și supus fermentării. S-au utilizat șapte tipuri de levuri selecționate astfel: V1-Fermativ Blanc Aromatique Sodinal®, V2-Lalvin Rhone 2056 Yseo Lallemand®, V3-Maurivin AB®, V4-Yseo Cross Evolution Lallemand®, V5-Fermactive Thyol Sodinal®, V6-Afinity ECA5 Levure-Yeast®, V7-Fermactive RBR®. Fermentația

¹University of Agricultural Sciences and Veterinary Medicine Iasi, Romania

²Research Centre for Oenology, Romanian Academy - Iași, Romania

primară a durat două săptămâni, la temperatura constantă de 18° C. Cidrul obținut după prima fermentație a fost separat de pe drojdii și îmbuteliat, alături de „licoarea de tiraj” pentru declanșarea fermentației secundare. Pentru analiza compușilor de aromă din cele șapte variante experimentale de cidru obținute folosind diferite sușe de levuri selecționate s-a utilizat gaz-cromatografia. Trebuie menționat faptul că nu este posibil să se efectueze analiza cantitativă a compușilor de aromă, astfel că s-au utilizat ariile picurilor corespunzătoare compușilor identificați. S-a studiat cum crește aria în funcție de sușele de levuri folosite. Rezultatele obținute indică un conținut ridicat de compuși de aromă din grupa alcoolilor, esteri și acizi în toate cele șapte variante. Din toate cele șapte variante de preparate levuriene s-a remarcat în urma experimentului efectuat cu un număr ridicat de compuși aromați, V3-Maurivin AB®.

Cuvinte cheie: cidru, compuși de aromă, preparate levuriene

INTRODUCTION

Native from France, cider is known as an alcoholic drink made from apples. In France, about 2 million hectoliters are produced annually of which half is marketed. The main French regions producing cider are: Normandy, Brittany, the Land of the Loire, the Basque Country etc. (Lagrang, 1995). In order to obtain cider, it is preferable to use apple varieties with a lower sugar content, which at maturity have a dense pulp and a tawny taste (Delambre, 2001). From apples harvested with low quantity of sugars or fallen, a cider with lower sensory and quality properties will be made. Therefore, raw material preparation operations are important because the quality of the raw material influence on the quality characteristics of the final product - the cider (Lagrang, 1995).

It should be noted that the fermentation of the apple juice is done immediately after clarification and filtration and it is recommended that the alcoholic fermentation be carried out with the selected yeast (Stănculescu, 1973). The rate of fermentation of sugars depends on the characteristics of yeast strains, the amount of inoculum, the physiological state of the culture, the concentration in the wort extract and its composition, the fermentation temperature, the pressure, the shape of the container (Hough, 1995).

Saccharomyces cerevisiae is known as *Saccharomyces cerevisiae* variety ellipsoideus or *Saccharomyces elipsoideus* and is the most important yeast for fermentation of musts. Yeasts of this species have an ellipsoidal shape, but globular or elongated cells can also be encountered. The yeasts have a high yield, averaging 1 ml of pure alcohol from 17 g of sugars (Cotea, 1985). The fermentation temperature should be between 15 and 18 °C, but it is preferable that after the start of the fermentation, the temperature should be lower at 10-12 °C. A low fermentation temperature has the following advantages: flavors do not volatilize, some of the harmful microorganisms work harder and the cider obtained will be finer, more "silky" (Neacșu *et. al.*, 2012).

These flavors are mostly attributed to classes of compounds such as higher alcohols, aldehydes, ethyl esters of fatty acids, fatty acids, ketones, monoterpenes and volatile phenols (Andujar-Ortiz *et. al.*, 2009).

MATERIAL AND METHOD

The purpose of this study was to obtain data on aromatic compounds composition from cider obtained from apples using different selected yeast. The raw material was 110L of apple juice harvested in 2017.

The apple juice was divided into seven glass containers of 15 liters of juice (tab. 1) and subjected to fermentation.

Table 1

The main compositional characteristics of apple juice used to obtain experimental variants of cider

Compositional characteristics	Value
Sugar (g/L)	142.6
Total acidity (g/L malic acid)	3.35
pH	2.6
Density (g/cm ³)	1.062
Malic acid (mg/L)	2.57
Glucose (g/L)	36.2

In every glass container was introduced a selected yeast: V1-Fermativ Blanc Aromatique Sodinal[®], V2-Lalvin Rhone 2056 Yseo Lallemand[®], V3-Maurivin AB[®], V4-Yseo Cross Evolution Lallemand[®], V5-Yseo Cross Evolution Lallemand[®], V6-Fermactive Thyol Sodinal[®], V7- Afinity ECA5 Levure-Yeast[®] (tab. 2).

Table 2

Quantity and selected yeast used to samples

Sample	Selected yeast	Quantity (g/15L)
V1	Fermativ Blanc Aromatique Sodinal [®]	2.25
V2	Lalvin Rhone 2056 Yseo Lallemand [®]	4.80
V3	Maurivin AB [®]	4.50
V4	Yseo Cross Evolution Lallemand [®]	3.75
V5	Fermactive Thyol Sodinal [®]	2.25
V6	Afinity ECA5 Levure-Yeast [®]	6
V7	Fermactive RBR [®]	2.25

In this mode we was obtained seven samples of cider. The primary fermentation lasted for two weeks at a constant temperature of 18 °C. After completion of the alcoholic fermentation, the cider was separated from yeast and then was bottling. For secondary fermentation which was happened in bottle we used same selected yeast which used to primary fermentation.

For each sample taken after filtration and decarbonation of the sample, physicochemical analyzes (***)2015), determination of flavor compounds were performed. The aromatic compounds in these ciders were identified using the Shimadzu GC-2010 equipment coupled with the QP2010 Plus spectrophotometer.

RESULTS AND DISCUSSIONS

Even if apples juice intended for cider had homogeneous composition characteristics, the composition of the cider is different due to the different yeast used.

Product analyzes were performed after primary fermentation before bottling and after the second fermentation. The main physical-chemical parameters of the analyzed ciders samples are shown in table 3.

Table 3

The main compositional characteristics of experimental cider variants after the second fermentation

Sample	Total acidity (g/L malic acid)	Volatile acidity (g/L acid acetic)	pH	Density ρ_{20}^{20}	Alcoholic strength (%vol.)	Sugar (g/L)
V ₁	1.97	0.51	4.2	0.9961	7.53	1.91
V ₂	1.91	0.49	4.1	0.995	7.23	4.05
V ₃	1.71	0.48	4.1	0.9951	7.92	4.15
V ₄	1.87	0.48	4.1	0.9963	8.11	4.22
V ₅	2.22	0.54	4.1	0.9961	6.97	3.5
V ₆	1.59	0.42	4.2	0.995	7.1	4.19
V ₇	2.54	0.39	4.2	0.9999	7.66	3.8

Once the volatile compounds was extracted, they was analyzed by gaz-chromatography. The cromaptographic system is composed by an injector, a column inside an oven and a detector. An acquisition system collects the information that arrives to the detector. The simple mode to identify volatile compounds is comparing retention times of the interest peaks with those of pure standard compounds. All analysis was performed in duplicate. Resulted of volatile compounds are presented in table 4.

Table 4

The volatile compounds identified in cider samples

Identified compound		
Acids	Alcohol	Esters
acetic acid	ethyl alcohol	isoamyl acetate
hexanoic acid	isobutanol	ethyl caprylate
octanoic acid	4-methyl 2-pentanol	ethyl caprate
n-decanoic acid	3-methyl-1-butanol	3-methylbutyl octanoate
lauric acid	phenylethyl alcohol	ethyl myristate
heptanoic acid	2-methyl 1- propanol	ethyl palmitate
	1-hexanol	hexyl acetate
	2-hexanol	9-ethyl <i>decanoate</i>
	1-octanol	ethyl hexanoate
	1-decanol	ethyl stearate
	benzenetanol	

Cider esters have formed both during fermentation and during storage. At temperatures of 10 °C, it is possible to develop esters that will impress the product fructose, and at temperatures of 15 °C there may appear those that give smells of sweet, waxy. Isoamyl acetate is found in all seven experimental samples, but predominantly V3 variant, giving them a pleasant smell of bananas, sweet fruits, pears, being highly fragrant. Ethyl caprylate was identified in most samples

(except variants V4 and V6). These will have a fruity odor, apricot, banana, pear, and sometimes it can develop a smell of wine, cognac or even wax. The ethyl caprate present in all seven cider samples makes them smell of grapes, apples and in some cases they can develop odors that can be associated with cognac or wax scents. The presence of octanoate 3-methylbutylester in most samples except for the V5-Fermactiv Thyol Sodinal® sample and a high concentration in V3 indicates that they will have a sweet green fruit smell, but there will also be notes of pineapple and coconut. Ethyl palmitate found in six samples except sample V3. It gives a less pleasant smell of soap, lard or tallow, with a weak dairy taste, if the perception threshold is exceeded. The occurrence of these substances in cider, as is the case with ethyl palmitate, should be avoided as far as possible, as they lead to its qualitative impairment. Hexyl acetate present only in samples obtained with Lalvin Rhone 2056 Yseo Lallemand® and Maurivin AB® strains gives rise to a fresh, apple, pear, and sweet taste of banana peel. Ethanol hexanoate is present only when the Maurivin AB® variant is used and indicates that fruit flavors, pineapples, sometimes with green banana shades may develop.

Alcohol 3-methyl-1-butanol, which gives a pleasant smell, is found in a high proportion in the variety of Maurivin AB® yeast strain. The high amounts of phenylethyl alcohol present in the experimental variants, except for the fermented RBR® variant, give them a floral, fresh honey odor. The hexanol present in the variants used with AB®, Fermactiv Thyol®, Afinity ECA5 Levure-Yeast® and Fermactiv RBR® results in a fruity odor but also in a light cauliflower. The 1-octanol present only in samples V3 and V7 gives the cider an odor of freshly cut grass, melon with a slightly spicy tinge and a slightly green, fruity taste.

The 1-decanol present only in the last sample has the property of giving it a floral, sweet, orange odor.

Acetic acid, present in all cider samples, leads to increased volatile acidity and imparts a gentle odor and an unpleasant taste. This is found in the largest quantity in the sample where the yeast used was Afinity ECA5 Levure-Yeast®, the content of this sample in acetic acid being at least 10 times higher than most samples. The presence of hexanoic acid in experimental variants, with the exception of variant V3, may lead, if the acidity of this acid increases, to flavorings of sour, if the values of this acid would exceed the perception threshold. Along with octanoic acid, n-decanoic acid may also contribute to the formation of odors, which may lead to unpleasant, sour, odorous odors if the perception threshold is exceeded. This acid is found in the largest quantity in the sample using the yeast strain Lalvin Rhone 2056 Yseo Lallemand®.

Lauric acid, present only in four of the seven samples, gives rise to a bacon flavor of coconut.

Heptanoic acid, found in Maurivin AB® and Yseo Cross Evolution Lallemand® seedlings, gives them sweet, fruity, pineapple flavors.

CONCLUSIONS

The present paper presents the influences of different yeast strains selected on the aroma content of the seven variants of cider obtained in the U.S.A.M.V. Oenology Laboratory of Iași Romania and the determination of their compositional characteristics.

Following the results, we can conclude that:

Although the same raw material was used to obtain the seven variants of cider, some of the results obtained from the physico-chemical analyzes show wide variations, as in the case of the alcoholic concentration which varied after the secondary fermentation from 7.1 to 8.23 vol. alcohol. These differences are given by yeast strains used for fermentation. The most extractive cider variants are those obtained with Yseo Cross Evolution Lallemand® yeasts (V4) and Fermactiv RBR® (V7), from which they result that they have a large amount of glycerol among other non-reducing compounds, the cider being (for variant V4, the total extract and the non-reducing extract are 19.3 g / L and 15.08 g / L respectively), while variant V7 records values of 27.1 g / L and 23.3 g / L).

Following the application of the gas-chromatographic method on cider samples, one can notice that the predominant flavor of these is fruit (especially apples, pears) and floral. The esters identified in the experimental samples impart to them fruity hues, the most important of which is isoamyl acetate which is found in all samples in high quantities, and in particular gives the aroma of bananas, pears, apricots.

From the structure point of view, the V3- Maurivin AB® variant presents the highest values of volatile compounds, resulting in the best balance of the existing components, which gives the product higher quality than the rest of the obtained variants.

This study can be further explored by using other levurian species (possibly isolated from Romania) or by modifying the technological process including other fruits along with apples. It has also been proposed to use other apple varieties that can confer higher acidity or other aromatic profile.

REFERENCES

1. **Andujar-Ortiz et. al., 2009** - *Analytical performance of three commonly used extraction methods for the gas chromatography-mass spectrometry analysis of wine volatile compounds*. Journal of Chromatography A, Volume 1216, Pages 7351-7357.
2. **Cotea V. V., 1985** - *Tratat de enologie*. Editura Ceres, București.
3. **Delandre M., 2001** - *Vinul și cidrul*. Editura Alex-Alex, București.
4. **Lagrang L., 1995** - *La comercialisation des produits agricoles et alimentaires*. Editura Lavoisier.
5. **Neacșu I. et. al., 2012** - *Oenologie*. Editura Academiei Române, București.
6. **Stănculescu Gh., 1973** - *Fabricarea băuturilor alcoolice naturale*. Editura Tehnică, București.
7. ***** 2015** - *Recueil des méthodes internationales d'analyse des vins et de moûts*. Office International de la Vigne et du Vin, Édition Officielle, juin, Paris.

THE STUDY OF BIOLOGICAL CONTROL OF ONION THRIPS IN PEPPER

STUDIUL COMBATERII BIOLOGICE A TRIPSULUI COMUN LA ARDEI

**CĂLIN Maria¹, CRISTEA Tina Oana¹, AMBARUS Silvica¹, BREZEANU
Creola¹, BREZEANU P. M.¹, MUSCALU S. P.¹, PRISECARU Maria²,
COSTACHE M.³, ȘOVAREL Gabriela³, BRATU Liliana³**

e-mail: sclbac@legumebac.ro

Abstract. *The trials of trips attack and ecological control of pests were performed at Vegetable Research and Development Station Bacau – Romania, during 2016 - 2017. The dynamic of trips attack in pepper and effectiveness of *Amblyseius swirskii* At.-H. (Arachnida, Mesostigmata, Phytoseiidae) releases in control of onion trips at pepper collection of cultivars in tunnels was studied. The trial of *A. swirskii* in trips control was performed at the following release rates: V1 – 500,000 mites/ha; V2 – 700,000 mites/ha; V3 – 900,000 mites/ha; V4. 1 million mites/ha; V5 - Control. On observed that the reducing trips degree attack by release of *A. swirskii* at pepper is effective in August - September using the release rates between 700,000 ex /ha - 1,000,000 ex / ha.*

Key words: thrips, attack, pepper, biological control, *Amblyseius swirskii*

Rezumat. *În perioada 2016 - 2017 s-au efectuat studii privind atacul și controlul ecologic al tripsului comun la Stațiunea de Cercetare - Dezvoltare pentru Legumicultura Bacău - România. S-a monitorizat dinamica atacului de trips la ardei și s-a studiat eficacitatea prădătorului *Amblyseius swirskii* At.-H. în controlul tripsului comun într-o colecție cu soiuri de ardei cultivate în solarii. S-a efectuat studiul prădătorului *A. swirskii* în combaterea tripsului comun pentru următoarele rate de lansare: V1 - 500.000 prădători / ha; V2 - 700.000 ex. / ha; V3 - 900.000 ex. / ha; V4. 1 milion de ex. / ha; V5 - Control. Lansarea prădătorului *A. swirskii* la ardei a fost eficientă în august - septembrie, utilizând rate de lansare între 700.000 ex / ha și 1.000.000 ex / ha.*

Cuvinte cheie: trips, atac, ardei, combatere biologică, *Amblyseius swieskii*

INTRODUCTION

Onion trips - *Thrips tabaci* Lind. is a cosmopolitan insect. It feed on a wide variety of vegetable and flower plants, small grains, field crops and weeds. It causes damage to plants by feeding adults and larvae. He is vector specie for the following viruses: *Iris yellow spot virus*, *Strawberry necrotic shock virus*, *Tobacco streak virus*, *Tomato spotted wilt virus*. It is an important pest of pepper and bean in tunnels and green houses.

¹Vegetable Research and Development Station Bacau, Romania

²“Vasile Alecsandri” University Bacau, Romania

³Vegetable and Flower Research and Development Institute Vidra, Romania

Amblyseius swirskii At.-H. (Arachnida, Mesostigmata, Phytoseiidae) is a beneficial predatory mite for onion trips. It is natives in: Israel, Italy, Cyprus, Greece and Egypt. Here it can be found on crops like apples, apricot, citrus, vegetables and cotton. This predator, feeds pest species as *Bemisia tabaci*, *Trialeurodes vaporariorum*, *Frankliniella occidentalis* or pollen and plant exudates (EPPO, 2013).

It was first released in 1983 in North America for control of citrus pests in California. Since 2005, it was used as biological control agent of mites, trips and whiteflies in greenhouse and nursery crops. Now is currently reared and sold commercially in Austria, Belarus, Belgium, Denmark, Finland, France, Germany, Greece, Guernsey, Hungary, Israel, Italy, Jersey, Morocco, Netherlands, Norway, Poland, Spain, Turkey, UK, USA, China, Japan, Argentina, etc. (Arthurs *et al.*, 2009; Cedola and Polack, 2011; EPPO, 2013; Kade *et al.*, 2011; Sato and Mochizuki, 2011; Chen *et al.*, 2011).

Amblyseius swirskii is used to control trips in greenhouse vegetables (cucumber, pepper and eggplant) and some ornamental crops (Buitenhuis *et al.*, 2010; Messelink *et al.*, 2006). *Amblyseius swirskii* is not susceptible to diapauses and it can be used in periods with temperatures that exceed 22°C. The mites are released directly in the crops in bran or vermiculite carriers sprinkled on the leaves or substrates, or may be broadcast via air blast (Buitenhuis *et al.*, 2010; Opit *et al.*, 2005). The release rates are 25 - 100 mites per m² depending on pest species, pest density, and crop. The effectiveness of *Amblyseius swirskii* as a biological control agent may be reduced when multiple pest species are present (Kumar *et al.*, 2016). Another research showed that predator provided better control on the foliage of pepper plants, compared with the flowers. Similar results obtained and Kakkar *et al.*, 2016 in cucumber crops, where *Amblyseius swirskii* fed preferentially and control melon trips on leaves, but didn't provide effective control of common blossom trips from cucumber flowers.

MATERIAL AND METHOD

During 2016 – 2017 period, tunnels experiments were performed in Vegetable Research-Development Station Bacau - Romania, in order to evaluate the biological control of onion trips attack in peppers.

The effectiveness of *A. swirskii* in control of *Thrips tabaci* Lind., was studied in pepper collection of cultivars, in tunnels. When the degree attack of trips exceeded the economic threshold of damage, the predatory mites were released in the 4 variants. The trial was accomplished during summer and early autumn period. The maximum day temperature was between 28-32°C with peaks up to 40°C.

The trial of *A. swirskii* in trips control was performed at the following release rates:

- V1 – 500,000 mites/ha;
- V2 – 700,000 mites/ha;
- V3 – 900,000 mites/ha;
- V4 - 1 million mites/ha;
- V5 - Control.

Each variant area had 45 square meters.

The effectiveness of predator releases was determined by decadal observations of the attack on the plant and monitoring the pest population of onion trips.

The observations were accomplished every 10 days in August and September.

The attack estimation was determined using the following indicators:

- Frequency of attack (F%),
- Intensity of attack (I%),
- Degree of attack (DA%).

The effectiveness processing of *A. swirskii* in trips control was performed by the Sun - Shepard method.

The obtained results will be used in integrated pest management control in organic agriculture in order to increase the ecological pest control practices in vegetables.

RESULTS AND DISCUSSIONS

The dynamic of degree attack of pests in release rate variants at pepper is presented in table 1 and fig. 1.

Table 1

Degree attack of *Thrips tabaci* at pepper plant

No.	Release rate (mites - ex/ha)	Degree attack (%) in month and decade					
		August			September		
		1	2	3	1	2	3
2016							
V1	500000	15.4	11.2	6.2	3.5	3.1	1.5
V2	700000	17.2	10.1	4.9	3.5	2.9	1.5
V3	900000	13.5	9.8	4.7	3.4	3.0	1.3
V4	1000000	14.9	9.1	4.7	3.1	2.8	1.4
V5	Control	12.4	15.2	20.4	25.1	23.3	18.5
2017							
V1	500000	2.1	2.0	2.4	2.8	2.1	2.1
V2	700000	1.6	1.5	1.7	2.4	2.0	2.0
V3	900000	1.3	1.3	1.6	2.1	2.1	2.1
V4	1000000	1.9	1.6	1.8	2.3	1.9	1.9
V5	Control	1.8	1.7	2.1	2.8	3.1	4.5

The presented results show a different effectiveness of different release rate of *A. swirskii* in reducing the trips attack. In 2016 in first variant, the degree of onion trips attack was reduced from 15.4% in the first decade of August to 1.5% in the third decade of September. Increasing of mite predator release rate at 700,000 ex./ha, had a powerful downward dynamic during the last decades of August and first decades of September.

The release rate of *A. swirski* with 900 thousand and one million ex./ha decreased the degree attack of onion trips at 1.3% in V3 and 1.4% in V4. These

results were obtained in the conditions of upward dynamic of trips degree attack in control variant (25.1% until the first decade of September).

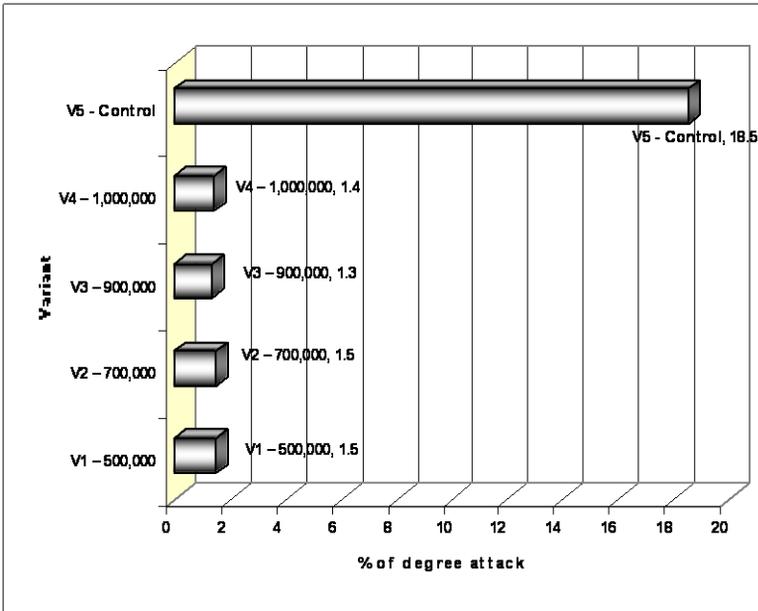


Fig. 1 The degree attack (%) of onion trips in last decade of September 2016

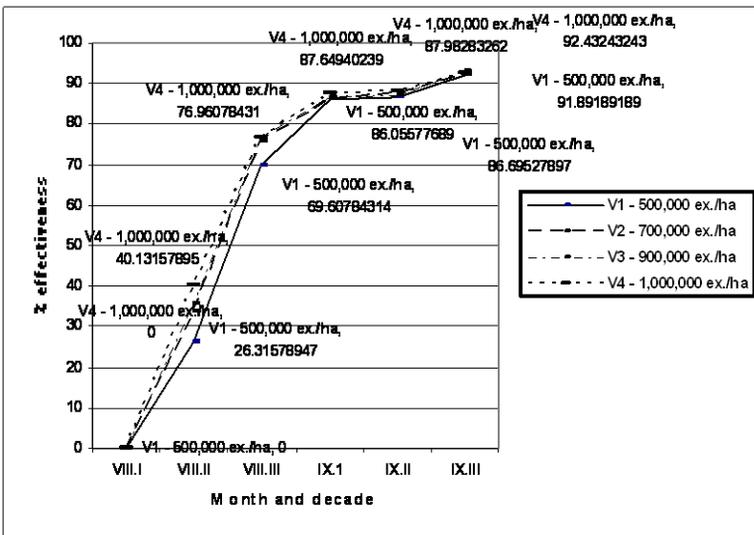


Fig. 2 Effectiveness of *A. swirski* releases for the control of onion trips at pepper in 2016

The effectiveness of different release rates (fig. 1) were:

- V1, 26.3% in second decade of August; 69.6% in third decade of August; 86.1% in first decade of September; 86.7% in second decade of September and 91.9% in last decade of September.
- V2, 33.5% in second decade of August; 75.9% in third decade of August; 86.1% in first decade of September; 87.6% in second decade of September and 91.8% in last decade of September.
- V3, 35.5% in second decade of August; 76.9% in third decade of August; 86.4% in first decade of September; 87.1% in second decade of September and 92.9% in last decade of September.
- V4, 40.1% in second decade of August; 76.9% in third decade of August; 87.6% in first decade of September; 87.9% in second decade of September and 92.4% in last decade of September.

The presented data show that reducing trips degree attack by release of *A. swirskii* at pepper is effective in August - September using the release rates between 700,000 ex /ha - 1,000,000 ex/ ha.

In 2017 the trips attack was reduced (below 2.1%). In these conditions the *A. swieski* release were accomplished during the first decade of September. All variants of releases had a very good efficacy, being over 95% (Fig. 3).

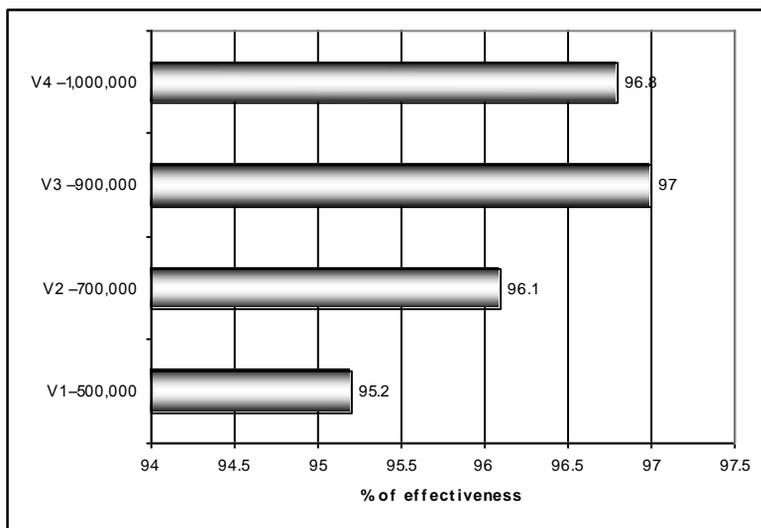


Fig. 3 Effectiveness of *A. swirski* releases in control of onion trips at pepper in 2017

CONCLUSIONS

In 2016 in first variant with *A. swirskii* release, the degree of onion trips attack was reduced from 15.4% in the first decade of August to 1.5% in the third decade of September. Increasing of mite predator release rate at 700,000 ex. /ha, had a powerful downward dynamic during the last decades of August and first

decades of September. The release rate of *A. swirski* with 900 thousand and one million ex./ha decreased the degree attack of onion trips at 1.3% in V3 and 1.4% in V4.

The effectiveness of different release rates were: V1, 91.9% in last decade of September; V2, 91.8% in last decade of September; V3, 92.9% in last decade of September; V4, 92.4% in last decade of September. The obtained data show that reducing trips degree attack by release of *A. swirskii* at pepper is effective in August - September using the release rates between 700,000 ex /ha - 1,000,000 ex/ ha.

In 2017 the trips attack was reduced (below 2.1%). In these conditions the *A. swieski* releases were accomplished during the first decade of September. All variants of releases had a very good efficacy, being over 95%

REFERENCES

1. **Arthurs S, Mckenzie CI, Chen J, Dođramaci M, Brennan M, Houben K, Osborne L., 2009** - *Evaluation of Neoseiulus cucumeris and Amblyseius swirskii (Acari: Phytoseiidae) as biological control agents of chilli thrips, Scirtothrips dorsalis (Thysanoptera: Thripidae) on pepper.* Biological Control 49, p. 91-96.
2. **Buitenhuis R, Shipp L, Scott-Dupree C., 2010** - *Dispersal of Amblyseius swirskii Athias-Henriot (Acari: Phytoseiidae) on potted greenhouse chrysanthemum.* Biological Control 52, p. 110-114.
3. **Cedola C, Polack A., 2011** - *First record of Amblyseius swirskii (Acari: Phytoseiidae) from Argentina.* Revista de la Sociedad Entomologica Argentina 70, p. 375-378.
4. **Chen X, Zhang Y, Ji J, Lin J., 2011** - *Experimental life table for population of Amblyseius swirskii (Athias-Henriot) fed on Tetranychus truncatus (Ehara).* Fujian Journal of Agricultural Sciences 3, p. 018.
5. **EPPO (European and Mediterranean Plant Protection Organization), 2013** - *Commercially used biological control agents - Arachnida, Acarina.*
6. **Kade N, Gueye-Ndiaye A, Duverney, C, Moraes G. J., 2011** - *Phytoseiid mites (Acari: Phytoseiidae) from Senegal.* Acarologia 51, p. 133-138.
7. **Kakkar G, Kumar V, Seal Dr, Liburd Oe, Stansly P., 2016** - *Predation by Neoseiulus cucumeris and Amblyseius swirskii on Thrips palmi and Frankliniella schultzei on cucumber.* Biological Control 92, p. 85-91.
8. **Kumar V, Mckenzie CI, Avery Pb, Osborne L., 2016** - *Ornamental pepper banker plants: Can we bank on them?* Pest Management Science (in press)
9. **Messelink G.J, Van Steenpaal Sef, Ramakers Mj., 2006** - *Evaluation of phytoseiid predators for control of western flower thrips on greenhouse cucumber.* Biocontrol; 51(5), p.753-768.
10. **Opit, G.P., Nechols, J.R., Margolies, D.C. & Williams, K.A., 2005** - *Survival, horizontal distribution, and economics of releasing predatory mites (Acari: Phytoseiidae) using mechanical blowers.* Biological Control 33, p. 344-351.
11. **Sato Y, Mochizuki A., 2011** - *Risk assessment of non-target effects caused by releasing two exotic phytoseiid mites in Japan: can an indigenous psytoseiid mite become IG prey?* Experimental and Applied Acarology 54, p. 319-329.

USING OF TRICHODERMA SPP. (*TRICHODERMA HARZIANUM* AND *TRICHODERMA KONINGII*) AND ITS EXTRACT TO CONTROL PATHOGENIC FUNGI IN THE SOIL IN VITRO

UTILIZAREA TRICHODERMA SPP. (*TRICHODERMA HARZIANUM* ȘI *TRICHODERMA KONINGII*) ȘI EXTRACTUL ACESTEIA PENTRU INHIBAREA CIUPERCILOR PATOGENICE DIN SOLUL IN VITRO

RADHI M.N.¹, CONSTANTINESCU Flori², ANDREI Ana Maria²,
SHALLAL Hadi Hoobi¹, ROȘCA I.¹
e-mail: mradhi84@yahoo.com

Abstract. *The present study was designed to investigate the effect of Trichoderma harzianum and Trichoderma Koningii on pathogenic fungi such as Fusarium oxysporum, Rhizoctonia solani and Pythium sp. The results of the study showed the ability of fungi Trichoderma harzianum and Trichoderma koningii on the inhibition of pathogenic fungi Fusarium oxysporum, Rhizoctonia solani and Pythium sp. in medium PDA as well as the viability of bio-fungi on production of the enzymes cellulase, chitinase and amylase and dissolve phosphorus in the medium, also these fungi have effect on the growth indicators on tomato plant.*

Key words: *Trichoderma harzianum, Trichoderma koningii, enzymes*

Rezumat: *Prezentul studiu a fost conceput pentru a investiga efectul Trichoderma harzianum și Trichoderma koningii asupra ciupercilor patogene cum ar fi Fusarium oxysporum, Rhizoctonia solani și Pythium sp. Rezultatele studiului au arătat capacitatea fungilor Trichoderma harzianum și Trichoderma Koningii asupra inhibării fungilor patogeni Fusarium oxysporum, Rhizoctonia solani și Pythium sp. în mediu PDA, precum și viabilitatea bio-fungilor la producerea enzimelor celulază, chitinază și amilază și dizolvarea fosforului în mediu, de asemenea, aceste ciuperci au efect asupra indicatorilor de creștere pe planta de tomate.*

Cuvinte cheie: *Trichoderma harzianum, Trichoderma koningii, enzime*

INTRODUCTION

In the context of specialization and high concentration of protective measures plant in order to stabilize or increase agricultural production, a key factor in obtaining high yields and guaranteed crop, keeping their quality seems high efficiency and versatility chemical methods of plant protection rapid return to traditional farming, organic seems to be the dominant system of safeguards that will be applied. *Trichoderma* species are the most common species of fungal used as biological control agents and are as commercial as biofungicide, biofertilizers

¹University of Agronomical Sciences and Veterinary Medicine Bucharest, Romania

²Research and Development Institute for Plant Protection, Bucharest, Romania

and soil, to activate the system resistance induced in plants by treatments with preparations fungal (Jin *et al.* 1991; Inbar and Chet, 1992; Paulitz, 1997). It is considered that involves several mechanisms (Micoparazitismul; antibiosis, competition for space and nutrients, stress tolerance caused by increased development of roots and plant; Leaching and retention of inorganic nutrients, resistance induced; inactivation of enzymes patogenulicare make species of *Trichoderma* agents biocontrol very efficient. It has an important activity fitostimulare nutrition. Most separates of the sort *Trichoderma* that were found to go about as mycoparasites of numerous financially essential ethereal and soil-borne plant pathogens, have been delegated *Trichoderma harzianum* Rifai (Gams and Meyer, 1998). The aim of this study to know the effect of *Trichoderma* spp and its filtrates on controlling pathogenic fungi in the soil.

MATERIAL AND METHOD

Antagonism tests antithesis between strains pathogenic fungus and bio fungus *T.harzianum* and *T.Koningii*. According to the method of Bell *et al.* (1982). Cellular enzymatic activity in solid cultural mediums cellulase enzyme adopted the method described by (Reese and Mandels, 1963) and (Yeoh *et al.*, 1985). While amylase enzyme activity was detected by the method of (Hankin and Anagnostakis, 1975) and Chitinase detection was measured according to (Agrawal and Kotasthane, 2012). Screening of *T.harzianum* and *T.koningii* isolates for phosphate solubilization two fungal isolates were screened for their *in vitro* phosphate solubilizing potential in solid medium according to (Nautiyal, 1999). Fermentation assay method, the fermentation of *T.harzianum* and *T.Koningii* adopted by the method of (Tayung *et al.*, 2011). Effect of *T.harzianum* and *T.Koningii* filtrates sterilized in the growth of pathogenic fungi adopted according to (Matrood, 2015). Prepare a vaccine of fungi, the vaccine of fungus *Trichoderma* was prepared depending on (Papavizas *et al.*, 1982), *Pythium* was prepared according to (Pratt and Janke, 1980), *F.oxysporum* and *R.solani*. prepared depending on (Dewan, 1989). The effect of fungi *T.harzianum* and *T.Koningii* and their filtrates on pathogenic fungi on tomato plant in pots in the laboratory, take the peat moss then sterilized with $\text{Ca}_3(\text{PO}_4)_2$ (1g per 1Kg), then placed in sterilized pots. Add the fungal vaccine of the millet seeds, yellow corn flour into the soil by 1% w/w was mix well with the soil. Add the vaccine fungal bran into the soil after 5 days of fungi from the addition to vaccine pathogenic with ratio 1% w / w and mixing well, also irrigated pots daily for three days after that planted the seeds of tomato by five seeds per pot and put in a growth chamber at 28 °C after 10 days calculated the percentage of germination and after 20 days calculated the proportion of seedling death and after 50 days were measured growth indicators and estimate the proportion of phosphorus and chlorophyll in the leaves, where the treatments are as following; T.h. = *Trichoderma harzianum*, T.K. = *Trichoderma koningii*, ex T.h. = extract of *Trichoderma harzianum*, ex T.k. = extract of *Trichoderma koningii*, F.oxo = *Fusarium oxysporum*, R.solani = *Rhizoctonia solani*. The studied growth indicators, the ratio of germination and seedling death calculated by using (Mickenny, 1923) equation contained in AL-Waily (1988). The severity of the infection were calculated according to the following scale: 0=no infection, 1= slight infection, 2= mild infection 3= severe infection, 4=very severe infection. The growth indicators were calculated after 50 days after planting. Determination of Phosphor and Chlorophyll, phosphorus was estimated depending on

Cresser and Parsons (1979) and Murphy and Riley (1962). To determine the individual levels of both chlorophyll a (Ca) and chlorophyll b (Cb) and the total amounts of carotenoids (C x+c) and chlorophylls (Ca+ Cb) [in pg.(ml of plant extract)-1] the measured absorbance values (A) at different wavelengths: (Smith and Benitez, 1955).

RESULTS AND DISCUSSIONS

The results of antagonism tests show that (fig. 1), that the fungi *T.harzianum* and *T.koningii* have a high antagonism ability against the pathogen fungi *F.oxysporum* and *Pythium spp.* the antagonistic ratio reached to 1, while against *R.solani* the antagonistic ratio reached to 2 according to the scale of (Bell *et al.*, 1982). These results were similar to previous studies (Tran, 1998; Ngo *et al.*, 2006) and the reason for this is due to the ease of isolation and the speed of its growth and it does not need to special dietary requirements and the variety of his work mechanisms (Paulitz 1997; Howell *et al* 2000).

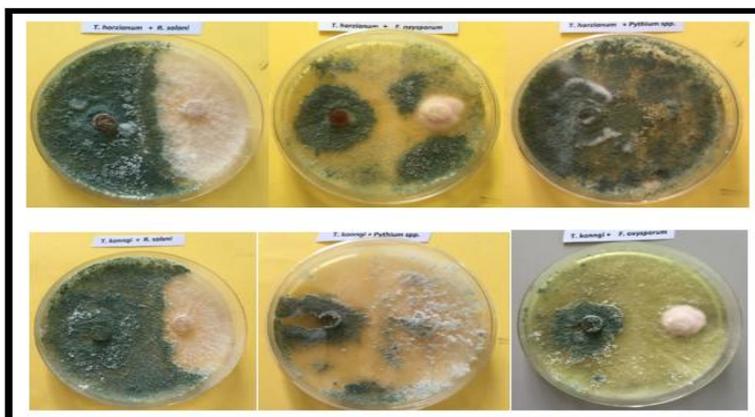


Fig.1 Antagonistic effect of fungi *T.harzianum* and *T.Koningii* on pathogenic fungi *F.oxysporum*, *Pythium* and *R.solani* in PDA medium

The results of enzymatic activity (fig. 2), show that the fungi *T.harzianum* and *T.Koningii* have the ability to production the cellulase enzyme (halo diameter) which reached to 5.75 cm and 6.5cm respectively, while the chitinase 5.25 cm and 6.25 cm respectively, and the amylase production was very low which reached to 1 cm and 0.75 cm respectively. *Trichoderma* species are capable of producing cell wall degrading enzymes such as cellulase, xylanase, pectinase, glucanase, lipase, amylase, arabinase, and protease (Strakowska *et al.* 2014). These enzymes play an important role in cell wall degrading of pathogenic fungi because they contain chitin ,cellulose , clogan and proteins (Lorito *et al.*, 1994; Carsolio *et al.*, 1999). (Sonika Pandey *et al.*, 2015) found that a different types of fungus *Trichoderma* can produce cellulase in a different medium. Figure 1 shows the levels of enzymes in *T.harzianum* and *T.koningii*.

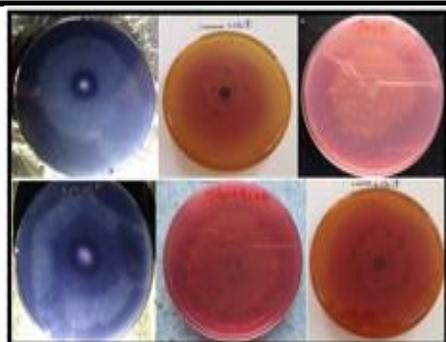


Fig. 2 Production of amylase, cellulase and chitinase in T.h and T.k

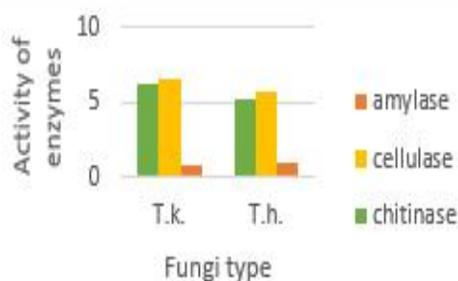


Fig. 3 Levels of amylase, cellulase and chitinase in T.h and T.k

Results in figure 4, show the ability of filtrates types of fungus *T.harzianum* and *T.Koningii* in a different concentrations to inhibit the pathogenic fungi. (Odebode ,2006) confirmed that the filtrates fungal biological control, including the fungus *T. harzianum* and *T. pseudo-koningii* have the ability in inhibiting the growth of many causes pathogenic to plants such as fungus *M. phaseolina* and *Fusarium solani* and *Alternaria sp* and *Aspergillus niger* and efficiently may outweigh the sometimes the efficiency of chemical pesticides (Kredics *et al.*, 2003).

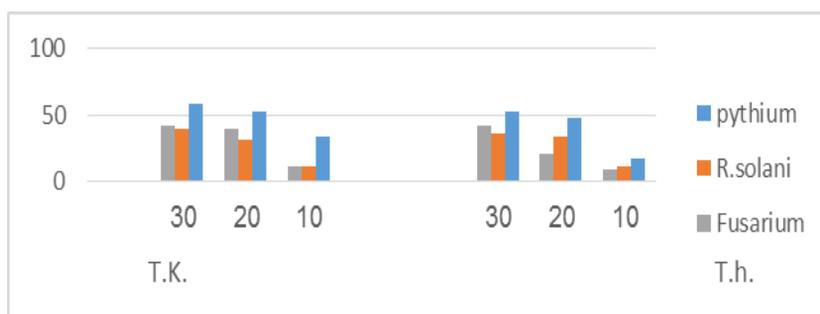


Fig. 4 The inhibition of the pathogenic fungi in a different concentrations of filtrates types of fungus *T.harzianum* and *T.Koningii*

Figure 5 show the results the ability of fungus *T.harzianum* and *T.koningii* in solid medium to dissolve the phosphorus, where the halo diameter was 1.8 cm and 2.5 for fungus *T.harzianum* and *T.Koningii* respectively. (Whitelaw, 2000) noted that the precipitation of phosphorus technology in the solid medium useful in isolating microorganisms are considered one of the successful methods of excellence fungi that have the ability to dissolve phosphorus and tested on the plant, are consistent with a study by (Saravana kumar *et al.*, 2013), which demonstrated the ability of sorts fungus *Trichoderma spp* to form a transparent zone around the colonies, this indicates its ability to dissolve phosphorus.



Fig. 5 Formation a halo by *T.harzianum* and *T.Koningii* in solid medium

Results in the table 1, the effect of *T.harzianum* and *T.Koningii* on pathogenic fungi *F.oxysporum*, *Pythium* and *R.solani* in germination, dead seedlings and the severity of infection in tomato plant. Some studies have confirmed that the fungus *T.harzianum* has a high potential to control a wide range of pathogens, Fungus showed effectiveness in resisting *R.solani* fungus that causes seed rot and seedling death and wilting wheat (Salih and Bidn, 1999) and it work on reducing the proportion and the severity diseases that caused by a fungus *Fusarium spp.* in the roots of plants like wheat, rice, tomato, eggplant, potatoes, split peas (Michalikova and Michrina 1997; Harman 2000).

Table 1

The effect of *T.harzianum* and *T.koningii* on pathogenic fungi *F.oxysporum*, *Pythium* and *R.solani* in germination, dead seedlings and the severity of infection in tomato plant

Treatment	% germination*	% dead seedlings*	% infection severity*
T.h.	93.33	0	0
T.h. +F.oxo	73.33	18.18	15
T.h. + R.solani	66.66	20	25
T.h. + Pythium	66.66	20	12
T.k.	100	0	0
T.k. +F.oxo	80	16.66	17
T.k. + R.solani	66.66	27.27	28
T.k. + Pythium	73.33	20	10
ex T.h.	93.33	0	0
T.h. +F.oxo	73.33	27.27	35
T.h. + R.solani	60	33.33	42
T.h. + Pythium	66.66	30	37
ex T.k.	86.66	0	0
T.k. +F.oxo	73.33	20	34
T.k. + R.solani	66.66	30	40
T.k. + Pythium	66.66	22.22	35
F.oxysporum	66.66	27.27	50
R.solani	53.33	37.5	60
Pythium	60	30	45
control	93.33	0	0
L.S.D _{0.05}	0.35	11.02	4.21

Table 2 has shown the results of plant growth. The role of the fungus *T.harzianum* in the studied plants and increase production growth standards. Also its possibility to production plant hormones such as IAA (Malgorzata *et al.*, 1997; Yadav *et al.*, 2011).

Table 2

The effect of *T.harzianum* and *T.koningii* on pathogenic fungi *F.oxysporum*, *Pythium* and *R.solani* in plant growth indicators, phosphor and chlorophyll in tomato plant.

Treatment	Length of leaf (cm)	width of leaf (cm)	Length of stem (cm)	Length of root (cm)	No. of leaf	No. of leaflets	Dry weight (g)	Soft weight (g)	plant steam's diagram (cm)	Phosphor (mg/Kg)	Chlorophyll [†]		
											C a	C b	C x+c
	The average												
T.h.	16.66	3.33	24.33	13.5	5.33	9.33	2	7.083	0.85	0.46	5.53	2.67	384.07
T.h. +F.ox	12.66	3.08	19.5	9	4.33	7.33	1.033	5.166	0.506	0.41	5.36	2.05	348.08
T.h. + R.solani	10.33	1.83	17	10	4.33	6	0.916	4.916	0.613	0.39	5.11	1.91	351.70
T.h. + Pythium	12	2.83	17.66	11	5.33	6.66	1.233	5.166	0.556	0.34	5.14	2.09	369.56
T.k.	14.33	3.16	27.66	14	6.33	8.33	2.466	11.473	0.79	0.45	5.25	2.84	407.67
T.k. +F.ox	12.5	2.08	19.66	10	5	7.33	1.4	5.056	0.4	0.39	6.31	2.53	423.75
T.k. + R.solani	12	2.66	16.16	11	4	6.33	0.916	6.143	0.5	0.39	5.48	2.26	410.73
T.k. + Pythium	9.66	2.08	15.33	10.5	4.66	5.66	1.123	6.653	0.5	0.29	6.00	2.36	435.52
ex T.h.	12.83	2.83	23.66	11.5	5.66	6.66	0.086	4.066	0.506	0.24	8.87	3.42	585.63
T.h. +F.ox	10.16	2.33	17.66	10	4	5	0.083	3.5	0.496	0.2	5.34	2.09	368.10
T.h. + R.solani	10	2	14	6	3.66	4.33	0.073	2.4	0.313	0.22	6.22	2.53	445.95
T.h. + Pythium	9.66	1.58	16.33	10.5	4.33	6	0.093	5.556	0.55	0.23	5.53	2.23	446.63
ex T.k.	12.16	2.16	20.66	11	5.33	6.66	0.096	4.633	0.706	0.26	8.04	3.00	532.65
T.k. +F.ox	9.33	2	18.66	8	4	7.33	0.073	3.033	0.43	0.21	5.68	2.12	434.33
T.k. + R.solani	7	1.16	10.66	5.5	3	4.66	0.063	2.85	0.33	0.19	5.74	2.25	469.15
T.k. + Pythium	11.33	1.83	16	11	5	8	0.09	5.233	0.626	0.19	4.07	1.78	342.11
F.oxysporum	9	1.83	17	8	4	6.33	0.073	3	0.41	0.11	3.19	1.50	423.20
R.solani	7.66	1.33	11	5.5	2.66	4.33	0.046	2.8	0.203	0.18	6.12	2.51	463.18
Pythium	10.66	2	14.33	9	4	6.66	0.063	3.1	0.513	0.17	2.99	1.34	259.72
Control	14	2.83	23.33	12	4.66	6.333	1.233	4.366	0.716	0.23	6.04	2.57	448.36
L.S.D _{0.05}	2.76	1.22	9.36	3.22	1.00	1.21	0.68	1.65	0.24	0.019	0.95	0.73	9.67

Results in the table 2 also shown the percentage of phosphor. Some fungi such as *T.harzianum* and *Aspergillus higen* and *Penicillium* variable susceptibility to dissolve phosphorus component of organic and mineral sources as this fungus recorded an important role in the inhibition of the growth of pathogens through secreted compounds Siderapheras and a number of organic acids (Vassilev *et al*, 2006). Table 2 also the results of chlorophyll, the fungus biogenic effect in improving growth and biochemical components including total chlorophyll. (Dubova, 2012) reported that the increasing of chlorophyll due to the using of *Trichoderma* on cucumbers and lettuce, also the low level of chlorophyll has been observed in lettuce leaves as a result of live microorganisms preparation use and it causes changes in the chlorophyll *a* and *b* ratio.

CONCLUSIONS

1. This study showed that bio-fungi have the ability to produce enzymes such as cellulase, amylase and chitinase, also they have the ability to dissolve phosphor.
2. The ability of *T.harzianum* and *T.koningii* to inhibit the pathogen fungi through antagonism
3. Protection and improvement of tomato plant pathogenic fungi.

REFERENCES

1. **Agrawal Toshy, Kotasthane Anil S., 2012** - *Chitinolytic assay of indigenous Trichoderma isolates collected from different geographical locations of Chhattisgarh in Central India*. Springer Plus. 1:73.
2. **AL-Waily, D. S. A., 1988** - *Studies of early blight of tomato caused by Alternaria solani*. Master thesis. Agric. College, Unvi. Of Baghdad .76 P.
3. **Bell D. K., Wells C. D., Mirkham C. R., 1982** – *In vitro antagonism of Trichoderma species against six fungal plant pathogens* . Phytopathology .72 : 379-382 .
4. **Carsolio C., Benhamon N., Haran S., Cortes C., Gutierrez A., Chet I., Herrera Estrella A., 1999** - *Role of the Trichoderma harzianum Endochitinase gene, exh 42, in Mycoparasit*. Applied and Environmental Microbiology. 65(3): 929-935.
6. **Cresser M.S., Parsons J.W., 1979** - *Sulphuric perchloric acid digestion of plant material for the determination of Nitrogen, Phosphours, Potassium, Calcium and magnesium* Analytic chemical Acta. 109; 43-436.
7. **Dewan M .M., 1989** - *Identity and frequency of occurrence of fungi in root of wheat and ryegrass and their affection take-all and host growth*. Ph. D. Thesis. Univ. Wes. Australin. 210 pp.
8. **DUBOVA Laila, ALSIA Ina, ŠTEINBERGA Vilhelmine, 2012** - *Comparison of Trichoderma Sp. Use Efficiency on Cucumbers and Lettuce*. Scientific Papers, Series B, Horticulture, Vol. LVI.
9. **Gams W., Meyer W., 1998** - *What exactly is Trichoderma harzianum Rifai?* Mycologia 90: 904-915.
10. **Hankin L., Anagnostakis S.L., 1975** - The use of solid media for detection of enzyme production by fungi. Mycologia 67:597-607.
11. **Harman G.E., 2000** - *Myths and Dogmas of Biological Changes is perceptions derived from research on Trichoderma harzianum strain T.22*. Plant Dis. Report. 84:377-393.
12. **Howell C.R., Hanson L.E., Stipanovic R.D., Puckhaber, 2000** - *Induction of Terpenoid Synthesis in cotton roots and control of Rhizoctonia solani by seed treatment with Trichoderma virens* . Phytopathology 90: 248-252.
13. **Inbar J., Chet I., 1992** - *Biomimics of fungal cell-cell recognition by use of lectin-coated nylon fibers*. J. Bacteriol. 174: 1055-1059.
14. **Jin X., Harman G.E., Taylor A.G., 1991** - *Conidial biomass and desiccation tolerance of Trichoderma harzianum produced at different medium Water potentials* Bio. Control 1: 237-243.
15. **Kredics L., Antal Z., Manczinger L., Szekeres A., Kevei F., Nagy E., 2003** - *Influence of environmental parameter on Trichoderma strain with Biocontrol potential, food Technol. Biotechnol.* 41(1): 37 – 42.
16. **Lorito M., Peterbauer C., Hayes C.K., Harman G.E., 1994** - *Synergistic interaction between fungal cell wall degrading enzymes and different antifungal compounds enhances inhibition of spore germination*. Microbiology. 140: 623-629.
17. **Malgorzatz M., Dorota F., Alekandra P., Hanna D., 1997** - *Promoting effect Trichoderma sp . on cutting growth in biocontrol of Fusarium carnation*. Folia Horticulture Turae, 3- 13.

18. **Matrood Abdulnabi A., 2015** - *Integration to control charcoal rot disease in sunflower that caused by *Macrophomina phaseolina* (Tassi) Goid. PhD thesis.*
19. **Michalikova A., Michrina J., 1997** - *Biological control of *Fusarium root rot* in wheat seedling by *Trichoderma harzianum*. Biological (Slovic republic) V.52 (4). P: 591-598.*
20. **Mickenny H. H., 1923** - *Influence of soil temperature and moisture on infection of wheat seedling by *Helminthosporium sativum*. Agri. Research. 26: 195 – 217.*
21. **Murphy T., Rile J.R.J., 1962** - *A modified singl solution method for the determination of phosphate in natural weters. Anal. Chem. Acta, 27: 31-36.*
22. **Nautiyal C.S., 1999** - *An efficient microbiological growth medium for screening phosphorus solubilizing microorganisms. FEMS Microbiology Letters170, 2017–2021.*
23. **Ngo B. H., Vu D. N., Tran D. Q., 2006** - *Analyze antagonist effects of *Trichoderma spp.* For controlling southern stem rot caused by *Sclerotium rolfsii* on peanut. Plant Protection 1:12-14.*
24. **Odebode A.C., 2006** - *Control of postharvest pathogens of fruits by culture filtrate from antagonistic fungi on *Macrophomina phaseolina* and *Colchicine Contenton* sunflower. Plant Protect. Sci Vol. 48, No. 3: 110–115.*
25. **Papavizas G. C., Lewis J. A., Abd-Elmoity T. H., 1982** - *Evolution of new biotypes of *Trichoderma harzianum* for tolerance to benomyl and enhanced Biocontrol capabilities. Phytopathology. 72: 126-132.*
26. **Paulitz T.C., 1997** - *Biological control of root pathogens in soil less and hydroponic systems. Hort. science 32, 2: 193-197.*
27. **Pratt R.G., Janke G.D., 1980** - *Pathogenicity of three species of *Pythium* to seedlings and mature plants of grains sorghum. Phytopathology. 70: 766- 771.*
28. **Reese E.T., Mandles M., 1963** - *Enzymic hydrolysis of celluloseand its derivatives. In methods in carbohydrat chemistry. Vol.3.R.L. Whisler (ed.) Academic Press, New York, 139-143.*
29. **Salih Yehya Ashour, Mohamed Mohsen Bidn, 1999** - *Chemical and Life resistant to fungus *R. solani* causes the death of seedling in the tomato. Basra Journal of Agricultural Sciences. Volume 12 (1): 3-14.*
30. **Saravanakumar K., Arasu V.S., Kathiresan K., 2013** - *Effect of *Trichoderma* on soil phosphate solubilization and growth improvement of *Avicennia marina*.J Aquatic Botany 104:101–105. Sarhad J. Agric., 2: 253–5.*
31. **Smith J. H. C., Benitez A., 1955** - *Modern Methods of Plant Analysis (Peach, K. and Tracey, M. V., eds.), vol. 4, pp. 142-196, Springer-Verlag,Berlin.*
32. **Sonika Pandey, Mukesh Srivastava, Mohammad Shahid, Vipul Kumar, Anuradha Singh, Shubha Trivedi, Srivastava Y.K., 2015** - **Trichoderma species Cellulases Produced by Solid State Fermentation. Data Mining Genomics Proteomics, 6:2.**
33. **Strakowska J., Błaszczuk L., Chełkowski J., 2014** - *The significance of cellulolytic enzymes produced by *Trichoderma* in opportunistic lifestyle of this fungus. J. Basic Microb. 54(Suppl. 1): S2–13. DOI: 10.1002/jobm.201300821.*
34. **Tayunk K., Barik B.P., Jha D.K, Deka D.C., 2011** - *Identification and Characterization of Antimicrobial Metabolite from an Entophytic Fung: *Fusarium solani* Isolated from Bark of Himalayan Yew. J. Mycosph., 2:203-213.*
35. **Tran T. T., 1998** - *Antagonistic effectiveness of *Trichoderma* against plant fungal pathogens. Plant Protection 4: 35-38.*
36. **Vassilev N., Vassileva M, Nikolaeva I., 2006** - *Simultaneous Psolubilizing and biocontrol activity of microorganisms: potentials and future trends. Appl Microbiol Biotechnol, p 71, p:137–144.*
37. **Whitelaw M. A., 2000** - *Growth promotion of plants inoculated with phosphate solubilizing fungi. Adv. Agron. 69, p:99-151 .*
38. **Yadav J., Verma J. P., Tiwari K. N., 2011** - *Plant growth promoting activities of fungi and their effect on chickpea plant growth. Asian J. Biol. Sci., 4: 291-299.*
39. **Yeoh H.H., Khew E., Lim G., 1985** - *A simple method of screening cellulolytic fungi. Mycologia, 77(1):161-162.*

RESEARCHES ON THE PESTS EVOLUTION IN GRAFTED WATERMELON CROPS

CERCETĂRI PRIVIND EVOLUȚIA DĂUNĂTORILOR ÎN CULTURILE DE PEPENI VERZI ALTOIȚI

SIKAVELIS K.¹, ROȘCA I.¹

e-mail: ioanrosca_usamv@yahoo.com

Abstract. *Grafting, at watermelons, could be used to increase resistance to environmental stress, in order to increase resistance to soil pathogens and pests (nematodes, European mole cricket, wire, white or grey worms), also could reduce, during the vegetation period, the pests attack (aphids, thrips, two-spotted spider mite, seedcorn maggot and mining fly). It is presented the situation of the trade, made by Kileler Plants SRL with grafted seedlings of green melons, grafted vegetables from Greece. Plants obtained from grafted melon seedling have not been attacked by nematodes, and the percentage of plants attacked by European mole cricket, wireworms, white worms and gray worms was lower, less than 0.1% of grafted plants have been destroyed by pests, in respect with 4.8% from non-grafted plants. The pest control technology during the vegetation period, is presented, showing that in the case of grafted plants at least one control treatment may be reduced.*

Key words: watermelons, grafted seedlings, pests

Rezumat. *Altoirea (grafting-ul), la pepenii verzi, poate fi folosit pentru a crește rezistența la factorii de stres de mediu, pentru a obține rezistență la agenții patogeni și dăunători din sol (nematodi, coropișnița, viermii sârmă, viermii albi și buha cenușie), poate reduce, în perioada de vegetație atacul dăunătorilor (afidele, tripsii, păianjenul roșu comun, musca plântuțelor și musca minieră). Este prezentată situația comerțului, realizat de firma Kileler Plants SRL cu răsaduri altoite de pepeni verzi, legume greșate din Grecia. Plantele obținute din răsadurile de pepeni altoiți nu au fost atacate de nematodi iar procentul de plante atacate de coropișnița, viermi sârmă, viermi albi și viermi cenușii a fost mai scăzut, sub 0,1% din plantele altoite au fost distruse de dăunători, față de 4,8% în cazul plantelor nealtoite. Este prezentată tehnologia de control a dăunătorilor în perioada de vegetație arătându-se că în cazul plantelor altoite se poate reduce cel puțin un tratament de combatere.*

Cuvinte cheie: pepeni verzi, răsaduri altoite, dăunători

INTRODUCTION

Melons, considered fruits or vegetables (of some), belong to the *Cucurbitaceae* family, along with the cucumber. In general, they are known as the watermelon (*Citrullus vulgaris*-in Romanian „harbuz, lubeniță or curcubete”) or the cantaloupe with several groups or varieties, [*Cucumis melo cantalupensis*,

¹University of Agronomical Sciences and Veterinary Medicine Bucharest, Romania

Cucumis melo reticulatus and *Benincasa hispida* (melon or Chinese melon)]. Growth in protected or sheltered areas, their culture is affected by diseases and pests. The cultivated and wild watermelon appear to have diverged independently from a common ancestor, possibly *C. ecirrhosus* from Namibia (Dane and Liu, 2007). After Paris H. S., from Research teams-Newe Yaar, quoted by Strauss, (2015) the true ancestor of the modern watermelon is indigenous to northeastern Africa: *Citrullus lanatus* var. *colocynthoides*, known as gurma in Sudan and gurma in Egypt. The first crops and melon consumption were recorded 4,000 years ago, the plant being originally from Iran, India and Africa (Paris, 2015). The first record of interspecific, herbaceous grafting as a yield increase and pest/disease control strategy was for watermelon (*Citrullus lanatus*), using a squash rootstock (*Cucurbita moschata*), reportedly developed by a watermelon farmer in Japan (Tateishi, 1927). Use of grafted seedlings in commercial vegetable production occurred as early as the 1930s in Japan for watermelon grafted on *Lagenaria siceraria* (Oda, 2002). Research on grafting cucumber (*Cucumis sativus*) also started in the late 1920s, but wider commercial applications did not happen until 1960 (Sakata *et al.*, 2008). Main benefits from using grafted watermelon plants are that, in this way, is easier to manage soil-borne diseases such as *Fusarium* wilt (sometimes soil pests) and plant productivity is increasing vigorous root system at grafted plants. Grafting of seedlings has been used for decades in many parts of the world, but adoption of the technique is still limited in many countries, due in part to higher costs of grafted seedlings and the uncertainty of grafting benefits under certain conditions. In Romania, watermelon production has been continued declining since 2013, even in this year, mainly due to late spring frosts, in these conditions, watermelon imports come from Greece (about 40%), the Netherlands, Germany and Turkey in 2016, 280 times as much as exports, according to Eurostat data. It is presented the situation of the trade, made by Kileler Plants SRL with grafted seedlings of green melons, grafted vegetables from Greece. Plants obtained from grafted melon seedling have not been attacked by nematodes, and the percentage of plants attacked by European mole cricket, wireworms, white worms and gray worms was lower, less than 0.1% of grafted plants have been destroyed by pests, in respect with 4.8% from non-grafted plants. The pest control technology during the vegetation period, is presented, showing that in the case of grafted plants at least one control treatment may be reduced.

MATERIAL AND METHOD

It is presented the situation of the trade, made by firm Kileler Plants SRL with grafted seedlings of green melons (fig. 1), grafted vegetables from Greece and results obtained in condition of production, at Dăbuleni. In 2016-2017, from firm Kileler Plants SRL, considering that 2,500 grafted seedlings/ha have been planted (lower than for plants without being grafted where seedling recommended density is 4000-6000 plants/ha), result that the company provided the planting material for 502 ha (from which 456 ha in 2017) (tab. 1). The planting of the grafted seedlings was done

between April 10 and April 30, in the targeted fields, crops being protected in the tunnels (for the first period).

Table 1

The grafted seedlings sold by the firm Kileler Plants SRL in zona Dăbuleni

Companies that marketed	2016	2017	TOTAL
Velbil Trans Srl	50,000	200,000	250,000
Adrilex	15,000	700,000	715,000
Cooperativa Agricola "Gheorghe	30,000	180,000	210,000
Stoica Constantin	20,000	60,000	80,000
TOTAL	115,000	1,140,000	1,255,000

Monthly observations were made, from the planting of seedlings till the harvest time, to 7 farms (**A**-Bileru Nicolae 25 ha, **B**-Ștefănel Robert 10 ha, **C**-Popescu Marinel 3 ha, **D**-Fluerătoru Florin 5 ha, **E**-Țurlacu Daniel 3 ha, **F**-Nucu Andrian 2 ha, Rabbit Cristian 2 ha). The attack of *Fusarium* in the fields (with grafted compared to without grafted plants) has been recorded. The attack of the main diseases and pests was assessed as a scale of 1-5 notes awarded after the percentage of attacked plants (1= 0<1; 2= 1<5; 3=5<10; 4=10<25; 5=25<50). At the end of the vegetation period (at harvest) we weighed, in 4 repetitions, the fruits of 5 plants, referring the total production to the hectare.

RESULTS AND DISCUSSIONS

In Dăbuleni, the area with the largest melon plantations, in Romania, farmers generally only use grafted seedlings, most of them bought, very few and for small areas, produce grafted seedlings, even if the price of a grafted plant of watermelon or yellow is of 2-3 lei. As a curiosity in area of Dăbuleni *Lagenaria siceraria* (synonym *L. vulgaris*), also known by many other names (that include: tigva, in Romania, calabash, bottle gourd, long melon and so on), has become the preferred type of watermelon rootstock, mainly due to its resistance and affinity to the graft is the most used as parent stock. In the rest of watermelon cultivating areas from Romania, interspecific cucumber (*C. maxima* x *C. moschata*) is used for high plant vigor, higher resistance to disease, and higher tolerance to abiotic stress factors (cold, heat and salinity). The farmers ordered at firm when and which kind of grafted seedling watermelon (parent stock and graft) they want. As graft it was used varieties Celine F₁ (from France), Sorento F₁, Pata Negra F₁ (black), Baronesa F₁ (black) (from Holand), hybrids that are especially grown in the Dăbuleni area. Many of the important diseases of green melon such as fusariose, viral and bacterial diseases, and pests such as nematodes usually, are impossible to control, therefore it is necessary to strictly quit to the crop and return to the same soil only after 5-6 years. Since planting, plants from healthy grafted seedlings are healthy, uniform and during vegetation period all plants are of the same size and will develop uniformly. Important diseases managed by grafting are caused by fungal several soil-borne pathogens such as *Fusarium oxysporum* (fig. 2), *Verticillium dahliae*, *Erwinia tracheiphila*, *Phytophthora*

spp. and *Phytophthora* spp., root knot nematodes and several soil-borne pests as Root gall (fig. 3) and Sting nematodes, European mole cricket, wire worms, white grubs, grey grubs and seedcorn maggot. Farmer has less work because he spends no longer time with seedlings as the cultivator and in the same time there is an economy of land by using almost half of the number of plants used in a non-grafted crop. Plants obtained from watermelon grafted seedlings were not attacked by nematodes, and the percentage of plants attacked by European mole cricket, wire worms, white grubs and grey worms was lower, less than 0.1% of the grafted plants were destroyed by pests, 4.8% for non-grafted seedling plants. The pest control technology is modified during the vegetation period, in the case of grafted plants at least one control treatment can be minimized. In the same time in fields with grafted seedlings were applied at less 1-2 chemical treatment no longer needed (particular in May) due to the high tolerances at soil born pathogens (tab. 2) and pests (tab. 3) of grafted plants. There is no great differences on main pests and diseases (as downy mildew, fig. 4) attack which appear late spring and summer beginning. For the others most important pest (*Aphids*, *Thrips*, Seedcorn maggot, Two spotted spider mite) and diseases (*Pseudoperonospora cubensis*, *Sphaerotheca fuliginea*, *Colletotrichum lagenarium*, viral infections) which appears during vegetation period and which are not being connected with soil, benefic effect of grafting seems to be due to the rootstock which is acting as a superior conductor of water, providing more water and nutrients to the stems, leaves and fruits, mainly because of the better developed root system.



Fig. 1 Grafted watermelon seedlings



Fig. 2 *Fusarium* wilt symptoms



Fig. 3 Symptoms of root gall nematodes



Fig. 4 Symptoms of downy mildew

Influence of grafted seedlings sold by the firm Kileler Plants SRL in area Dăbuleni on the frequency of pathogens

Farm	Hybrid seedlings								Grafted seedlings									
	<i>Fusarium oxysporum</i>	<i>Verticillium dahliae</i>	<i>Erwinia tracheiphila</i>	<i>Phyium</i> spp. and <i>Phytophthora</i> spp	<i>Didymella bryoniae</i>	<i>Pseudoperonospora cubensis</i>	<i>Sphaerotheca fuliginea</i>	<i>Colletotrichum lagenarium</i>	<i>Viral infections</i>	<i>Fusarium oxysporum</i>	<i>Verticillium dahliae</i>	<i>Erwinia tracheiphila</i>	<i>Phyium</i> spp. and <i>Phytophthora</i> spp	<i>Didymella bryoniae</i>	<i>Pseudoperonospora cubensis</i>	<i>Sphaerotheca fuliginea</i>	<i>Colletotrichum lagenarium</i>	<i>Viral infections</i>
A	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	0	0	
B	1	1	1	2	1	2	2	0	1	0	1	1	1	1	2	2	0	1
C	1	2	1	2	1	3	2	1	1	1	0	1	1	1	2	2	1	1
D	2	2	1	2	1	2	3	1	1	1	0	1	1	1	1	1	1	1
E	3	1	1	3	1	3	3	1	1	1	1	1	1	3	3	1	1	
F	3	2	2	3	1	3	3	1	2	1	1	1	1	3	2	2	1	

There is an increased yield in fields where were cultivated grafted seedling plants than in those fields where are cultivated non-grafted seedlings (tab. 4) this fact is due to the rootstock acting as a superior conductor of water, providing more water and nutrients to the stems, leaves and fruits, mainly because of the better developed root system. Due to an earlier and better start harvesting is, of course and harvesting is done earlier and the price is higher.

Table 3

Influence of grafted seedlings sold by the firm Kileler Plants SRL in area Dăbuleni on the frequency of pests

Fa	Hybrid seedlings									Grafted seedlings								
	Root gall and Sting nematodes	European mole cricket	Wire worms	White grubs	Grey grubs	Aphids	Thrips	Seedcorn maggot	Two spotted spider mite	Root gall and Sting nematodes	European mole cricket	Wire worms	White grubs	Grey grubs	Aphids	Thrips	Seedcorn maggot	Two spotted spider mite
A	1	1	0	1	0	2	3	0	3	0	0	0	0	0	2	2	0	2
B	1	1	0	2	1	3	3	0	3	0	1	0	1	0	2	2	0	3
C	1	0	0	2	1	3	2	1	2	0	0	0	0	0	2	1	0	2
D	2	1	1	2	0	4	3	1	3	0	0	0	1	3	3	0	2	
E	1	1	0	3	1	2	3	1	4	0	1	1	0	0	3	2	1	3
F	2	0	0	3	0	4	3	1	3	0	1	1	2	1	3	3	1	3

Influence of grafted seedlings sold by the firm Kileler Plants SRL in area Dăbuleni on the production (t/ha)

Farm	Hybrid seedlings	Grafted seedlings
A	95	120
B	95	115
C	85	100
D	95	105
E	90	100
F	80	95

CONCLUSIONS

Grafting is an important integrated pest management strategy to manage soil borne pathogens and other pests of watermelon crops.

Grafting of watermelon onto resistant rootstock was found to provide effective resistance to *Fusarium* wilt but at an increased cost per hectare and with an increased yield in fields where were cultivated grafted seedling plants than in those fields where are cultivated non-grafted seedlings

Acknowledgments: Thanks, in this way, to the company Kileler Plants SRL, for its support in realizing observations and permission to use the data obtained, also we we must thank to those 7 farmers from Dăbuleni, where observations have been made.

REFERENCES

1. Dane Fenny, Liu Jiarong 2007 - Diversity and origin of cultivated and citron type watermelon (*Citrullus lanatus*). Genetic Resources and Crop Evolution, 54, (6), p. 1255-1265.
2. Oda M., 2002 - Grafting of vegetable crops. Sci. Rep. Agr. & Biol. Sci. Osaka Pref. Univ., 54, p. 49-72.
3. Paris H.S., 2015 - Origin and emergence of the sweet dessert watermelon, *Citrullus lanatus*. Annals Botany, 116, (2), p. 133-148.
4. Sakata Y., Ohara T., Sugiyama M., 2008 - The history of melon and cucumber grafting in Japan. Acta Hort., 767, p. 217-228.
5. Strauss M., 2015 - The 5,000-Year Secret History of the Watermelon. National Geographic, August 21.
6. Tateishi K., 1927 - Grafting watermelon on squash. Japan. J. Hort. 39, p.5-8.

OBSERVATIONS ON THE STRUCTURE, DYNAMICS AND ABUNDANCE OF CARABID SPECIES (ORDER COLEOPTERA, FAMILY CARABIDAE) FROM FRUIT TREE ORCHARDS

OBSERVAȚII PRIVIND STRUCTURA, DINAMICA ȘI ABUNDENȚA SPECIILOR DE CARABIDE (ORD. COLEOPTERA, FAM. CARABIDAE) DIN PLANTAȚIILE POMICOLE DE MĂR

TĂLMACIU M.¹, TĂLMACIU Nela¹, HEREA Monica¹,
MOCANU Ionela¹
e-mail: mtalamciu@yahoo.fr

Abstract. *The paper presents the obtained results from the observations made in a apple fruit tree orchards within SC Loturi Service SRL Delești, Vaslui County. The material collection was done using the Barber traps once a week during June - September. Several collections of entomological material captured in the soil traps were made, then the carabid species were selected and identified. The collected species belong mainly to the following genres: Harpalus, Pterostichus, Amara, Calathus, Carabus etc.*

Key words: Barber traps, apple orchards, Amara

Rezumat: *În lucrare sunt prezentate rezultatele obținute în urma observațiilor făcute într-o plantație pomicolă de măr din cadrul SC Loturi Service SRL Delești, jud. Vaslui. Colectarea materialului s-a făcut cu ajutorul capcanelor Barber o dată pe săptămână în perioada iunie - septembrie. Au fost făcute mai multe colectări ale materialului entomologic capturat în capcanele de sol, apoi au fost selectate și identificate speciile de carabide. Speciile colectate aparțin, în special, următoarelor genuri: Harpalus, Pterostichus, Amara, Calathus, Carabus, etc.*

Cuvinte cheie: capcane Barber, livezi de măr, Amara

INTRODUCTION

Globally, the apple is one of the most important tree species, cultivated on all continents. In world fruit production, apples have a special place, and together with bananas and oranges account for 2/3 of the total annual harvest.

Under the pedo-climatic conditions of Romania, because of the large yields that can be obtained on the surface unit, the apple culture is one of the most profitable agricultural crops.

Regarding crop systems and orchard types, in the second half of the century, XX has increasingly emphasized the tendency to intensify tree culture,

¹University of Agricultural Sciences and Veterinary Medicine, Iași, Romania

which has led to new ways of driving, steering and maintaining the crown to cope with the increase in tree density per hectare.

However, modest tree-growing has implicitly led to the rise to environmental and health insensibility, the use of pesticides, fertilizers and other chemically active substances, whose shortcomings we know well. In this context, the pollution of the environment with pesticides and fertilizers, fruit growing occupies one of the main places.

At present, manifestations of global attitudes towards the environment and human health are increasingly evident, through the sustainable exploitation of natural resources and especially of agriculture as an essential factor in changing the environment.

Phytosanitary protection is a key link in apple culture technology, with an important role in achieving high and constant production, knowing that the production potential of these horticultural systems can be reduced by 20-30% or sometimes total compromise due to the disease and pest attack.

"Loturi Servive" SRL owns an area of 30 ha, cultivated with apple, obtained by the purchase of private orchards from the private owners as well, with the restitution of the land to the former owners of significant areas of the state exploited farms in the communist period.

Considering the necessity of performing phytosanitary treatments at the optimal moments of control of the complex of pests and phytopathogens specific to the apple, in the orchards belonging to SC "Loturi Servive" SRL, as in all intensive orchards in the area, among the rows of trees is arranged a vegetal carpet consisting mainly of garmin, with the main purpose of providing access to plant phytosanitary treatments every time when required, often in short periods without rains.

Also, by adopting the culture technology, the maintenance of the vegetal carpet is done by mowing it 2-3 times during a vegetative season, chopping the resulting material and using it as a mulch, thus ensuring an intake of organic matter to enrich the nutrient intake of soil.

In addition to this advantage, the vegetal carpet can influence local ecosystem conditions, such as: physical, chemical and microbiological properties of the soil; biodiversity of useful entomofauna; reducing the level of attack of phytopathogenic agents and specific pests, and with multiple effects on the quantity and quality of fruit and ultimately on the profitability of apple crops.

MATERIAL AND METHOD

Barber soil traps were used to collect the biological material. These consisted of introducing into the soil recipients in which a solution of formalin (40%) diluted with water to a concentration of 5% was placed.

The experience was organized on two rows, at a distance of 12 meters between rows and at a distance of 6 meters between traps, and each row had 3 traps.

The sampling was done between May and August at intervals of about 10-15 days.

At each harvest, the collected insects were placed in gauze cloth, each sample separately and replaced, or the trap fluid was then filled. The collected biological material was labeled, with the label specifying: the collection date, the trap number and the stationary.

In the laboratory the material was cleaned of vegetal remains and then washed under the water jet, selected on a systematic order, and then the carabid species were determined.

As far as the data interpretation is concerned, a number of ecological indicators have been centralized following the collection of the material.

Structure - represents the organization, selection and centralization of insect species from an ecosystem with specific characteristics.

Abundance-Express the number of individuals collected.

Species dynamics - all changes (quantitative) occurring within a population unit.

The situation of sampling during the research period is the following:

- The first harvest on 18.05.17;
- The second harvest on 26.05.17;
- The third harvest on 07.09.17;
- Fourth harvest on 28.07.17;
- Fifth harvest on 18.08.17;
- The sixth harvest on 15.07.17.

RESULTS AND DISCUSSIONS

The research was carried out in a fruit tree plantation that targeted the useful and harmful entomofauna belonging to the Carabidae family, which was harvested using Barber soil apertures.

Thus, after identifying the 39 specimens collected, 19 species belonging to the Carabidae family (Chatened du Gaetan, 1990; Panin 1951) were recorded.

The largest number of specimens collected (12) was recorded at the first harvest on 18.05.2017, and the collared species were: *Amara aenea*, *Panagaeus bipustulatus*, *Pseudophonus pubescens*, *Calathus fuscipes*, *Panagaeus cruxmajor*, *Amara crenata*, *Calosoma denticole*, *Microlestes nigrita*, *Tachyura quadrisignata*. At the second harvest on May 26, 2017, 7 species of carabid were recorded which totalized a total of 10 specimens and these were: *Harpalus calceatus*, *Carabus violaceus*, *Anisodactylus binotatus*, *Brachinus elegans*, *Harpalus tardus*, *Cicindela solute*, *Pterostichus niger*. At the next harvest on July 15, 2017, the total number of specimens collected was 7, belonging to the 4 species of *Amara aenea*, *Anisodactylus binotatus*, *Calosoma denticole*, *Harpalus griseus*. On 28.07.2017, at the fourth harvest a number of three species, *Carabus violaceus*, *Anisodactylus binotatus*, *Lebia humeralis*, with a total of 5 specimens were collected. The two collected species (*Anisodactylus binotatus*, *Lebia humeralis*) at the second harvest on 18.08.2018 totalized a total of 2 specimens. At the sixth harvest on September 7, 2017, the three harvested species (*Carabus violaceus*, *Harpalus aeneus*, *Harpalus calceatus*) totalized 4 specimens.

Table 1

Structure, dynamics and abundance of carabid species for each harvest

No	Name species of	Harvested number / Date of harvested					
		Harvest 1/ 18.05.17	Harvest 2/ 26.05.17	Harvest 3/ 15.07.17	Harvest 4/ 28.07.17	Harvest 5/ 18.08.17	Harvest 6/ 07.09.17
1	<i>Calathus fuscipes</i> Goeze.	1	-	-	-	-	-
2	<i>Panagaeus cruxmajor</i> L.	1	-	-	-	-	-
3	<i>Carabus violaceus</i> L.	-	1	-	1	-	2
4	<i>Amara aenea</i> De Geer.	2	-	4	-	-	-
5	<i>Amara crenata</i> Dejean	1	-	-	-	-	-
6	<i>Anisodactylus binotatus</i> Fabr.	-	1	1	2	1	-
7	<i>Brachinus elegans</i> Chaudoir	-	1	-	-	-	-
8	<i>Calosoma denticole</i> L.	1	-	1	-	-	-
9	<i>Harpalus aeneus</i> F.	-	-	-	-	-	1
10	<i>Harpalus calceatus</i> Duft.	-	4	-	-	-	1
11	<i>Harpalus griseus</i> Panz.	-	-	1	-	-	-
12	<i>Harpalus tardus</i> Panz.	-	1	-	-	-	-
13	<i>Cicindela solute</i> L.	-	1	-	-	-	-
14	<i>Microlestes nigrita</i> Wollaston	1	-	-	-	-	-
15	<i>Panagaeus bipustulatus</i> Fabr.	2	-	-	2	-	-
16	<i>Pseudophonus pubescens</i> Mul	1	-	-	-	-	-
17	<i>Tachyura quadrisignata</i> Duft.	2	-	-	-	-	-
18	<i>Lebia humeralis</i> Dejean.	-	-	-	-	1	-
19	<i>Pterostichus niger</i> Schall.	-	1	-	-	-	-
TOTAL - 19 species		12	10	7	5	2	4

After the diet (Constantineanu and Piscă, 1977; Manole *et al.*, 2009; Talmaciu *et al.*, 1996; Talmaciu *et al.*, 2007), a number of 12 species predator behavior (Ps), making them useful species within the group and 7 species are mixed feeding regime are thus deemed as harmful species. Also, 24 (61.48%) of the total number of specimens collected belong to the useful entomofauna and only 15 (38.52%) specimens belong to the harmful entomofauna.

Table 2

The situation to the regarding on the type of fauna and the representative percentage

No.	Name of species	Total samples	Type of fauna	%
1	<i>Anisodactylus binotatus</i> Fabr.	5	P	12.82
2	<i>Carabus violeceus</i> L.	4	P	10.25
3	<i>Panagaeus bipustulatus</i> Fabr.	4	P	10.25
4	<i>Calosoma denticole</i> L.	2	P	5.12
5	<i>Tachyura quadrisignata</i> Duft.	2	P	5.12
6	<i>Calathus fuscipes</i> Goeze.	1	P	2.56
7	<i>Brachinus elegans</i> Chaudoir	1	P	2.56
8	<i>Cicindela solute</i> L.	1	P	2.56
9	<i>Microlestes nigrita</i> Wollaston	1	P	2.56
10	<i>Lebia humeralis</i> Dejean.	1	P	2.56
11	<i>Panagaeus cruxmajor</i> L.	1	P	2.56
12	<i>Pterostichus niger</i> Schall.	1	P	2.56
Total predator species		24		61.48
13	<i>Amara aenea</i> De Geer.	6	M	15.38
14	<i>Harpalus calceatus</i> Duft.	4	M	10.25
15	<i>Amara crenata</i> Dejean	1	M	2.56
16	<i>Harpalus aeneus</i> F.	1	M	2.56
17	<i>Harpalus griseus</i> Panz.	1	M	2.56
18	<i>Harpalus tardus</i> Panz.	1	M	2.56
19	<i>Pseudophonus pubescens</i> Mul	1	M	2.56
Total mixed species		15		38.52
TOTAL - 19 species		39		100

P_s- predator species

M- mixed species (they show mixed diet regime, have also phytophagous preferences, but do not deny the predatory insect status)

In total, in the SC Loturi Service SRL, Delesti, Vaslui stationary in the fruit apple orchard, during the whole of the six harvests were collected 39 specimens of carabids belonging to the useful and harmful entomofauna that can affect directly or indirectly the production or the quality of the fruits.

CONCLUSIONS

In 2017, in the apple fruit orchard belonging to Loturi Service SRL stationary were collected by using the soil traps type Barber, 39 samples of Carabid beetles belonging to 19 species, the largest number of samples being recorded species: *Amara aenea*, *Anisodactylus binotatus*, *Carabus violeceus*,

Panagaeus bipustulatus, *Harpalus calceatus*, *Calosoma denticole*, *Tachyura quadrisignata*, and the other 12 carabid species recorded a one samples.

In 2017, in apple orchards we mentioned that we performed a total of six sampling by the traps method type Barber, between May and September.

REFERENCES

1. **Chatened du Gaetan, 1990** - *Guide des Coleopteres d'Europe*. Délaçrois et Niestlé, Paris.
2. **Constantineanu M., Pisciă C., 1977** - *Fauna Republicii Socialiste România, Insecta*, fascicula 5,6,7,8. Editura Academiei Republicii Socialiste România, București.
3. **Georgescu T., 2006** - *Entomologie horticolă*, Editura Dosofoei, Iasi.
4. **Manole Liliana, Tălmăciu M., Tălmăciu Nela, 2009** - *Some aspects on the structure and abundance of species coleoptere for rapeseed crop-autumn*. Annals of the University of Craiova, Series Agriculture, Vol. 39:216-222.
5. **Panin I., 1951** - *Determinatorul Coleopteleror dăunătoare și folositoare din R.P.R.* Editura de Stat, București.
6. **Perju, T., 1980** - *Entomologie horticolă*, Ed. Did. Ped., București, pag 252-253.
7. **Rogojanu V., Perju T., 1979** - *Determinator pentru recunoașterea dăunătorilor plantelor cultivate*. Editura Ceres, București.
8. **Tălmăciu M., Georgescu T., Mitrea I., Filipescu C., Badeanu Marinela, Radu C., 1996** – *Contributions to the knowing of the carabid fauna of the vine plantation in Husi vineyard, Vaslui District*. Lucrari stiintifice, vol. 39, Seria Horticultura, U.S.A.M.V. IASI, pp.267 - 271.
9. **Tălmăciu M., Tălmăciu Nela, Diaconu A, 2007** - *The efficacious fauna of carabids (Coleoptera: Carabidae) from apple plantations in north-eastern Romania*. Symposium Intern. „Plant Protection and plant Health in Europe” Germania-Berlin, vol.no. 82, p.114-115. ISSN 0306-3941, ISBN 13:978-1-901396-82-9.

CONSIDERATIONS ON THE ENTOMOFAUNA IN SOME APPLE ORCHARDS

CONSIDETAȚII ASUPRA ENTOMOFAUNEI DIN UNELE PLANTAȚII POMICOLE DE MĂR

TĂLMACIU Nela¹, TĂLMACIU M.¹, HEREA Monica¹,
MOCANU Ionela¹

e-mail: mtalamciu@yahoo.fr

Abstract. *Observations were made at the SC Loturi Service SRL Delești, Vaslui in a fruit-growing orchard with intensive apple trees where a vegetal carpet is made especially of grasslands between the rows of trees. The plantation has been chosen to maintain the vegetal carpet that can influence the local ecosystem conditions, such as the physical, chemical and microbiological characteristics of the soil; biodiversity of useful entomofauna; reducing the level of attack of phytopathogenic agents and specific pests, and with multiple effects on the quantity and quality of fruit and ultimately on the profitability of apple crops. For the collection of the entomological we have been used Barber traps type soil of being six in number, arranged in a single row of fruit at a distance of 10 m between them. Samples were harvested constantly every 10-25 days. At each collection, the trap material was cleansed by plant debris, and the entomofauna collected was brought to the lab and then the useful and harmful species were identified.*

Key words: vegetal carpet, biodiversity, apple orchard

Rezumat. *Observațiile au fost realizate în cadrul fermei SC Loturi Service SRL Delești Vaslui într-o plantație pomicolă cultivată cu măr intensiv unde este amenajat un covor vegetal alcătuit în special din garminee între rândurile de pomi. În plantație s-a optat pentru întreținerea covorului vegetal ce poate influența condițiile locale de ecosistem, cum sunt cele referitoare la: însușirile fizice, chimice și microbiologice ale solului; biodiversitatea entomofaunei utile; reducerea nivelului de atac al agenților fitopatogeni și dăunătorilor specifici ș.a., cu efecte multiple asupra cantității și calității fructelor și în final asupra rentabilității culturii mărului. Pentru colectarea materialului entomologic au fost utilizate capcanele de sol de tip Barber ce au fost în număr de șase, dispuse pe un singur rând de pomi la o distanță de 10 m între ele. Recoltarea probelor s-a realizat constant la fiecare 10-25 zile. La fiecare colectare, materialul din capcane a fost curățat de resturile vegetale, iar entomofauna colectată a fost adusă în laborator și apoi au fost identificate speciile utile și dăunătoare.*

Cuvinte cheie: covor vegetal, biodiversitate, livada de măr

¹University of Agricultural Sciences and Veterinary Medicine, Iași, Romania

INTRODUCTION

The first scientific papers, concerning the study of insects generally appeared in XVII th century (Redi); in XVIII th century, were described numerous species of beetles by Fabricius, Latreille and in the XIX century (Reitter). In our country, the first works concerning the study of beetles refers to Banat and Transilvania regions (Bielz 1865), and the most representative one belongs to Seidlitz (Fauna Transylvanica -1891).

By scientifically value is the work of Fleck (1906), in which are described more than 2400 of species, chiefly in Muntenia and Dobrogea regions. The researches on the epigeous fauna developed continuously after 1920 in Romania, and after 1950 in Oltenia too, being published numerous works: Marcu (1927-1967) and Bobârnac (1955-1985) for Oltenia; Ienistea (1956-1976) for Dobrogea and Muntenia; Panin (1941-1965) for Romania (after Bobârnac B., 1994).

In this paper are presented some species of entomofauna that were identified in apple tree plantations.

MATERIALS AND METHODES

Collected of the material was made with the Barber soil traps, from an apple tree orchard, from the region of Delesti, Vaslui district. The observations were made in 2017; the biological material have been gathered from May to September. Collected of the biological material have been done from 10 to 25 days period of time, (Varvara, Tâlmăciu) totally being effectuated a number of 6 collected, at the next data: the first collected on 18 May; the second collected, on 26 May; the third collected, on 15 July; the forth collected on 28 July; the fifth collected on 18 August; the sixth collected on 08 September. From the collected material were retained the Coleopterans species that were later determined and stocked (Reitter, 1908; Rogoianu and Perju, 1979; Panin, 1951; Chatened du Gaetan, 1990).

RESULTS AND DISCUSSIONS

The first haverst was collected a number of 10 species with 52 samples. The species collected were: *Opatrum sabulosum* (40), *Calathus fuscipes*, *Panagaeus cruxmajor*, *Panagaeus bipustulatus*, *Amara aenea*, *Amara crenata*, *Calosoma denticole*, *Microlestes nigrita*, *Pseudophonus pubescens*, *Tachyura quadrisignata*.

The second harvest was collected a number of 9 species with 71 samples. These were: *Opatrum sabulosum* (58), *Carabus violaceus*, *Harpalus calceatus*, *Harpalus tardus*, *Cicindela solute*, *Pterostichus niger*, *Anisodactylus binotatus*, *Dermestes laniarius*, *Brachynus elegans*

The third haverst was collected a number of 7 species with 25 samples. The species collected were: *Amara aenea*, *Anisodactylus binotatus*, *Calosoma*

denticole, *Harpalus griseus*, *Otiorrhynchus niger*, *Cantharis livides* ab.*rufipes*, *Opatrum sabulosum*.

The fourth harvest were collected 19 samples belongings of 8 species. The species collected were: *Anisodactylus binotatus*, *Carabus violaceus*, *Panagaeus bipustulatus*, *Opatrum sabulosum*, *Coccinela 7 punctata*, *Otiorrhynchus raucus*, *Otiorrhynchus singularis*.

The five harvest were collected 4 species with 10 samples. The species collected were: *Anisodactylus binotatus*, *Lebia humeralis*, *Dermestes lanarius*, *Cantharis livides* ab.*rufipes*.

The six harvest were collected 18 samples belonging at 4 species. The species collected were: *Carabus violaceus*, *Harpalus aeneus*, *Harpalus calceatus*, *Coccinela 7 punctata*.

Table 1

The date of samples harvesting, the collected species and the number of the individuals insects

No.	Date	No.	Specie's name	Number of sample	Total
1	18.05.2017	1	<i>Opatrum sabulosum</i> L.	40	52
		2	<i>Calathus fuscipes</i> Goeze.	1	
		3	<i>Panagaeus cruxmajor</i> L.	1	
		4	<i>Panagaeus bipustulatus</i> Fabr.	2	
		5	<i>Amara aenea</i> De Geer.	2	
		6	<i>Amara crenata</i> Dejean	1	
		7	<i>Calosoma denticole</i> L.	1	
		8	<i>Microlestes nigrita</i> Wollaston	1	
		9	<i>Pseudophonus pubescens</i> Mull.	1	
		10	<i>Tachyura quadrisignata</i> F.	2	
2	26.05.2017	1	<i>Opatrum sabulosum</i> L.	58	71
		2	<i>Carabus violaceus</i> L.	1	
		3	<i>Harpalus calceatus</i> Duft.	4	
		4	<i>Harpalus tardus</i> Panz.	1	
		5	<i>Cicindela solute</i> L	1	
		6	<i>Pterostichus niger</i> Schall.	2	
		7	<i>Anisodactylus binotatus</i> Fabr.	1	
		8	<i>Dermestes lanarius</i> Illig.	2	
		9	<i>Brachynus elegans</i> Chaudoir	1	
3	15.07.2017	1	<i>Amara aenea</i> De Geer.	4	25
		2	<i>Calosoma denticole</i> L.	1	

		3	<i>Anisodactylus binotatus</i> Fabr.	1	
		4	<i>Harpalus griseus</i> Panz.	1	
		5	<i>Otiorrhynchus niger</i> Fbr.	14	
		6	<i>Opatrum sabulosum</i> L.	2	
		7	<i>Cantharis livides ab.rufipes</i> Hrbst	2	
4	28.07.2017	1	<i>Anisodactylus binotatus</i> Fabr.	2	19
		2	<i>Carabus violaceus</i> L.	1	
		3	<i>Panagaeus bipustulatus</i> Fabr.	2	
		5	<i>Opatrum sabulosum</i> L.	2	
		6	<i>Coccinela 7 punctata</i> L.	8	
		7	<i>Otiorrhynchus raucus</i> Fbr.	2	
		8	<i>Otiorrhynchus singularis</i> L.	2	
5	18.08.2017	1	<i>Anisodactylus binotatus</i> Fabr.	1	10
		2	<i>Lebia humeralis</i> Dejean.	1	
		3	<i>Dermestes laniarius</i> Mlig.	2	
		4	<i>Cantharis livides ab.rufipes</i> Hrbst	6	
6	8.08.2017	1	<i>Carabus violaceus</i> L.	2	18
		2	<i>Harpalus aeneus</i> F.	1	
		3	<i>Harpalus calceatus</i> Duft.	1	
		4	<i>Coccinela 7 punctata</i> L.	14	

The families, genera and species of *Coleoptera* collected are presented in the table 2.

Studing this table we can observe the following:

- the were collected 154 samples from 5 families, 5 genus and 7 species;
- the mast represantives excluding the *Carabide* family was the *Tenebrionidae* family with *Opatrum sabulosum* specie with 102 total sample);
- family *Curculionidae* with 3 species and 18 samples;
- family *Cantharidae* with 8 samples, by a single species: *Cantharis livida ab.rufipes*.
- family *Dermestidae* with 4 samples, by a single species: *Dermestes laniarius*.

Table 2

**The structure of families, genera and species from
Coleoptera collected and number**

No.	Family	Genus	Species	Number of samples	Total
1	<i>Tenebrionidae</i>	<i>Opatrum</i>	<i>Opatrum sabulosum</i> L.	102	102
2	<i>Coccinelidae</i>	<i>Coccinella</i>	<i>Coccinella 7 punctata</i> L.	22	22
3	<i>Curculionidae</i>	<i>Oriorrhynchus</i>	<i>Otiorrhynchus niger</i> Fbr.	14	18
			<i>Otiorrhynchus raucus</i> Fbr.	2	
			<i>Otiorrhynchus singularis</i> L.	2	
4	<i>Cantharidae</i>	<i>Cantharis</i>	<i>Cantharis livida ab.rufipes</i> Hrb.	8	8
5	<i>Dermestidae</i>	<i>Dermestes</i>	<i>Dermestes lanarius</i> Ilig.	4	4
5 families		5 genus	7 species	154	

CONCLUSIONS

1. The soil traps of Barber type were used for collecting of the entomofauna which moves on the soil surface, out of which the coleoptera species were kept, these traps worked from May to September.

2. There were effected a number of 6 collections in the year 2017, after taking the collected material from the traps and simultaneously it was change or completed the solution of formol of 3-4% concentration.

3. It was collected in totality 154 samples of *Coleoptera* belonging to the following families: *Tenebrionidae*, *Cantharidae*, *Dermestidae*, *Curculionidae* and *Coccinelidae* (excluding the *Carabidae* family)

- The most representative was *Tenebrionidae* family was well represented relating to the number of samples collected (102 samples), having just one species, *Opatrum sabulosum*. The other families had a reduced number of species and samples. The family *Coccinellidae* with 22 samples, the *Curculionidae* with 18 samples; the family *Cantharidae* with 8 samples and the family *Dermestidae* with 4 samples, by a single species: *Dermestes lanarius*.

REFERENCES

1. **Chatened du Gaetan, 1990**, - *Guide des Coleopteres d'Europe*. Délaçrois et Niestlé, Paris.
2. **Panin I., 1951** - *Determinatorul Coleopteleror dăunătoare și folositoare din R.P.R.* Ed. de Stat, București.
3. **Rogojanu V., Perju T., 1979** - *Determinator pentru recunoașterea dăunătorilor plantelor cultivate*. Ed. Ceres, Bucuresti.
4. **Reitter E., 1908** - *Fauna Germanica*. Die Käfer des Deutschen Reiches Band I, Stuttgart.
5. **Talmaciu M., Georgescu T., Mitrea I., Filipescu C., Badeanu Marinela, Radu C., 1996** – *Contributions to the knowing of the carabid fauna of the vine plantation in Husi vineyard, Vaslui District*. 1996 - Lucrari stiintifice, vol. 39, Seria Horticultura, USAMV Iasi, pp.267 - 271.
6. **Talmaciu M., Talmaciu Nela, Diaconu A., 2007** - *The efficacious fauna of carabids (Coleoptera: Carabidae) from apple plantations in north-eastern Romania*. Symposium Intern. „Plant Protection and plant Health in Europe” Germania-Berlin, vol.no. 82, p.114-115. ISSN 0306-3941, ISBN 13:978-1-901396-82-9.
7. **Tălmăciu M., Tălmăciu Nela, Diaconu A., Artene I., 2006** - *Contribution in relation to cognition structure, dynamics and abundances of species from coleopteres (Coleoptera) in plantation of apple*. Rev. Cercetări agr. în Moldova, vol 4 (128), p.33-41, ISSN 0379-5837
8. **Varvara M., Tălmăciu M., Georgescu T., 1995** - *Structura speciilor de carabide (Coleoptera - Carabidae) în câteva plantații viticole din Moldova*. Rev. Cercetări Agronomice în Moldova.vol 1-2 (104), p.66-69.

**PASSIFLORA – SOURCE OF SANOGENIC COMPOUNDS,
PROSPECTS FOR MEDICINE AND CURRENT USES**

**PASSIFLORA – SURSĂ DE COMPUȘI SANOGENICI,
PERSPECTIVE PENTRU MEDICINĂ ȘI UTILIZĂRI CURENTE**

BOBOC Paula (OROS)¹, CANTOR Maria¹, HITTER Timea¹, GOCAN Tincuța¹
e-mail: marcantor@yahoo.com

Abstract. *Passiflora* genus includes over 500 species, being the most spread of tropical flora. Originally from South America, with more than 60 edible species, *Passiflora* genus presents more and more interest among researchers. The passion fruit is remarked by a high content of vitamins, polyphenols and carotenoids, antioxidants and anticancer substances (have been identified 13 types of carotenoids, including beta-, zeta- and alpha-carotene, b-cryptoxanthin, lycopene). The researchers demonstrated the antioxidant and antibacterial activities of leaves and stems of *Passiflora quadrangularis*, *Passiflora caerulea* and *Passiflora edulis*. *Passiflora incarnata* species has been extensively studied due to its high content of active substances, which has been reported as antispasmodic, sedative and analgesic use. Considering the available biochemical data and the recording of sanogenic effects of the *Passiflora* genus, it is intended to increase the popularity of these species in order to raise their interest for acclimatization and cultivation in Romania.

Key words: ornamental plants, *Passiflora* species, medicine, bioactive compounds

Rezumat. Genul *Passiflora* cuprinde peste 500 de specii, fiind cel mai răspândit din flora tropicală. Originar din America de Sud, cu peste 60 de specii comestibile, genul *Passiflora* prezintă tot mai mult interes în rândul cercetătorilor. Fructul pasiunii se remarcă printr-un conținut ridicat de vitamine, polifenoli și carotenoizi, substanțe antioxidante și anticancerigene (fiind identificate 13 tipuri de carotenoizi dintre care beta-, zeta- și alpha-caroten, b-cryptoxanthin, lycopene). Cercetătorii au demonstrat activitățile antioxidante și antibacteriene ale frunzelor și tulpinilor de *Passiflora quadrangularis*, *Passiflora caerulea* și *Passiflora edulis*. Specia *Passiflora incarnata* a fost amplu studiată datorită conținutului ridicat în substanțe active, consemnându-se întrebunțările sale ca antispasmodic, sedativ și analgezic. Având în vedere datele biochimice disponibile și consemnarea efectelor sanogene ale genului *Passiflora*, se urmărește creșterea popularității acestor specii pentru a spori interesul în vederea aclimatizării și cultivării lor în România.

Cuvinte cheie: plante ornamentale, specii de *Passiflora*, medicină, compuși bioactivi

INTRODUCTION

Plants are a source of bioactive compounds, food and human health being closely related to the presence of plants. Since ancient times, plant material is

¹University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Romania

important for man's survival. The plant kingdom is the main supplier of chemical compounds used in food, pharmaceutical, cosmetic or agrochemical industries with significant economic value.

The *Passiflora* genus belongs to the Passifloraceae family, the largest of tropical plants, comprising over 500 species, and the genus is the most widespread of tropical flora. More than 350 species of the Passifloraceae family were found in tropical regions and tropical rainforests in South America, and 60 of them are edible (Patil, 2013). In addition to the decorative role of the *Passiflora* creepers, the sanogenic effects of these plants were first discovered in Peru, where the Spanish doctor Monardes, brought it to Europe in 1569. The *Passiflora* aerial parts were the most popular ingredients incorporated in most sedative extracts, tablets and sedatives. Infusion from plant leaves was used in North America in the mid-1800s. In many countries in Europe, America and Canada have been used as tranquilizers for neurosis for more than 200 years. *Passiflora* was first registered as an official medicine in the 1970s and 1990s by pharmacopoeias in America, Great Britain, Germany, France, Switzerland, Egypt and India. For example, in Germany, as early as 1979, there were 42 sedatives and six cardiotonics prepared from derivatives of this species. It has also been used to treat colic, dysentery, diarrhea, menstrual pain, insomnia, headache, eye pain, epilepsy and convulsions in pain or muscle spasms (Mowrey, 1986; Tyler 1994; Gontijo Silva, 2000).

Among the bioactive compounds that may be present in *Passiflora* leaves are counting alkaloids, saponins, cyanogen compounds, and mainly phenolic compounds. The passion fruit is appreciated for taste and aroma, but it is an important source of nutrients such as carbohydrates, flavonoids, alkaloids, ascorbic acid, carotenoids, vitamins, minerals and terpenoids. More than 200 components of passion fruit flavors have been described (Gislaine C. Silva *et al.*, 2014).

MATERIAL AND METHOD

Passiflora quadrangularis (fig. 1) is a decorative vine appreciated for the great flowers, and especially for its tasty fruits. This species produces the biggest fruit of the *Passifloraceae*. The *Passiflora quadrangularis* extract is used in Caribbean to treat headaches or as sedative. Leaf tea is used to treat high blood pressure and diabetes (Dhawan *et al.*, 2004).



Fig. 1 *Passiflora quadrangularis*
(www.chilternseeds.co.uk)



Fig. 2 *Passiflora edulis*
(<https://en.wikipedia.org>)

Passiflora edulis (fig. 2.) is recognized and cultivated for its edible fruits and for its decorative impact. The traditional use of *P. edulis* for its sedative properties is well known in South America, particularly in Brazilian traditional medicine. Such a traditional use is based on the utilization of leaves and roots. Fruits are also highly appreciated and use against stomach cancer, considered as a digestive stimulant, against constipation and as a remedy against gastric carcinoma. Also, *P. edulis* has anthelmintic, diuretic, sedative properties, is used against colic sugars and in menopausal symptoms (Chopra *et al.*, 1956, Watt *et al.*, 1962, Hartwell, 1970; Kirtikar *et al.*; Mowrey, 1993).

Passiflora incarnata (fig. 3) has been recommended since the beginning of the century against insomnia and nerve manifestations during menopause. Its aerial parts (flowers, fruits and stems) have been used in traditionally medicine (in the USA) against anxiety and neuralgia (Brasseur *et al.*, 1984; Leclerc, 1920 cited by Gontijo Silva, 2000). *P. incarnata* is cultivated in Europe and widely used in homeopathy and phytotherapy. Since this species has a slightly sedative effect, it can be used in combination with other species of the same type of effect, such as *Valeriana officinalis*, *Humulus lupulus* and *Piscidia piscipula* for the treatment of insomnia (Rehwald *et al.*, 1995 cited by Gontijo Silva, 2000). In addition to these uses, it was also considered beneficial against headaches and blood pressure (Ody, 1996).

Passiflora caerulea (fig. 4) is especially appreciated for its ornamental value, its fruits are traditionally used as sedatives and anxiolytics. In India, Netherlands and South America the root was used as sedative and vermifug, and in Italy as antispasmodic and sedative (Kirtikar *et al.*, 1975; Hickey *et al.*, 1988 cited by Dhawan *et al.*, 2004).



Fig. 3 *Passiflora incarnata*
(<https://en.wikipedia.org>)



Fig. 4 *Passiflora caerulea*
(<http://en.hortipedia.com>)

RESULTS AND DISCUSSIONS

Bioactive compounds. The *Passiflora* genus has been deeply investigated to determine bioactive substances. The chemical content of the species is not yet well established. Researchers are trying to differentiate if its sedative effects are due to hallucinogenic alkaloids such as harmin and harmalin, or flavonoids such as apigenin, luteolin or scopolentin (Tiwari *et al.*, 2016). Phytochemical analyzes highlighted the content of alkaloids, phenols, cyanogenic compounds and flavonoid glycosydes of *P. edulis* and *P. incarnata*. Passicol is a substance with antifungal and antimicrobial action, found in *Passiflora* leaves, produced in a higher rate when living tissue is injured (Nicolls, 1973).

✓ **Flavonoids** are the main bioactive compounds of Passifloraceae. From their category are part of apigenin, luteolin, C-glycosyl flavonoids, kaempferol, quercetin, vitexin, isovitexin, orientin and isorientin. The largest quantities of flavonoids have been found in leaves between pre-flowering and the flowering stages of the plant (Dhawan *et al.*, 2004; Ingale *et al.*, 2010).

✓ **Glycosides** are basic compounds of *P. edulis*. Passiflorins are the main glycosidic compounds active in this species, including luteolin-6-C-quinovoside, luteolin-6-C-fucoside, cyanophedinoid cyanohydrin glycosides, passicapsin, pasibiflorin, epipasicoracin and epithephilin (Seigler *et al.*, 1989; Olafsdottir *et al.*, 1989; Mareck *et al.*, 1991 cited by Dhawan *et al.*, 2004). One of the six isolated alkaloids of *P. incarnata* is called "passiflorine", a chemical compound considered by some researchers the active compound of the planet (Tiwari *et al.*, 2016).

✓ **Chrysin** is a natural flavor extracted from *P. caerulea* acting as an aromatase inhibitor, administered to cultures and athletes as a dietary supplement. The inhibitory effect of chrysin on mammary carcinoma cells, thyroid cancer cells and prostate tumors has also been reported (Yin *et al.*, 1999, Knowles *et al.*, 2000, Yin *et al.*, 2001 cited by Ingale *et al.*, 2010).

Therapeutical properties. *Passiflora* extracts are used in the pharmaceutical, food, or cosmetic industries. Traditional medicine plays an important role in the treatment of affections suffered by man, so that the population relies on traditional and plant-based medicines to 80%, according to The World Health Organization.

✓ **Generalized anxiety** may occur with twice the incidence in women than in males and up to 9% of the population. The *Passiflora* extract can improve the benzodiazepine concentration for generalized anxiety management. Passion flower tincture has anxiolytic effects. *Passiflora* treatment improves the control of emotions, diminishes irritability, and favors a calm state, so it can also be used to treat furies from panic attacks (Coleta *et al.*, 2006).

✓ **Hypertension** and cardiovascular disease remain the main cause of morbidity and mortality worldwide. *P. edulis* has been reported for its antihypertensive effects. The methanol or luteolin extracts from this plant has significantly lowers blood pressure by oral administration. *Passiflora* reduces the predisposition to infarction by almost 40%. Moreover, in combination with *Crataegus* spp., *Passiflora* increases effort, relieves breathing and improves the quality of cardiac life (Ichimura *et al.*, 2006).

✓ **Antimicrobial activity** of Passifloraceae may be an important step in the development of medicine. The identification or development of new antimicrobial substances is one of the priority directions for the elimination of antibiotic resistance situations. Passicol is a chemical component of *Passiflora* with antimicrobial properties. The extracts from passion flower leaves (with ethanol and acetone) against human pathogenic bacteria (*Pseudomonas putida*, *Vibrio cholerae*, *Shigella flexneri* and *Streptococcus pyogenes*) were tested by agar

inoculation. The results demonstrated remarkable activity against all bacterial pathogens (Mohanasundari *et al.*, 2007). The antifungal activity of extracts of *P. caerulea* and *P. edulis* on the mycelium of *Candida albicans* and *Cryptococcus neoformans* was tested to demonstrate the inhibition of germination and micellar growth of the fungus (Nicolls, 1973).

CONCLUSIONS

The *Passiflora* genus is known on a large area at world level being highly appreciated for the gardens and terraces decoration, but also growing in pots for bright and spacious interiors. Numerous studies have demonstrated the use of the species in antimicrobial, cardiac or neurodegenerative treatments. Various types of extracts have been found to have compounds with a broad spectrum of action on certain organs, biochemical processes or physiological functions. At the level of Romania, the *Passiflora* genus is not sufficiently studied, but the potential culture and valorification of this plant would be high, both of the ornamental value and the therapeutic properties. Therefore, studies can be carried out on the acclimatization of *Passiflora* in Romania, as well as supplementing the research on the sanogenic potential and medicinal impact.

REFERENCES

1. Brasseur T., L. Angenot, 1984 - *Contribution a l'etude pharmacognostique de la passiflore*. Journal de Pharmacologie Belge 39(1), p. 15.
2. Chopra R.N., Nayar S.L., Chopra I.C., 1956 - *Glossary of Indian Medicinal Plants*. CSIR, New Delhi, India, p. 186–187.
3. Coleta M., Batista M.T., Campos M.G., Carvalho R., Cotrim M.D., Lima T.C., A.P. Cunha, 2006 - *Neuropharmacological evaluation of the putative anxiolytic effects of Passiflora edulis Sims its sub-fractions and flavonoid constituents*. Phytother. Res., 20(12), p. 1067-1073.
4. Dhawan K., S. Dhawan, A. Sharma, 2004 - *Passiflora: A review update*. Journal of Ethnopharmacology, nr. 94, p. 1–23.
5. Gontijo Silva Cláudia, 2000 - *Tissue culture and phytochemical studies of Podophyllum, Diphyllia and Passiflora species*. PhD thesis, University of Nottingham, p. 21, 23.
6. Hartwell J.L., 1967 - *Plants used against cancer: a survey*. Lloydia 30(4), p. 379-436.
7. Hickey M., King C., 1988 - *100 Families of Flowering Plants*. Cambridge University Press, Cambridge, p.130–133.
8. Ichimura T., Yamanaka A., Ichiba T., Toyokawa T., Kamada Y., Tamamura T., Maruyama S., 2006 - *Antihypersensitive effect of an extract of Passiflora edulis rind in spontaneously hypersensitive rat*. Biosci.Biotechnol. Biochem., 70-3, p. 718-721.
9. Ingale A.G., A.U. Hivrale, 2010 - *Pharmacological studies of Passiflora sp. and their bioactive compounds*. African Journal of Plant Science Vol. 4(10), p. 417-426.
10. Kirtikar K.R., Basu B.D., 1975 - *Indian Medicinal Plants*. Periodical Experts, Dehradun, India, p. 1103.
11. Knowles L.M., Zigrossi D.A., Tauber R.A., Hightower C., Milner J.A., 2000 - *Flavonoids suppress androgen-independant human prostate tumor proliferation*. Nutr. Cancer, 38-1, p. 116-122.
12. Leclerc H., 1920 - *Note sur le traitement de l'insomnie consecutive a la grippe par la passiflore*. Bulletin des Sciences Pharmacologiques 27, p. 548-553.

13. Mareck U., Herrmann K., Galensa R., Wray V., 1991 - *The 6-Cchinovoside and 6-C-fucoside of luteolin from Passiflora edulis*. *Phytochemistry* 30, p. 3486–3487.
14. Mohanasundari C., Natarajan D., Srinivasan K., Umamaheswari S., Ramachandran A. 2007 - *Antibacterial properties of Passiflora foetida L. a common exotic medicinal plant*. *Afr. J. Biotechnol.*, 6-23, p. 2650-2653.
15. Mowrey D.B., 1993 - *Herbal Tonic Therapies*. Keats Publ. Incorporation, New Canaan, CT.
16. Mowrey D.B. 1986 - *The Scientific Validation of Herbal Medicine*. Keats Publishing, NewCanaan, p. 316.
17. Nicolls J.M., J. Birner, P. Forsell, 1973 - *Passicol, an Antibacterial and Antifungal Agent Produced by Passiflora Plant Species: Qualitative and Quantitative Range of Activity*. *American Society for Microbiology*, Vol. 3, No. 1, USA p. 110-117.
18. Nicolls J.M., J. Birner, 1973 - *Passicol, an Antibacterial and Antifungal Agent Produced by Passiflora Plant Species: Preparation and Physicochemical Characteristics*. *American Society for Microbiology*, Vol. 3, No. 1, USA, p. 105-109.
19. Ody P., 1996 - *Handbook of Over-the-Counter Herbal Medicines*. Kyle Cathie Ltd., London. p. 446.
20. Olafsdottir E.S., Andersen J.V., Jaroszewski J.W., 1989-*Cyclopentenoid cyanohydrin glycosides. Part 9. Cyanohydrin glycosides of Passifloraceae*. *Phytochemistry* 28, p. 127–132.
21. Patil A.S., H.M. Paikaro, S.R. Patil, 2013 - *Passiflora foetida linn: a complete morphological and phytopharmacological review*. *International Journal of Pharma and Bio Sciences*, USA, p. 286.
22. Rehwald A., O. Stieher, B. Meier, 1995 - *Trace analysis of hannan alkaloids in Passiflora incarnata by reversed-phase high performance liquid chromatography*. *Phytochemical Analysis* 6, p. 96-100.
23. Seigler D.S., Spencer K.C., 1989 - *Corrected structures of passicoriacin, pipassicoriacin and epitetraphyllin B and their distribution in the Flacourtiaceae and Passifloraceae*. *Phytochemistry* 28, p. 931–932.
24. Silva C. Gisláine, Carla B.G. Bottoli, 2014 - *Analyses of Passiflora compounds by chromatographic and electrophoretic technique*. *Critical Reviews in Analytical Chemistry*, London.
25. Tiwari S., S. Singh, S. Tripathi, S. Kumar, 2016 - *A pharmacological review: Passiflora species*. *IJP Vol. 3(1)* p. 10-18.
26. Tyler E.V., 1994 - *Nervous system disorders*, Smith MC (ed.). *Herbs of Choice: The Therapeutic Use of Phytomedicinals*, Pharmaceutical Products Press, Binghamton, New York, p. 117-134.
27. Watt J.M., Breyer-Brandwijk M.G., 1962 - *The Medicinal and Poisonous Plants of Southern and Eastern Africa*. Edinburg, Livingston, p. 826–830.
28. Yin F., Giuliano A.E., Law R.E., Van Herie A.J., 2001 - *Apigenin inhibits growth and induces G2/M arrest by modulating cyclin CDK regulators and ERK MAP kinase activation in breast carcinoma cells*. *Anticancer Res.*, 21-1A, p. 413-420.
29. Yin F., Giuliano A.E., Van Hearle A.J., 1999 - *Growth inhibitory effects of flavonoids in human thyroid cancer cell lines*. *Thyroid*, 9(4), p. 369-376.
30. ***, https://www.chilternseeds.co.uk/item_960c_passiflora_quadrangularis_seeds
31. ***, http://en.hortipedia.com/wiki/Passiflora_caerulea
32. ***, https://en.wikipedia.org/wiki/Passiflora_edulis
33. ***, https://en.wikipedia.org/wiki/Passiflora_incarnata

THE RESCUE OF IASI CITY LANDSCAPE, HOMAGE TO G. M. CANTACUZINO

SALVAREA PEISAJULUI CITADIN IEȘEAN, OMAGIU LUI G. M. CANTACUZINO

*DASCĂLU Doina Mira*¹, *DASCĂLU V.*², *COJOCARIU Mirela*¹
e-mail: doinamira@yahoo.com

Abstract. *Great architect and a type of Renaissance personality "Homo Universalis", G. M. Cantacuzino placed his mark on Iași mainly through his writings full of a special love for this city. Apparently a city that had nothing to impresses travelers, Iași city managed however to reveal to G. M. Cantacuzino his subtle charm. Shortly before his death, worried about the gloomy post-war future which was expected for Iași urban environment, the architect pleaded for the salvation of the city landscape in his conferences in 1955 and 1958, titled "Iași City, a landscape". His alarm signal related to what could be saved from the historical built ensemble of old Iași was ignored at that time. Shortly after these conferences, in the old Iași started the destruction and the urban renovation, as happened with many of the historic cities of Romania.*

Key words: city landscape, history, rescue

Rezumat. *Mare arhitect și personalitate de tip renescentist "Homo Universalis", G. M. Cantacuzino a amprentat Iașul mai ales prin scrierile sale pline de o iubire specială pentru acest oraș. Aparent un oraș care nu putea impresiona călătorii dornici de peisaje construite fastuoase, Iașul a reușit totuși să-i dezvăluie lui G. M. Cantacuzino farmecul său subtil. Puțin înainte de moartea sa, îngrijorat de viitorul postbelic sumbru care se preconiza pentru cadrul urban ieșean, arhitectul a pledat pentru salvarea peisajului citadin în conferințele sale din 1955 și 1958, intitulate "Orașul Iași un peisagiu". Semnalul său de alarmă legat de ceea ce se mai putea salva din ansamblul istoric al vechiului Iași a fost ignorat la acea vreme. La scurt timp după aceste conferințe în vechiul Iași a început distrugerea și renovarea urbană, așa cum s-a întâmplat cu multe din orașele istorice din România.*

Cuvinte cheie: peisaj citadin, istorie, salvare

INTRODUCTION

A great architect and complex personality, like renaissance "Homo Universalis", G.M. Cantacuzino considered himself in 1947 as one of those architects who "think it is necessary to find a balance, without disregarding any of the modern themes and without turning back from the tradition " (Teodorovici,

¹University of Agricultural Sciences and Veterinary Medicine Iasi, Romania

²"Gh. Asachi" Technical College, Iasi, Romania

2016). Passionate for history, Cantacuzino managed an original synthesis between modernism, the architectural traditions of Romania and classicism. Because of his views, always sincerely exposed about the history of human culture and civilization, he was treated with aggressiveness, both by fascists and communists. Following a missed attempt to flee the country and to support students' revolt anticommunist movements, he was condemned to jail and forced labor, put under scrutiny, having a ban on leaving the country. Considering the epoch of the extremes experienced painfully by him, the way he had the courage to preserve his intellectual integrity is remarkable. Iasi was the only city that received him in 1957, entrusting him with the important project of the two palaces within the metropolitan enclosure. This work motivated and kept him alive until his unexpected death in 1960.

MATERIAL AND METHOD

The paper focuses on G.M. Cantacuzino passion for the landscape and on the fact that the landscape of Moldova and especially of Iasi marked his life. A few years before his death, worried about the gloomy post-war future expected for the historic city of Iasi, the architect advocated for the salvation of the city's landscape in his conferences, in 1955 and 1958, with the theme "The city of Iași - a landscape". At that time, and also later, his alarm signal related to what could be saved from the historical ensemble of old Iasi was ignored. Shortly after these conferences, in the old areas of Iasi began urban destruction and renovation, as happened in many of the historical cities of Romania.

RESULTS AND DISCUSSIONS

During the design of the twin palaces of Iași Metropolitan Ensemble (1957-1960), G.M. Cantacuzino lived austere like a monk in a cell of the Metropolia, designing, drawing relentlessly and supervising the works on the site. Partly refreshed by this project, the architect felt an intense need to continue his memoirs in his diary called "Letters to Simon." Many evokes are from Moldova, from his grandparents places, memories through which he managed to convey feelings and impressions of both childhood and maturity. Many of them reveal that his classic attitude (through which the architect succeeded in linking modernism to tradition and aesthetics of ethics) was impregnated by a huge passion for the landscape.

In this context, we can say that the landscape played a very important role in the life of G. M. Cantacuzino.

The natural, historical or modern landscape was present not only in everything he wrote but also in his paintings. The way he describes the landscapes is inimitable, yet he is extremely eloquent but also overwhelmingly charming (Dascălu, 2006). In Cantacuzino's Third Letter, he recounted how he perceived in his childhood the natural setting in Hoisești (at his grandmother's mansion in Moldova) when he first arrived in the country from abroad: "The country road rushed in lazy curves along those hills always seen. To get into the general harmony of the sunset, the horses were advancing without any hurry. Everything

was swollen in this view without straight lines." (Cantacuzino, 1993). This waved landscape clearly reminds us of Blaga and the relief of the valley-hill-valley of its "mioritic/pastoral" space (Mitican, 2007). At the same time, in a walk with his grandfather, he received an important lesson about the significance of the Moldavian landscape: "We came to a place where the gaze contained all the sight. There was a lonely bank, which my grandfather sat down and, taking me on his lap, began to tell me about the *meaning of the landscape*. Caring this significance deep in his soul, G.M. Cantacuzino confessed: "The poetry of Moldova, as well as that of the sea, have been, throughout my life, generous springs, which have spread to my memory, creating a special moment of my inner life." (Cantacuzino, 1993). In the last years of life, the architect passionately worked in his austere cell: "I do not see anyone anymore and I get my dinner in a hurry. Stood up early, drawing late at night. I have not worked so much and with so much zeal, so much optimism, for I have not had such a long and grateful project in my hands ... Caught up by enthusiasm I could not see, feel or be interested but of my work." (Cantacuzino, 1993). In a letter to his wife, he described these projects as having the purpose of "improving the urban landscape of Iasi" (Teodorovici, 2016). He designed a square in front of the monumental steps of access to the pavilions. The opening of this square, which could not be never realized, would have highlighted the classical beauty of the pavilions (fig. 1), having as background perspective the entrance to the Metropolitan Church.



Fig. 1. Classical beauty of pavilions

<http://ansamblulmitropolitaniasi.ro/cladirea-administrativa/cancelaria-mitopolitana>

Feeling tired, in order to relax in the late evening or at night, he often started to walk on the old and beloved streets of Iasi. Apparently a settlement that could not impress by grandiose constructions, Iasi city managed to reveal to G.M. Cantacuzino the alchemy and subtle beauty of the historical landscape. The description of his trails is full of the flavor and the charm of the places, a charm that only he could evoke with his prodigious talent. "In the tower of Golia and in Tătărași the bells were ringing in the evening...The violet shadows waved the streets, while the sunset scattered the last rubies on a corner of a wall or on the curve of a dome...In one of the last nights, before it started to snow, I went out to stretch up. I have been drawing for a long time, my eyes were burning, and I felt

sleep was still distant. It was long past midnight. Starting from the Metropolis, I headed for Golia and Barboi. The dark and close sky seemed to be carried by the bell towers, which, in their gloomy verticality, strived to prevent, in a desperate effort, that the vault of the air would crush the city. Here and there a city lamp shaken by the wind casts shadows and lights on the old walls” (Cantacuzino, 1993). In his wanderings, he always revealed with the same satisfaction that "the profiles of the walls and the towers of Iasi corresponded with a certain harmony that I have not found elsewhere". In relation to the landscape, he makes a tremendous confession in his Fourth Letter: "Romanian generosity, when it is not darkened by a false education, gives to the Romanian landscapes a nobility not seen in other places" (Cantacuzino, 1993).

The subtle charm of Iasi intensified his desire to do something real helpful, a public pleading for preserving the historical and ambiental values of the city specific landscape. The first conference was in Bucharest in 1955, followed in 1958 by the one at University of Iasi held at the invitation of the Architects Union of Romania. He courageously highlighted in these lectures the historical magnificence of Iasi and the real fact that after the union of 1859 the city was transformed into a province town. He spoke about the danger of the communist tendency of replacing the historical urban tissue, pointing out that their supreme argument and their last solution was the pick-tool.

CONCLUSIONS

Despite his precarious health, refusing to be a victim of the communist system, architect G.M. Cantacuzino pleaded with dignity and courage to save the Iasi historical landscape in his conferences. Underlining the existence of many valuable monuments, G. M. Cantacuzino asked the authorities to classify the historical center of Iași as a protected historical area. His message, a strong alarm signal, was obviously ignored and could not save the old Iasi. Even in the year of his death, in 1960, many historical buildings, in the area adjacent to the Union Square, were demolished without arguments in order to create a modern area. Nowadays, his message about the preservation of Romanian historical centers constitutes valuable and precious lessons for all.

REFERENCES

1. **Cantacuzino G. M., 1993** - *Scrisorile către Simon*, Ed. Dacia, Cluj-Napoca, p.33-46.
2. **Dascălu Doina Mira, 2006** - *The sentimental aesthetics of G. M. Cantacuzino*, Intersections vol. 3, nr. 8 « Architecture and Urbanism », Ed. Societății Academice Matei-Teiu Botez, Iași, articolul nr. 63, p. 7-11
3. **Mitican I., 2007** - *Moștenirea ieșeană a arhitectului G. M. Cantacuzino*, Ziarul Lumina, Iași.
4. **Teodorovici D., 2016** - *George Matei Cantacuzino. Modernismul hybrid*, Ed. Simetria, București, p. 131-137.

RESEARCH ON SUSTAINABLE METHODS OF MAINTENANCE OF GREEN ROOFS

CERCETĂRI PRIVIND METODE SUSTENABILE DE ÎNTREȚINERE A ACOPERIȘURILOR VERZI

PAȘCU Roxana¹, ZLATI Cristina¹, BERNARDIS R.R.¹
e-mail: ing.dr.roxana@gmail.com

Abstract. *The practice of developing vegetation roofs can be said to have ancient origins, proof being the legendary Babylonian hanging gardens that were decorated with trees and flowers on top of the palaces. As a result, today, this attractive practice has a high environmental value and therefore in this paper we present methods through which we want to add the new valency of ambiental improvement and safety in maintenance green terraces, thanks to new modern technologies available at the moment. Special attention was paid to drainage and water retention in order to adjust stratigraphy of green terraces. Thus, by reducing the weight and reducing the costs of maintenance activities, it was determined that the time evolution of the roof is directly related to the economic and environmental sustainability of the system and as a result, three levels of maintenance have been defined. In achieving these levels two fundamental aspects have been highlighted: a visible one, mainly related to aesthetic aspects and another, imperceptible at first glance, involving the elements of structure, protection, maintenance and safety.*

Key words: green roof, sustainability, landscape design

Rezumat. *Practica amenajării acoperișurilor cu vegetație putem aprecia că are origini antice, dovadă fiind legendarele grădini suspendate babiloniene care ornau cu arbori și flori partea superioară a palatelor. Drept urmare, în zilele noastre, această practică atractivă are o ridicată valoare ambiantală și, de aceea, în cadrul acestei lucrări sunt prezentate metode prin intermediul cărora se dorește să se adauge fascinantelor terase verzi, noi valențe de ameliorare ambiantală și siguranță în întreținere, grație celor mai moderne tehnologii disponibile în acest moment. O atenție specială a fost acordată drenajului și retenției de apă în scopul ajustării stratigrafiilor teraselor verzi. Astfel, prin reducerea greutății și diminuarea costurilor activităților de întreținere, s-a determinat faptul că evoluția în timp a acoperișului este direct legată de sustenabilitatea economică și ambiantală a sistemului, și drept urmare s-au definit trei nivele de întreținere. În realizarea acestor nivele s-au evidențiat două aspecte fundamentale: unul vizibil, în principal legat de aspectele estetice și altul, imperceptibil la prima vedere, care implică elementele de structură, de protecție, de întreținere și de siguranță.*

Cuvinte cheie: acoperiș verde, sustenabilitate, design peisager

INTRODUCTION

If we think of the legendary Babylonian hanging gardens that decorated with trees and flowers the superior part of their palaces, we can appreciate that

¹University of Agricultural Sciences and Veterinary Medicine from Iași, Romania

terraces and roofs adorned with vegetation have ancient origins. Even today, this attractive practice has a high environmental value and, therefore, the theme of this work is to add new decorative valences and ambient improvement, fascinating green terraces, maintenance safety and waterproofing safety thanks to the most modern technologies available at the moment.

Special attention is paid to drainage and water retention in order to increase green tertiary stratigraphy by reducing the weight and reducing the costs of maintenance (Compagnone, 2009).

Taking into account the advantages of this arrangement, namely increased rainwater retention, smog and dust reduction, noise reduction, thermal insulation enhancement, effective protection of waterproofing against ultraviolet rays (Niachou *et al.*, 2001), waterproofing against thermal stress generated by temperature variations day-night/summer-winter, protecting the waterproofing against mechanical stress, improving the quality of life, the integration of the real estate in the natural environment and, last but not least, increasing the value of the real estate (Ekaterini and Aravantinos, 1998), the work focused on the study of some methods of maintenance of the roofs, considering that the degree of involvement in this technical segment leads to increased use period and, at the same time, to lowering the costs and the actual maintenance time (Dascălu and Pașcu, 2016).

Designing in the field is guided by a series of standards that regulate roof landscaping (Haggas, 2006), some of which are presented in table 1.

Table 1

Standards in the field of coatings

ELEMENT	FUNCTION	APPLICATION	THE STANDARD WHICH REQUESTS THE NORM 'CE' ON PRODUCTS
Support elements	Protection	Coverage	EN 13953
Isolating element for the root action (integrated or not)	Root limiting barrier	Coverage	UNI EN 13978 plus the declaration of conformity that the membrane serves the green terrace applications
Drainage element	Drainage	Coverage	EN 13952

MATERIAL AND METHOD

The present paper analyzed in the smallest detail the development of flexible systems of green roofs, suitable for adaptation even on surfaces defined by complex structures (Cirstolovean, 2007) and with different inclinations. An example is the green terrace with a steep slope, where the materials and maintenance solutions guarantee a constant and uniform greening. Layer structure details for this variant, depending on the degree of inclination, are shown in figure 1.

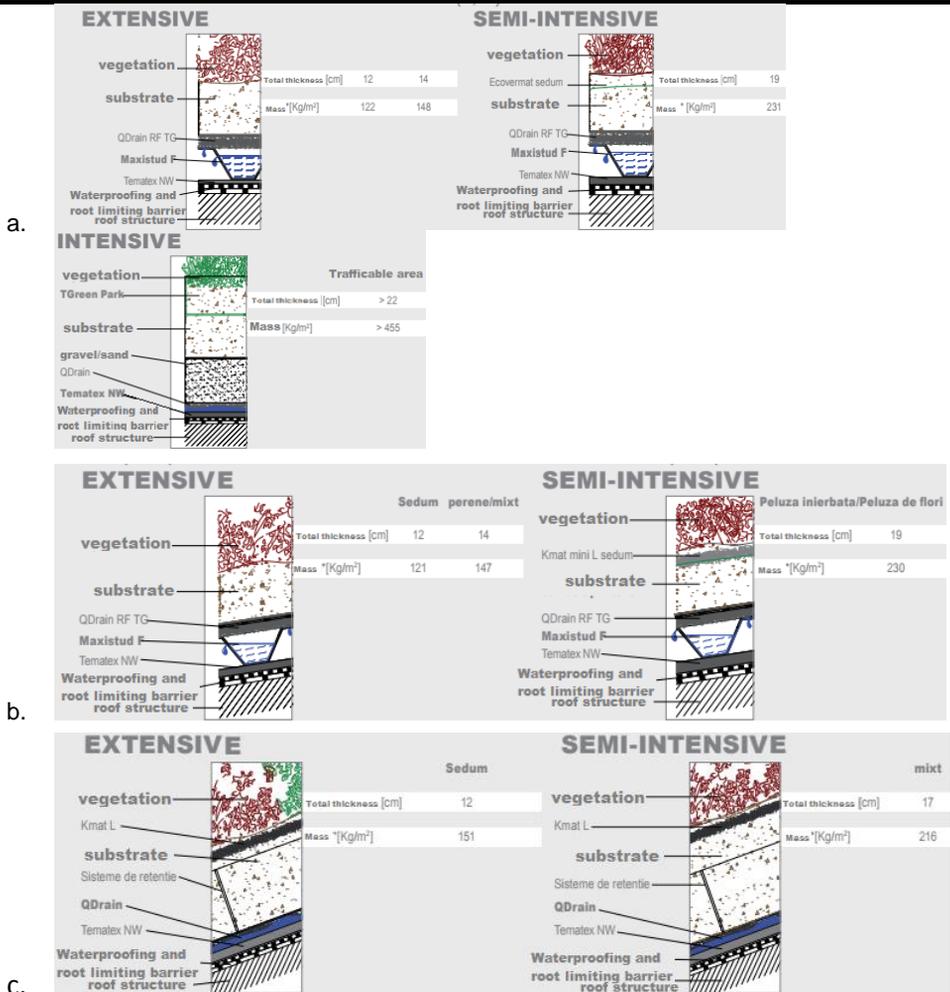


Fig.1 Structure of the system and layout of the layers for the roofs with a surface inclination a. small <5% (2.9 °) b. average <15% (8.5 °) and c. high <45% (24.2 °)

The construction system used consists of basic elements (primary elements), secondary layers and equipment that can be used in accordance with product operating recommendations, climatic and field conditions. The primary elements are made up of a carrying element, a supporting element, a root-protective element (integrated or not), a mechanic protection liner (Tematex NW), a draining element (QDrain TG), an water retaining element (Maxistud F) and a filter element (www.maccaferri.com) over which a culture substrate has been deposited. The last layer is being represented by the selected vegetation composed of species belonging to the genus *Sedum* (Negrea *et al.*, 2014) and other genus of poaceae and gramineae (Emilsson, 2008). Besides these primary elements, the secondary layers and the complementary equipment that make up a green roof consist of a vapor barrier layer, a protective layer, a thermo-insulating layer, a slope layer, a primer layer, a

leveling layer, vapor pressure diffusion and/or equalization layer, stiffening and unloading layer, separation layer and/or slag layer, protective layer, ballast layer, anti-erosion coating (Kmat L) and irrigation system (fig. 1).

RESULTS AND DISCUSIONS

In order to quantify the results, it was intended to observe the current standards in the field of coatings and to define the green roof system according to the total mass of the water-saturated system (Kg/m^2), the total thickness of the system (cm) and the compatibility with climate zone [adaptability to climatic zone 2 (Haggas, 2006)].

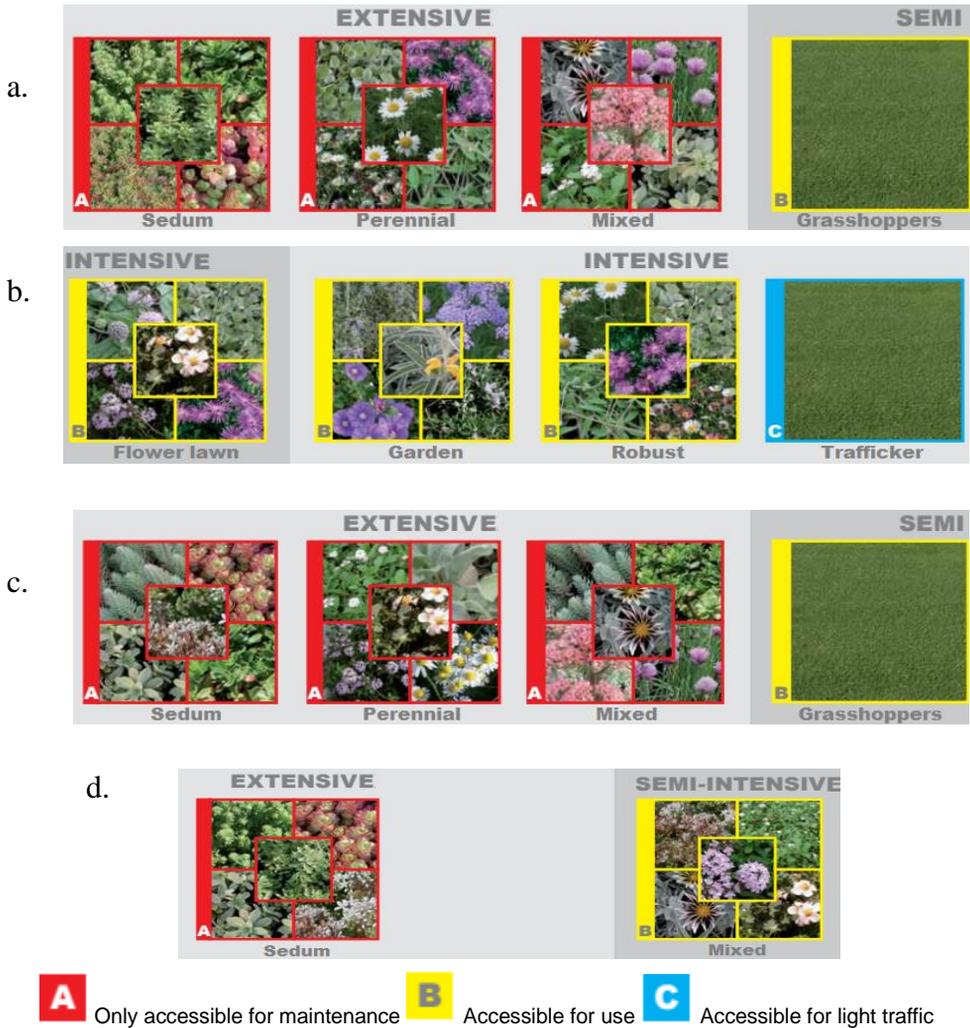


Fig. 2 Surface with: a and b with a low slope <5% (2, 90 °), c. with a mean slope <15% (8.5°), and d. with a steep slope <45% (24.2°)

The study found that green roofs had three different maintenance classes.

The three levels of maintenance differ according to the difficulty of maintenance work and their frequency:

- Class 1: Easy maintenance (extensive)
- Class 2: Medium maintenance (semi-intensive)
- Class 3: Frequent maintenance (intensive)

Easy Maintenance: (extensive system – fig. 2) to which maintenance interventions are limited to controlling system elements. Especially vegetal layers are checked by monitoring the physiological and phytosanitary status of plants, checks on the presence of parasites and weeds that may adversely affect the system's functionality. Irrigation can be done occasionally only to keep plants in unusual drought conditions alive.

The study found that for light maintenance coverage an intervention program of about 3 days a year could be foreseen at an area of 1,000 m².

Medium and frequent maintenance: (intensive system – fig. 2.a.) in which maintenance interventions include the verification of the system elements and the vegetation layer already foreseen in the intensive system to which all the agronomic activities necessary for the correct management of the green space . Avoid using improper equipment for such interventions. Irrigation will be specially designed only when it is necessary to maintain the green roof permanently.

By reducing the weight and maintenance costs, it has been determined that the time evolution of the roof is directly related to the economic and environmental sustainability of the system.

The results obtained from the study revealed two fundamental aspects: a visible one, mainly related to aesthetic aspects and another, imperceptible at first glance, involving elements of structure, protection, maintenance and safety.

CONCLUSIONS

Roof maintenance is directly related to the economic and environmental sustainability of the system and is necessarily assessed from the design stage by determining the maintenance costs.

The evolution in time of the roof is directly related to the economic and environmental sustainability of the system by reducing weight and reducing the cost of maintenance.

Also, this type of arrangement, by its novelty degree, offers the possibility for the active involvement of designers, builders and beneficiaries in assisting at the design phases as well as testing new environmentally friendly products in the context of the roofing sustainability and green terraces.

REFERENCES

1. **Cirstolovean L., 2007** - *Considerations regarding the optimum thermal insulation thickness of buildings by calculation in locations with high outdoor temperature due to solar radiation*, ISSN: 1843-6617, Transilvania University PRESS of Brasov, Romania, pp. 449.
2. **Compagnone G., 2009** - *Modular Green roof technology*, *Environmental Design & Construction*, ISSN 1095-8932, 10/2009, Volume 12, Issue 10, pp. 12.
3. **Dascălu Mira Doina, Pașcu Roxana, 2016** - *Plastic waste storage as multifunctional „green” modules for territorial use*. *Environmental Engineering and Management Journal*, August 2016, Vol.15, No. 8, Print ISSN: 1582-9596, Electronic ISSN: 1843-3707, <http://omicron.ch.tuiasi.ro/EEMJ>.
4. **Emilsson T., 2008** - *Vegetation development on extensive vegetated green roofs: Influence of substrate composition, establishment method and species mix*, *Ecological Engineering*, 33(3), pp. 265-277.
5. **Ekaterini Eumorfopoulou, Aravantinos D., 1998** - *The Contribution of a Planted Roof to the Thermal Protection of Buildings in Greece*. *Energy and Buildings*, Volume 27, Issue 1, pp. 29-36.
6. **Haggas C., 2006** - *Green Roof Plants: A Resource and Planting Guide*, *The Booklist*, ISSN 0006-7385, 10/2006, Volume 103, Issue 3, pag. 14.
7. **Negrea Roxana, Draghia Lucia, Ciobotari Gh, 2014** - *Influence of some culture systems on the ornamental value of Sedum spurium ‘Fuldaglut’ and Sempervivum tectorum species*, U.S.A.M.V. Iași, Vol. I (57) Horticulture Series, pp. 217-222, ISSN 1454-7376.
8. **Niachou A., Papakonstantinou K., Santamouris M., Tsangrassoulis A., Mihalakakou G., 2001** - *Analysis of the green roof thermal properties and investigation of its energy performance*, *Energy and Buildings*, ISSN 0378-7788, Volume 33, Issue 7, pp 719-729
9. *******, <https://www.maccafferri.com/ro/produse/green-terramesh/Qdrane>

PERMACULTURE CONCEPT IN 3 DIMENSIONAL AGRICULTURAL LANDSCAPING

CONCEPTUL DE PERMACULTURĂ ÎN AMENAJAREA PEISAGISTICĂ 3D

ZLATI Cristina¹, PAȘCU Roxana¹, BERNARDIS R.¹, VIERU I.¹
e-mail: zlaticris@uaiasi.ro

Abstract. *Permaculture is a design system for creating sustainable human environments, that expands its applicability also in agricultural landscaping. Permaculture is not limited to plant and animal agriculture, but also includes community planning and development, use of appropriate technologies (coupled with an adjustment of life-style), and adoption of concepts and philosophies that are both earth-based and people-centered, such as bioregionalism. The general aim of this study is to emphasise the benefits of permaculture concept in the actual globalization context and serve as a guidepost to right livelihood in concert with the global community and the environment, rather than individualism and indifference. Whereas permaculture ethics are more akin to broad moral values or codes of behavior, the principles of permaculture provide a set of universally applicable guidelines which can be used in designing sustainable habitats. Distilled from multiple disciplines—ecology, energy conservation, landscape design, and environmental science—these principles are inherent in any permaculture design, in any climate, and at any scale.*

Key words: permaculture, sustainability, landscape design

Rezumat. *Permacultura este un sistem de design pentru a crea un mediu de viață sustenabil pentru om, care își extinde aplicabilitatea și în peisajul agricol. Permacultura nu se limitează doar la domeniile agricole, ci include și planificarea și dezvoltarea comunității, utilizarea tehnologiilor adecvate (împreună cu o adaptare a unui stil de viață) și adoptarea unor concepte și filozofii care sunt centrate pe pământ și pe oameni, cum ar fi bioregionalismul. Scopul general al acestui studiu este de a extinde beneficiile conceptului de permacultură în contextul actual al globalizării și de a servi ca un ghid pentru a trăi corect, în armonie cu comunitatea globală și cu mediul, mai degrabă, decât în individualism și indiferență. În timp ce etica permaculturii este mai asemănătoare cu valori morale sau coduri comportamentale, principiile permaculturii oferă un set de linii directoare universal aplicabile care pot fi utilizate în proiectarea habitatelor durabile. Derivate din mai multe discipline: ecologie, conservarea energiei, designul peisajului și știința mediului - aceste principii sunt inerente oricărui design/proiect de permacultură, în orice climat și la orice scară.*

Cuvinte cheie: permacultură, sustenabilitate, design peisager

¹University of Agricultural Sciences and Veterinary Medicine from Iași, Romania

INTRODUCTION

Bill Mollison and David Holmgren, founders of permaculture concept in 1970, have defined permaculture as a design system to create a sustainable human environment (Mollison, 1979).

The present work have a serie of objectives as it follows:

- building a model of permaculture in Moldova region,
- involvement of the three axes of the 3D agricultural landscaping (plants, environment, and human),
- involving sustainable agriculture practices and land management techniques and strategies from around the world, forming a bridge between traditional cultures and emergent earth-tuned cultures.
- studying and systeming the literature on this subject,
- increasing surfaces cultivated with fruit growing species,
- expansion of urban green areas by using roofs as spaces suitable for landscape design.

With world population growth has increased and will further increase the demand for agricultural products which are the basis of human food. It is known that in agriculture in general and fruit growing, in particular, cultivar, by its superior qualities, is the main means of production. Diversification of the research in this area and finding new techniques for obtaining more efficient and rapid production of a higher quality is one of the current priorities of food safety programs. Through its objectives interdisciplinary work involving advanced methodologies, this research contributes to the development of knowledge in the field. Originality can be expressed through the expansion and diversification of bush culture methods (especially the strawberry) in the context of capitalization terraces. Green roofs represent a way of landscape development that combines aesthetics with ecological functions of these types of facilities, offering space for extending the strawberry culture.

MATERIAL AND METHOD

The general aim of this study is to emphasise the benefits of permaculture concept in the actual globalization context and presenting a permaculture example in 3 dimensional agricultural landscaping.

The 3 D-s involved in project's concept are refering to: Human aspect, Agricultural environment and Social context.

All humans have the same basic needs – to be safe, secure, have enough to eat and have a happy life, in harmony with the environment, either natural or agricultural, all aspects leading to a balanced society that meet the needs of all humans.

The site is under continuous development and with ever changing and evolving on ground research in practice; work is consistently in progress to develop more efficient and productive systems.

A project that involves two families that share the same vision, to live and to raise their children in a beautiful safe environment and to cultivate their land and to enjoy life fully.

Located on a residential district, Arcașilor Street, Galați, the aim of this project is to transform the previous location into an abundant garden, where the inhabitants and nature itself can thrive. So far, this process has come to transform the human

aspect, filling them with passion for what they are doing and giving them great joy. The aim is to share this experience with more people and make a real, strong positive change in the present society.

The strawberry culture is just a part of the production system. The project has a vegetable growing sector and an orchard. The production obtained covers 65% of the two families needs.

In figure 1 are presented different aspects during project implementation. The culture substrate involves different layers that ensures permeability and isolation. The upper layer is forest soil.

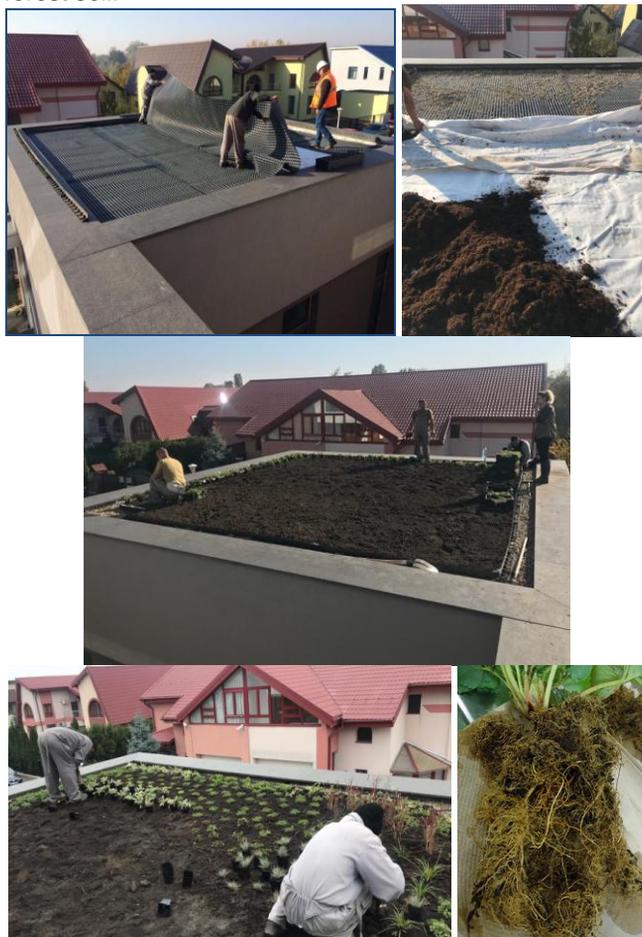


Fig. 1 Different stages of project implementation

RESULTS AND DISCUSSIONS

Permaculture is about designing and combining ecological human habitats with food production systems. This paper discusses on permaculture concepts and their applications, and offers listings of resource organizations and references on permaculture.

The social and economical context and environment quality. Permaculture is not limited to plant and animal agriculture, but also includes community planning and development, use of appropriate technologies (coupled with an adjustment of life-style), and adoption of concepts and philosophies that are both earth-based and people-centered, such as bioregionalism (Mollison and Holmgren, 1987).

The Ethics of Permaculture. Permaculture is unique among alternative farming systems (e.g., organic, sustainable, eco-agriculture, biodynamic) in that it works with a set of ethics that suggest we think and act responsibly in relation to each other and the earth.

The ethics of permaculture provide a sense of place in the larger scheme of things, and serve as a guidepost to right livelihood in concert with the global community and the environment, rather than individualism and indifference.

Care of the Earth - includes all living and non-living things—plants, animals, land, water and air.

Care of People - promotes self-reliance and community responsibility—access to resources necessary for existence.

Setting Limits to Population & Consumption - gives away surplus—contribution of surplus time, labor, money, information, and energy to achieve the aims of earth and people care.

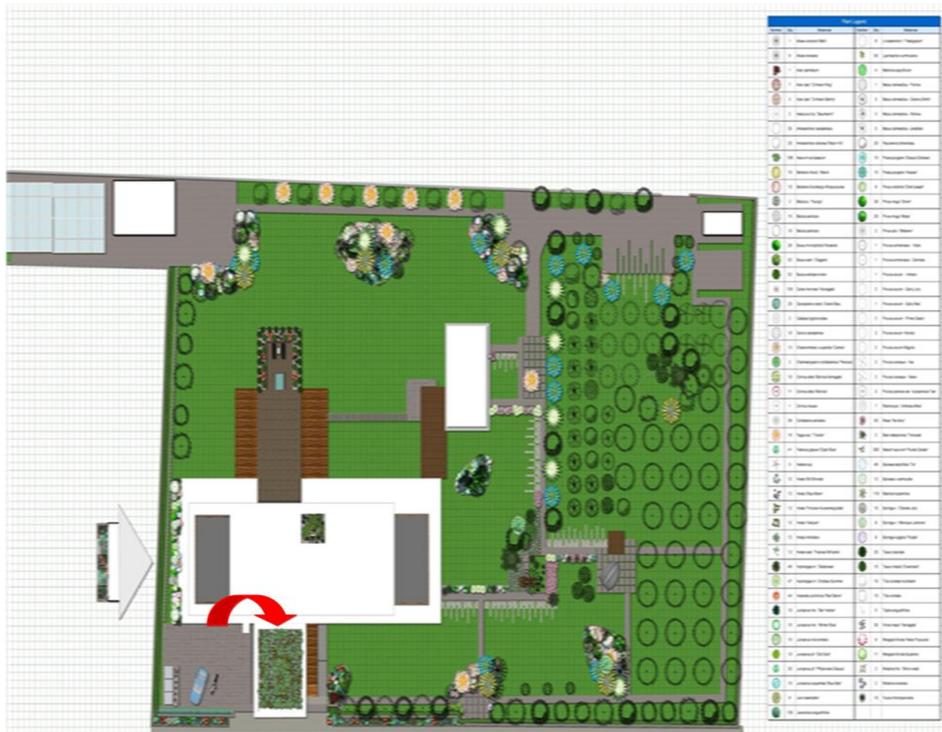


Fig. 2 The general plan of the site

The Principles of Permaculture Design Whereas permaculture ethics are more akin to broad moral values or codes of behavior, the principles of permaculture provide a set of universally applicable guidelines which can be used in designing sustainable habitats. Involving multiple disciplines—ecology, energy conservation, landscape design, and environmental science—these principles are inherent in any permaculture design, in any climate, and at any scale.

- Relative location,
- Each element performs multiple functions,
- Each function is supported by many elements,
- Energy efficient planning,
- Using biological resources,
- Energy cycling,
- Small-scale intensive systems,
- Natural plant succession and stacking,
- Polyculture and diversity of species,
- Increasing "edge" within a system,
- Observe and replicate natural patterns,
- Pay attention to scale,
- Attitude.

The sustainability of this approach lies in combining economic, aesthetic and functional aspects, especially of such areas, making them the primary aspects anchored in determining the choice of the most suitable crop systems.

Fruit trees with ornamental value are well represented by a great diversity of species and varieties that find, in our country, favorable climatic conditions for growth and prosperity, while ensuring decor spread throughout the year (Iliescu, 2005). For strawberry, there are developed many culture methods that have dual role: ornamental and economically.

Extending the concept of green roof has advantages in terms of encouraging environment, educational system and the community life, fostering solidarity population to achieve a framework for proper management of long-term spaces.

Inside the cities, these interventions lead to remodeling phenomena aimed at increasing the quality of life of the inhabitants, reunified under the name of urban regeneration.

CONCLUSIONS

Observations and researches have concluded that implementation of the concept of permaculture can be very successful, both in the short and long term, primarily by reducing pollution and improving the aesthetics of space designed and also including fruit production.

Promoting the concept of permaculture in conjunction with the already existing model of "green roof" and "garden on the roof", aims to promote new ideas untapped production at full capacity so far in our country. This involves the

use of these innovative concepts, such as an ongoing process of communication, information and advice noteworthy.

The originality of the proposed theme can be expressed through the expansion and diversification of methods of systematization urban green spaces in Romania by including tree species (strawberry) in design and exploitation of the full potential of urban spaces less exploited.

REFERENCES

1. **Dascălu Mira Doina, Pașcu Roxana, 2016** - *Plastic waste storage as multifunctional „green” modules for territorial use*. Environmental Engineering and Management Journal, August 2016, Vol.15, No. 8, Print ISSN: 1582-9596, Electronic ISSN: 1843-3707, <http://omicron.ch.tuiasi.ro/EEMJ>
2. **Emilsson T., 2008** - *Vegetation development on extensive vegetated green roofs: Influence of substrate composition, establishment method and species mix*, Ecological Engineering, 33(3), pp. 265-277.
3. **Haggas C., 2006** - *Green Roof Plants: A Resource and Planting Guide*, The Booklist, ISSN 0006-7385, 10/2006, Volume 103, Issue 3, pag. 14.
4. **Iliescu Ana-Felicia, 2005** - *Cultura arborilor și arbuștilor ornamentali*; Editura Ceres București.
5. **Luchkina Claire M., 2016** – *Online Permaculture Resources: An Evaluation of a Selected Sample, Inquiry*: The University of Arkansas Undergraduate Research Journal, Vol. 20, Article 7.
6. **Mollison B., Remy Mia Slay, 1991** - *Introduction to Permaculture*. Tagari Publishers, Tyalgum, Australia. 198 p.
7. **Mollison B., D. Holmgren, 1987** - *Permaculture One: A Perennial Agriculture for Human Settlements*, 3rd Edition. Tagari Publishers, Tyalgum, New South Wales, Australia. 127 p.
8. **Mollison B., 1979** - *Permaculture Two: A Practical Design for Town and Country in Permanent Agriculture*. Tagari Press, Stanley, Australia. 150 p.
9. **Morrow Rosemary, R. Allsop 1994** - *Earth User's Guide to Permaculture*. Kangaroo Press, Kenthurst, NSW Australia. 152 p.
10. **Negrea Roxana, Draghia Lucia, Ciobotari Gh, 2014** - *Influence of some culture systems on the ornamental value of Sedum spurium 'Fuldaglut' and Sempervivum tectorum species*, U.S.A.M.V. Iași, Vol. I (57) Horticulture Series, p. 217-222, ISSN 1454-7376.
11. **Ross M., 2005** - *The Basics of Permaculture Design*. Chelsea Green. p. 1. ISBN 978-1-85623-023-0.

RESEARCH REGARDING THE BEHAVIOUR OF SOME ROSE FROM THEA GROUP IN CROPPING CONDITIONS FROM IAȘI COUNTY, ROMANIA

CERCETĂRI PRIVIND COMPORTAREA UNOR TRANDAFIRI DIN GRUPA THEA ÎN CONDIȚIILE DE CULTURĂ DIN IAȘI, ROMANIA

*CHELARIU Elena Liliana¹ COJOCARIU Mirela¹,
DRAGHIA Lucia¹, BRÎNZĂ Maria¹, AVARVAREI B.V.¹*

e-mail: mirelacojocariu@gmail.com

Abstract. *The current paper aimed to analyse the behaviour of some rose from Thea group ('Ingrid Bergman', 'Maurice Utrilo', 'Monika') in the pedoclimatic conditions from Iași County, Romania. Determinations were carried out in cropping conditions provided by rose collection of Floriculture discipline from UASVM Iași, Romania. At the end of the study was observed that in the cropping conditions from North-East area of Romania, rose assortments had a very good adaptation. From spring till autumn plants are decorative, being suitable to be used in different types of landscape design.*

Key words: rose, adaptation, 'Ingrid Bergman', 'Maurice Utrilo', 'Monika'

Rezumat. *Lucrarea de față își propune analizarea comportării unor soiuri de trandafiri aparținând grupului Thea ('Ingrid Bergman', 'Maurice Utrilo', 'Monika') în condițiile pedoclimatice din județul Iași, România. Determinările au fost efectuate în condițiile de cultură oferite de colecția de trandafiri a disciplinei de Floricultură din cadrul USAMV Iași, România. La finalul cercetărilor s-a observat că în condițiile de cultură din zona de Nord-Est a României, soiurile de trandafiri au avut o foarte bună adaptare. Din primăvară până în toamnă plantele sunt decorative, putând fi folosite în diferite tipuri de amenajări peisagistice.*

Cuvinte cheie: trandafiri, adaptare, 'Ingrid Bergman', 'Maurice Utrilo', 'Monika'

INTRODUCTION

Genus *Rosa* L. belongs to Rosaceae family and includes various taxons cultivated for cut flowers which are used in floral art (Buta and Cantor, 2015) and in different compositions for landscape designs (Wagner, 2002).

From Antiquity, rose gains the rank of "Queen of flowers", due to it's multiply qualities, especially beauty and elegance of flowers (Buta and Cantor, 2015; Cantor and Buta, 2010; Wagner, 2002; Mikolajski, 2013).

Because in the last years, in Romania, the interest for rose utilization in landscape designs was inconstant, in the current study we aimed to evaluate the behaviour in cropping conditions from Iași, Romania, for three rose kinds belonging to theahybrida group.

¹University of Agricultural Sciences and Veterinary Medicine from Iași, Romania

MATERIAL AND METHOD

Research was carried out in the rose collection of Floriculture discipline belonging to USAVM Iași, Romania, during 2016-2017.

Research material was represented by three rose assortments belonging to theahybrida group (TH): 'Ingrid Bergman', 'Maurice Utrilo', 'Monika', planted in 2015.

Observations were realised starting with the end of May till October, based on some special files in which were mentioned the studied characters and features together with the maximal point value which could be attributed to each of them: bush form (5 points), bush vigour (8 points), aspect of leafage (8 points), resistance at pathogen agents attack (8 points), rod and floral peduncle (5 points), flowering intensity (10 points), rosebud shape (10 points), shape of opened flowers (7 points), flower durability (5 points), colour of petals at opening (6 points), colour of petals at flowering (6 points), falling mode of petals (5 points), flowers' perfume (7 points), other aspects (adaptability at cropping conditions) (10 points) (Wagner, 2002). Based on the mean obtained score were made appreciations regarding the behaviour in cropping conditions from Iași, Romania.

RESULTS AND DISCUSSIONS

'**Ingrid Bergman®**' (POULman) (fig. 1) is a theahybrid rose created by L. Pernille Olesen in Denmark, in 1985, when was registered under the name of POUlman. It has a compact bush aspect, dense, with a height which could reach 50-90 cm, well ramified. It presents straight and strong stems, and at their end appear solitary or grouped, big flowers with diameter of 10-14 cm, with 25-40 petals, having a warm and velvety intense red colour. The perfect shape of flower denotes a remarkable elegance. Leaves have a dark-green colour, being semi-glossy. It blooms abundant from summer till late in autumn (Wagner, 2002; Mikolajski, 2007). It tolerates well heat, rain and it is very resistant to pests and diseases. Also, was observed that has a remarkable resistance at frost.

It received numerous awards and was included, in 2000, into the list of worlds' favourite roses by World Federation of Rose Societies (https://en.wikipedia.org/wiki/Rosa_'Ingrid_Bergman'; <https://www.helpmefind.com/rose/l.php?l=1.3389>).

'Ingrid Bergman', in cropping conditions from Iași, obtained during research period a total score of 91.12 from 100 possible points (tab. 1). Plants were remarked by the shape of opened flowers, flower durability, colour of petals at opening, colour of petals at flowering, adaptability at cropping conditions, at which plant received the maximum score for each character. It was observed the fact that leafage was very beautifully preserved till late in autumn (7.78 points). Rosebuds are elegant (9.67 points). Plants showed a good resistance at pathogen agents attack (7.75 points). Flowers are less perfumed (1 point), bloom abundantly (9.78 points) till late in autumn (5 points).

This assortment could be considered as excellent for utilisation in landscape designs in areas with cropping conditions similar to Iași area.



Fig. 1 'Ingrid Bergman®' (original)

Table 1
Evaluation of 'Ingrid Bergman®' kind in cropping conditions from Iași, Romania

Evaluated character	Maximum score	Date										Mean score/ character
		28. V	12. VI	27. VI	12. VII	28. VII	11. VIII	31. VIII	18. IX	2. X		
bush form	5	4	5	5	5	5	5	4	4	4	4.56	
bush vigour	8	7	7	8	8	8	8	8	8	8	7.78	
aspect of leafage	8	8	8	8	8	8	8	8	7	7	7.78	
resistance at pathogen agents	8	8	8	8	8	8	7	7	7	7	7.55	
rod and floral peduncle	5	5	5	5	5	5	5	5	5	5	5	
flowering intensity	10	9	10	10	10	10	10	10	9	9	9.78	
rosebud shape	10	9	9	10	10	10	10	10	10	9	9.67	
shape of opened flowers	7	7	7	7	7	7	7	7	7	7	7	
flower durability	5	5	5	5	5	5	5	5	5	5	5	
colour of petals at opening	6	6	6	6	6	6	6	6	6	6	6	

colour of petals at flowering	6	6	6	6	6	6	6	6	6	6	6	6
falling mode of petals	5	4	4	4	4	4	4	4	4	4	4	4
flowers' perfume	7	1	1	1	1	1	1	1	1	1	1	1
adaptability at cropping conditions	10	10	10	10	10	10	10	10	10	10	10	10
Total score												91.12

‘Monika®’ (TANaknom, TANakinom) synonyms: Monica (fig. 2) is a theahybrid rose created by Hans Jürgen Evers, in Germany, 1985, and was introduced by Tantau Roses in the same year under the commercial name of Monica. It forms a bush with a great vigour, 50-120 cm, which present straight branches, with a reddish colour and few thorns. Leafage is dark green, glossy. Flowers have medium size with 25-28 petals, are light perfumed and could be founded solitary or in small groups on erected stems. Rosebuds are elongated and elegant, with an intense orange colour (Wagner, 2002). Colour intensity is well preserved during life cycle of flower on plant. Only when enter in decline, it decrease and turns slightly to pink. Have an abundant flowering in summer and autumn. In autumn have a light lose at base. In rainy years is sensitive to black spotting. Have a good resistance to frost, pests and diseases (<http://www.helpmefind.com/rose/pl.php?n=18205>).



Fig. 2 ‘Monika®’ (original)

In cropping conditions from Iași, Romania, 'Monika' kind had a good behaviour, obtaining a total score of 94.34 points (tab. 2). Bushes had a very good vigour (8 points), an elegant shape (4.78 points), very rich leafage which persisted till late in autumn (7.89 points) and a good resistance at pathogen agents attack (7.78 points). Rod, floral peduncle and floral rosebud are elegant. Flowers are pleasantly perfumed (3 points), with an orange colour, characteristic to kind, persistent (6 points). Have an abundant flowering till late in autumn (5 points).

This kind had a very good behaviour in cropping conditions from Iași area and could be recommended for vegetal compositions in landscape designs.

Table 2

Evaluation of 'Monika®' kind in cropping conditions from Iași, Romania

Evaluated character	Maximum score	Date										Mean score/ character
		28. V	12. VI	27. VI	12. VII	28. VII	11. VIII	31. VIII	18. IX	2. X		
bush form	5	5	5	5	5	5	5	5	4	4	4.78	
bush vigour	8	8	8	8	8	8	8	8	8	8	8	
aspect of leafage	8	8	8	8	8	8	8	8	8	7	7.89	
resistance at pathogen agents	8	8	8	8	8	8	8	8	7	7	7.78	
rod and floral peduncle	5	5	5	5	5	5	5	5	5	5	5	
flowering intensity	10	10	10	10	10	10	10	10	10	9	9.89	
rosebud shape	10	10	10	10	10	10	10	10	10	10	10	
shape of opened flowers	7	7	7	7	7	7	7	7	7	7	7	
flower durability	5	5	5	5	5	5	5	5	5	5	5	
colour of petals at opening	6	6	6	6	6	6	6	6	6	6	6	
colour of petals at flowering	6	6	6	6	6	6	6	6	6	6	6	
falling mode of petals	5	4	4	4	4	4	4	4	4	4	4	
flowers' perfume	7	3	3	3	3	3	3	3	3	3	3	
adaptability at cropping conditions	10	10	10	10	10	10	10	10	10	10	10	
Total score											94.34	

‘Maurice Utrillo®’ (DELstavo) synonym: Artist Panarose (fig. 3) is a theahybrid rose kind, recorded by Delbard in France, in 2004, under the name of DELstavo. Created in the memory of the great French painter, ‘Maurice Utrillo®’ rose, belongs to the unique collection DelbardPainters. Roses grouped here present flowers of which petals are opening into a whirl of luminous colours, lightly mixed, feature which reminds of the technique used by the Impressionists painters in application of colours on canvas. Their characteristic way of applying undiluted colours, next to each other on canvas, with a minimum possible mix constituted a veritable inspiration source for this collection which is certain totality homage paid to them (<http://www.helpmefind.com/roses>).

Those kind form a vigorous bush, compact, with a height of 50-90 cm, present a healthy leafage with a dark green colour and with big double flowers, with 20-26 petals, lightly perfumed, which appear solitary or grouped by 2-3 on straight stems. Flowers have a mix of red, yellow and white colours in unique variable proportions for each flower. While flower is opening its colours tend to turn from intense red ribbed with yellow and white to red-cyclamen mixed with buttered white. Have a good resistance of flower on plant. It is flowering in waves during the whole vegetation season. Have a good resistance at frost, pests and diseases (<http://www.thetutuguru.com.au/rosedebard/delbard.html>; <http://www.helpmefind.com/roses>; <http://www.helpmefind.com/gardening/pl.php?n=44621>).



a)



b)

Fig. 3 ‘Maurice Utrillo®’ (original)

‘Maurice Utrillo’ roses had a very good behaviour in cropping conditions from Iași, Romania, being obtained during research period a score of 92.9 points

from a total of 100 points (tab. 3). Bushes were vigorous (8 points), well garnished, with very rich leafage (8 points), a good resistance at pathogen agents attack (7.78 points). Flowering took place till late in autumn, flowers resisting very well on plant (5 points). Colour of flowers was a mix of red, yellow, white in different proportions, at the beginning of flowering predominant was white colour (fig. 3a), and after that white-yellowish one (fig. 3b).

'Maurice Utrillo' had a very good behaviour in cropping conditions from Iași, and together with the others two studied kinds could be observed in different landscape designs in the area.

Table 3

Evaluation of 'Maurice Utrillo®' kind in cropping conditions from Iași, Romania

Evaluated character	Maximum score	Date									Mean score/ character
		28. V	12. VI	27. VI	12. VII	28. VII	11. VIII	31. VIII	18. IX	2. X	
bush form	5	4	5	5	5	5	5	5	5	4	4.78
bush vigour	8	8	8	8	8	8	8	8	8	8	8
aspect of leafage	8	8	8	8	8	8	8	8	8	8	8
resistance at pathogen agents	8	8	8	8	8	8	8	8	7	7	7.78
rod and floral peduncle	5	5	5	5	5	5	5	5	5	5	5
flowering intensity	10	9	10	10	10	9	10	10	10	9	9.67
rosebud shape	10	10	10	10	10	10	10	10	10	10	10
shape of opened flowers	7	7	7	7	7	7	7	7	7	6	6.89
flower durability	5	5	5	5	5	5	5	5	5	5	5
colour of petals at opening	6	5	6	6	6	6	6	6	6	5	5.78
colour of petals at flowering	6	6	6	6	6	6	6	6	6	6	6
falling mode of petals	5	4	4	4	4	4	4	4	4	4	4
flowers' perfume	7	2	2	2	2	2	2	2	2	2	2
adaptability at cropping conditions	10	10	10	10	10	10	10	10	10	10	10
Total score											92.9

In landscape designs, plants from vegetal compositions must preserve as much time as possible in the year the ornamental characters (bush aspect, presence of leafage, flowers etc.). Perfume of flowers is one of the basic qualities of roses, and its intensity is correlated with colour of flowers. Generally, roses have a discrete perfume; the most perfumed flowers are the white ones, followed by the yellow and pink ones (Buta and Cantor, 2015). From the studied rose kinds 'Monika' have a fine, discreet perfume, being scored with 3 points (tab. 2) and 'Maurice Utrillo', noted with 2 points from 7 possible points (tab. 3).

CONCLUSIONS

In conclusion, we can affirm that all those three kinds of studied roses, 'Ingrid Bergman', 'Monika' and 'Maurice Utrillo', had a good behaviour in cropping conditions from Iași area, Romania, forming vigorous bushes, with a rich leafage, resistant to pathogen agents attack, with a long time flowering, being able to assure décor from May till late in autumn.

All the above mentioned things sustain the utilisation of those three kinds of roses in vegetal compositions from landscape designs from Iași area, Romania.

Acknowledgments: The current paper was funded from research grant with private funds nr. 19993 / 2014.

REFERENCES

1. Buta Erzsebet, Cantor Maria, 2015 – *Artă florală*. Editura AcademicPres, Cluj-Napoca, ISBN 978-973-744-462-2, 229 p.
2. Cantor Maria, Buta Erzsebet, 2010 – *Artă florală*. Editura Todesco, Cluj-Napoca.
3. Mikolajski A., 2007 – *Roses: Selecting, Growing*, Publisher Hove Apple, ISBN 9781845432089, 256 p.
4. Mikolajski A., 2013 – *Modern Roses: An Illustrated Guide to Varieties, Cultivation and Care, with Step-by-Step Instructions and over 150 Beautiful Photographs*. ISBN 9781780192727.
5. Wagner Ș., 2002 – *Trandafirul – de la mit la mileniul trei*. Editura Echard&Co SNC Cluj-Napoca, ISBN 973-0-02590-8, 284 p.
6. ***, <http://www.helpmefind.com/roses>
7. ***, <http://www.helpmefind.com/gardening/pl.php?n=44621>
8. ***, <https://www.helpmefind.com/rose/l.php?l=1.3389>
9. ***, <http://www.helpmefind.com/rose/pl.php?n=18205>
10. ***, https://en.wikipedia.org/wiki/Rosa_'Ingrid_Bergman'
11. ***, <http://www.thetutuguru.com.au/rosedebard/delbard.html>

**STUDIES REGARDING THE BEHAVIOUR OF
CHASMANTHIUM LATIFOLIUM (MICHX.) YATES
ORNAMENTAL SPECIES IN CROPPING CONDITIONS
FROM IAȘI COUNTY, ROMANIA**

**CERCETĂRI PRIVIND COMPORTAREA SPECIEI ORNAMENTALE
CHASMANTHIUM LATIFOLIUM (MICHX.) YATES ÎN CONDIȚIILE DE
CULTURĂ DIN IAȘI, ROMÂNIA**

CHELARIU Elena Liliana¹

e-mail: julia@uaiasi.ro

Abstract. *Chasmanthium latifolium* (Michx.) Yates belongs to Poaceae family and is classified in category of ornamental grasses. The aim of the current study was to identify a suitable substrate for producing *Chasmanthium latifolium* seedlings, as well as monitoring of its behaviour in the specific cropping conditions from Iași County, Romania. Experiment was carried out with four different substrates: V1 – garden soil; V2 – 1 part peat + 1 part garden soil; V3 – 2 parts peat + 1 part garden soil, V4 – 3 part garden soil + 1 part vermicompost. The obtained seedlings of *Chasmanthium latifolia* were grown in exactly the same field conditions. The best results for quality of seedlings were obtained at variant V4 and cropping plants showed a very good adaptation at the pedoclimatic conditions from Iași County, Romania.

Key words: adaptation, *Chasmanthium latifolium*, ornamental grasses, substrate, vermicompost

Rezumat. *Chasmanthium latifolium* (Michx.) Yates aparține familiei Poaceae fiind clasificată în categoria ierburilor ornamentale. Scopul prezentului studiu a fost identificarea cel mai bun substrat pentru producerea răsadurilor de *Chasmanthium latifolium*, precum și monitorizarea comportării acestora în condițiile de cultură specifice județului Iași, România. Experimentele s-au efectuat pe patru substraturi diferite: V1 – pământ de grădină; V2 – 1 parte turbă + 1 parte pământ de grădină; V3 – 2 părți turbă + 1 parte pământ de grădină, V4 – 3 părți pământ de grădină + 1 parte vermicompost. Răsadurile obținute de *Chasmanthium latifolia* au beneficiat de aceleași condiții în câmp. Cele mai bune rezultate pentru calitatea răsadurilor au fost obținute la varianta V4 iar în cultură plantele au arătat o foarte bună adaptare la condițiile pedoclimatice din județul Iași, România.

Cuvinte cheie: adaptare, *Chasmanthium latifolium*, ierburi ornamentale, substrat, vermicompost

INTRODUCTION

Chasmanthium latifolium (Michx.) Yates (syn. *Uniola latifolia* Michx.) is part of Poaceae botanical family and it is known, with common names, as Spangle Grass, River Oats, Sea Oats (Chelariu, 2013; Hockenberry Meyer and Mower, 1986). In world,

¹University of Agricultural Sciences and Veterinary Medicine from Iași, Romania

various assortments of those species are cultivated for ornamental purposes and are known as ornamental grasses (Ardle, 2007; Graham Rice, 2006). Is a species native from North America, herbaceous, perennial (Chelariu, 2013). Prefers lands with sunny exposure, fertile soils with constant moisture and can support a light semi-shadow. It is cultivated from (4)5 rusticity zone up to zone (8)9. Species is multiplied by seeds and by vegetative way through partition of bush (Hockenberry Meyer and Mower, 1986).

Hockenberry Meyer and Mower (1986) affirm that *Chasmanthium latifolium* (Michx.) Yates seeds could have difficulties at germination. In this way, the utilised substrates for sowing could influence seeds' germination. The utilised vermicompost in the sowing substrate leads to an improvement of seeds' germination rate and seedlings' quality by initial development of roots (Atiyeh *et al.*, 2000).

The current paper aimed to show the influence of substrate on seedlings' production at species *Chasmanthium latifolium* (Michx.) Yates and its' behaviour in the cropping condition from Iași, Romania.

MATERIAL AND METHOD

Research was carried out in 2017, in cropping conditions from didactical collection of Floriculture discipline belonging to UASVM Iași. Experiences were organized on 4 variants represented by cropping substrates (tab. 1).

Table 1

Experimental design

Species	Biological material	Variant	Substrate for sowing
<i>Chasmanthium latifolium</i> (Michx.) Yates	seeds	V1	garden soil (control)
		V2	1 part peat + 1 part garden soil
		V3	2 parts peat + 1 part garden soil
		V4	3 parts garden soil + 1 part vermicompost

Research aimed the behaviour of *Chasmanthium latifolium* (Michx.) Yates ornamental grass species (fig. 1) in cropping conditions from Iași and identification of a suitable substrate for production of seedlings.



Fig. 1 *Chasmanthium latifolium* (Michx.) Yates (original)

The utilized seeds were gathered from plants with an age of 3 years which are in the didactical collection. Vermicompost was provided SC SUPERPĂMÂNT SRL Iași. Sowing was realised in March 2017, and planting in field was done in May 2017, at a 40 cm distance. In field, planting was made function of the variants utilised for seedlings' obtaining.

There were made observations on germination rate, germination dynamics, germination duration, seedlings' quality at planting. After planting of seedlings in field were realised both phenological observation as well as biometrical ones (plants' height, leaf dimensions, number of inflorescences, dimension of inflorescences). The results which were obtained at the end of research were statistically processed by using the variance analysis method (LSD test) (Ardelean *et al.*, 2007).

RESULTS AND DISCUSSIONS

Chasmanthium latifolium (Michx.) Yates is an ornamental grasses species which could multiply both on generative way as well as on vegetative way (Hockenberry Meyer and Mower, 1986; Chelariu, 2013).

At the end of research it could be observed that seeds' germination rate varied from 84% (V1 control) to 97% (V4) (fig. 2).

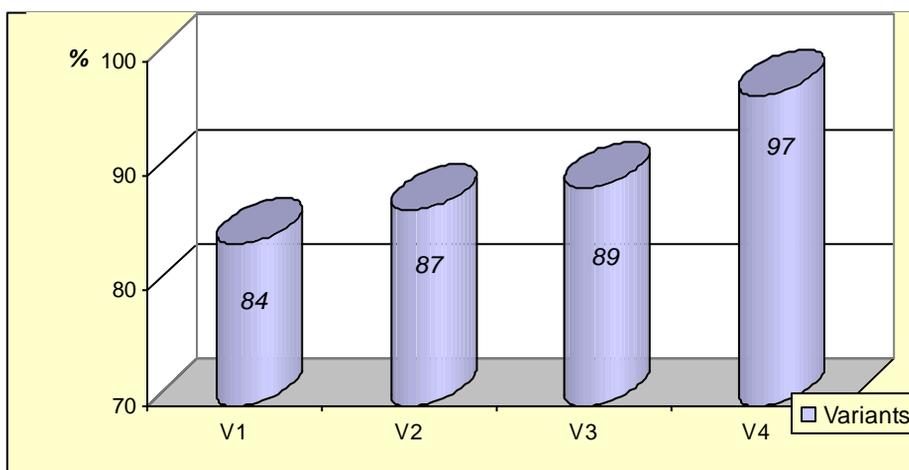


Fig. 2 Germination percentage (%)

Total duration of seeds germination was between 8 days at V4 and 12 days at V1. Vermicompost (V4) determined a light decreasing of germination period face to the others variants (fig. 3).

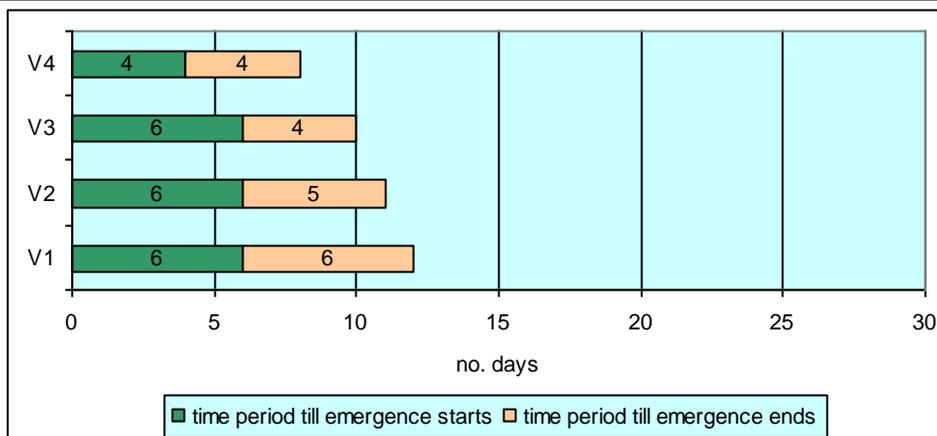


Fig. 3 Duration of germination (number of days from sowing)

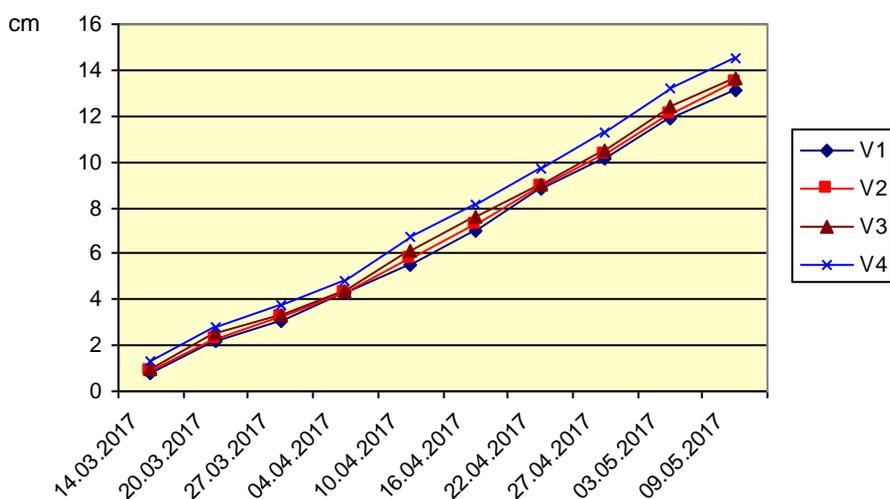


Fig. 4 Dynamics of seedlings' growing

At planting in field seedlings of *Chasmanthium latifolium* (Michx.) Yates had a height between 13.1 cm at variant V1 and 14.5 cm at variant V4 (fig. 4), and a mean number of leaves per plant between 11.3 and 13.4. Number of formed roots is important for a suitable development of seedlings. So, at planting in field seedlings had a mean number of main roots/plant between 5.4 (V1) and 6.8 (V4) (tab. 2).

Statically speaking, at all seedlings' characteristics, differences face to control are positive very significant at variant V4. At others variants differences face to control are positive distinct significant regarding number of leaves and

positive significant for average number of roots per plant (tab. 2).

Vermicompost played an important role at formation and development of plants' roots with effect on plants' quality (Atiyeh *et al.*, 2000).

Table 2

Seedlings' characterization at planting in field (May 2017)

Variant	Mean height (cm)	Mean number of leaves per plant (pieces)	Mean number of roots per plant (pieces)
V1 (control)	13.1	11.3	5.4
V2	13.5**	11.6**	5.6*
V3	13.6**	11.7**	5.7*
V4	14.5***	13.4***	6.8***
	LSD 5% = 0.2 cm LSD 1% = 0.4 cm LSD 0.1% = 0.6 cm	LSD 5% = 0.2 pieces LSD 1% = 0.3 pieces LSD 0.1% = 0.4 pieces	LSD 5% = 0.3 pieces LSD 1% = 0.4 pieces LSD 0.1% = 0.7 pieces

During research period, in cropping conditions from Iași area, Romania, plants of *Chasmanthium latifolium* (Michx.) Yates had stems with a mean height of 103.7-110.3 cm. Leaves with a light green colour, had a mean width of 0.8-1.2 cm and an average length between 12.9 cm and 14.2 cm. Flowers are grouped in lace and pendulum panicles. The little spikes which are flattened, reached a mean length between 1.8 cm and 2.4 cm and a width of 1.3-1.6 cm (tab. 3).

The best results were recorded at plants obtained from seedlings which were produced on a substrate with a vermicompost input.

Table 3

Characterization of plants in field (September 2017)

Variant	Mean height (cm)	Mean dimensions of leaves (cm)		Mean dimensions of spikes (cm)		Mean number of flowering stems per plant (pieces)
		Length	Width	Length	Width	
V1	103.7	12.9	0.8	1.8	1.3	10.2
V2	104.9	13.2	0.9	2.0	1.4	10.9
V3	105.2	13.5	1.1	2.1	1.4	11.1
V4	110.3	14.2	1.2	2.4	1.6	12.3

Table 4

Décor period

Species	Month											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
<i>Chasmanthium latifolium</i> (Michx.) Yates												
décor by leaves												
décor by leaves and inflorescences												
décor by dried inflorescences												

Chasmanthium latifolium (Michx.) Yates blooms from June till October and decorates all year round through the elegance of bush and softness of inflorescences (tab. 4). It could be used in landscape designs such as strips, groups and massifs, decorative pots and in floral art are capitalized the flowering rods both in fresh state and as well as in dried state.

Chasmanthium latifolium (Michx.) Yates had a good adaptation capacity at environmental conditions (Cunliffe and Hockenberry Meyer, 2002; Gao *et al.*, 2008). The current research confirms the previous studies (Chelariu, 2013), that this species had a very good adaptability (100%) in cropping conditions from Iași County, Romania.

CONCLUSIONS

Chasmanthium latifolium (Michx.) Yates is an ornamental grass species which in cropping conditions from Iași area, Romania, had a very good adaptation as perennial species.

The utilised substrates for seedlings' production determined a seeds' germination rate of over 84%, the best results being obtained at variant with vermicompost (97%).

Both at seedlings and at plants in field, the best results were obtained at variant with input of vermicompost.

REFERENCES

1. **Ardelean M., Seștraș R., Cordea Mirela, 2007** – *Tehnică experimentală horticolă*. Ed. AcademicPres, Cluj-Napoca, pp. 24-26.
2. **Ardle J., 2007** – *Bamboos and Grasses*, Royal Horticultural Society, Published by Dorling Kindersley Ltd. London, U.K., ISBN 978-1-4053-1683-5.
3. **Atiyeh R.M., Subler S., Edwards C.A., Bachman G., Metzger J.D., Shuster W., 2000** – *Effects of vermicomposts on plant growth in horticultural container media and soil*. *Pedobiologia*, vol. 44:579-590.
4. **Chelariu Elena Liliana, 2013** – *Evaluation and completing the ornamental grasses assortment from the N-E area of Romania*. Research project in the project number POSDRU/I.89/1.5/S62371 "Postdoctoral School in Agriculture and Veterinary Medicine area", UASVM Iași, Romania, 150 p.
5. **Cunliffe B.A., Hockenberry Meyer Mary, 2002** – *Propagation Time Affects Winter Survival and Finishing Date for Ornamental Grasses* *Journal of Environmental Horticulture* 20(4):201–203. December, available at www.hrresearch.org
6. **Gao H., Liu J.-X., Guo A.-G., 2008** – *Preliminary evaluation of adaptability and utilization value of ornamental grasses in Nanjing*. *Pratacultural Science*, abstract, http://en.cnki.com.cn/Article_en/CJFDTOTAL-CYKX200808033.htm
7. **Graham Rice, 2006** – *Royal Horticultural Society Encyclopedia of perennials*, Published in UK by Dorling Kindersley Ltd. London, ISBN -13: 978 1 40530 600 3.
8. **Hockenberry Meyer Mary, Mower R.G., 1986** – *Ornamental grasses for the home and garden*. *Information Bulletin* 64, A Cornell Cooperative Extension Publication, <https://ecommons.cornell.edu/bitstream/handle/1813/3268/Ornamental%20Grasses%20for%20the%20Home%20and%20Garden.pdf?sequence=2&isAllowed=y>

THE DYNAMICS OF BIOCEBOTICS INDICES OF THE SOIL IN THE FOREST ECOSYSTEM, "CODRII" RESERVATION

DINAMICA UNOR INDICI BIOCEBOTICI AI SOLULUI ÎN ECOSISTEMUL FORESTIER, REZERVAȚIA "CODRII"

COJUHARI Tamara¹, VRABIE Tatiana¹, KRIVOV Ludmila¹,
KOTERNEAK Ana-Maria¹, ANGHEL Liubovi¹
e-mail: cojuhari_tamara@mail.ru

Abstract. This paper represents a stage of long-term research in which we highlight the dynamics of humus, soil reaction indexes and hydrolytic acidity. During vegetation period, as a result of research in 3 types of forest it was established: territorial distribution of humus shows essential variations depending on the type of soil, vegetation type and depth. The typical gray clay forest soil over clay-sandy loam (oak with hornbeam forest, A) and brown clay soil over deeply gleyed clay (durmast oak with linden and ash forest, B) are much more supplied with organic matter, which in the 0-40 cm layers falls within the limits of 1.1-8.5%, 0.9-8.6% and 0.3-3.5% in the brown sandy loam soil over clay-sand (beech with durmast oak forest, C). The dynamics of the pH_{H_2O} , pH_{KCl} indices, hydrolytic acidity is determined by the soil type, depth and floral indices. Soil of forest A in layers 0-60 cm, characterized by neutral to weak acid pH_{H_2O} , pH_{KCl} to moderately acidic, low-medium hydrolytic acidity; Forest soil B is weak acid for pH_{KCl} and neutral-weak acid for pH_{H_2O} , hydrolytic acidity is low. The forest soil C is more acidic and has higher hydrolytic acidity.

Key words: biocenosis, forest type, humus dynamics, soil pH, hydrolytic acidity

Rezumat. Lucrarea dată prezintă o etapă a cercetărilor de lungă durată în care evidențiem dinamica humusului, indicilor de reacție a solului și acidității hidrolitice. În rezultatul cercetărilor în 3 tipuri de pădure, în perioada de vegetație s-a stabilit că repartiția teritorială a humusului indică variații esențiale în funcție de tipul de sol, tipul de vegetație și adâncime. Solul cenușiu tipic lutos pe lut-argilă (pădurea de stejar cu carpen, A) și brun lutos pe lut adânc gleizat (pădurea de gorun cu tei și frasin, B) sunt mult mai aprovizionate cu materie organică, care în straturile 0-40 cm se încadrează corespunzător în limitele 1,1-8,5 %, 0,9-8,6% și 0,3-3,5% în solul brun tipic luto-nisipos pe lut-nisip (pădurea de fag cu gorun, C). Dinamica indicilor pH_{H_2O} , pH_{KCl} , aciditatea hidrolitică, în cea mai măsură sunt determinate de tipul de sol, adâncime și indicii floristici. Solul pădurii A în straturile 0-60 cm, se caracterizează cu reacția pH_{H_2O} de la neutru la slab acidă, pH_{KCl} până la moderat acidă, valori mici-mijlocii ale acidității hidrolitice; solul pădurii B este slab acid pentru pH_{KCl} și neutru-slab acid pentru pH_{H_2O} , aciditatea hidrolitică este mică; solul pădurii C este mai acid și deține valori mai mari ale acidității hidrolitice.

Cuvinte cheie: biocenoză, tip de pădure, dinamica humusului, pH-ul solului, aciditatea hidrolitică

¹ National Museum of Ethnography and Natural History, Chisinau, Republic of Moldova

INTRODUCTION

It is known that the formation of the erbaceous layer is determined by biotic and abiotic factors. Due to the fact that the grassy species form small ecological niches, their spatial distribution is mostly favored by the dynamics of soil regimes. In the previous papers the main ecological indicators were simultaneously analyzed in the soil in profiles and semi-profiles (hydrici, physicochemical, minerals, including nutrition) and plants (structure and composition of the arboretums, floristic and numerical diversity, organic mass, Nutritive) (Cojuhari *et al.*, 2002, 2009, 2016, 2017; Grati *et al.*, 2012; Vrabie and Cojuhari, 2015).

This work is a continuation of these research and proposes the analysis of the spatial variations of ecopedological indices - humus, soil pH and hydrolytic acidity as indices that determine optimal conditions in the supply of plants with nutrients. These results can contribute to: tracking pedocenter processes in natural systems that are more stable to environmental factors; The soil-plant relationships presented in spatial and temporal dynamics can be used as authentic materials in ecological, pedological, botanical, forestry monitoring. For this reason, for greater clarity, we present the analytical results in the tables.

MATERIALS AND METHODS

Based on the long-term research carried out in three representative biocoenoses of the Rezervatia Codrii, namely: common oak with hornbeam forest on typical gray clay forest soils over clay-sandy loam (A); durmast oak with linden and ash forest on brown clay soil over deeply gleyed clay (B); beech with durmast oak forest on brown sandy loam soil over clay-sand (C), as a continuation the characterization of the ecological indices named above in the spatial and seasonal dynamics of 2001, in each association included in forest biocoenoses, established biocoenoses, as a forest type based on ecosystem methodology. Forest types and associations were determined by doc. Șabanov G. according to the classification of 3 Vegetation of the Republic of Moldova (Postolache, 1995). The determination of the species was carried out according to the determinant T. Gheideman, 1986, by G. Șabanov and T. Cojuhari. Determinations in soil were performed according to traditional methods (Аринушкина, 1970): humus-method Nitchin; current acidity, pH_{H_2O} - potentiometric; exchangeable acidity, pH_{KCl} - potassium chloride; hydrolytic acidity, H^+ - Cappen method; the vegetation homogeneity index according to the Sorensen method; Mathematical statistics - according to the method of Gorea S., 1986.

RESULTS AND DISCUSSIONS

Climate. After the stationary separation, the arbors from the studied territory belong to the deciduous forests. The thermal condition of the area is characterized by average annual temperatures of 8.7 °C -9 °C and annual average precipitation of about 510-525 mm. Taking into account the small differences of altitude and the general position of the slopes in the territory, one climatic level separates the slope, plateaus and valleys. There is a close correlation between climatic and filo-climatic level, the natural setting vegetation being made under the simultaneous action of the physico-geographic factors and the biotic factors. Temperature and atmospheric precipitation were determined on the basis of the meteorological points established within each research area (the meteorological station of the Rezervatia "Codrii"). In order to assess the climate correlation - the productivity process revealed variations in temperature and precipitation indices, also from the previous periods, which formed the basis of organic mass building.

Temperature. The results of temperature investigations in the biocenoses studied for the years 2000-2001 have shown similar results for all types of forests as these are located at fairly small distances. Some differences are due to the location of land at different heights above sea level. We highlight the maximum and minimum temperature indices in the annual dynamics (2000-2001), as extreme factors that determine plant adaptation to habitat. Maximum temperature: point 1 (hornbeam oak forest) - 33°C; 32°C; Point 2 (durmast oak with linden and ash forest) - 30°C; 32°C; Point 3 (beech with durmast oak forest) – 33 °C; 34 °C. Minimum temperature - point 1 - -12; -16 °C; Point 2 - -11 °C; -14°C; Point 3-13 °C; -13°C.

Monthly and decade-long amplitude indices are essentially lower. Highest temperature variation are followed in : March, April and October, which indicated higher oscillations for point 3, lower for point 2. However, these differences are insignificant in determining the growth and development of plants. We note that the temperature regime is favorable for plant growth and development in all surveillance sectors (fig. 1). Annual values are shown in table 1.

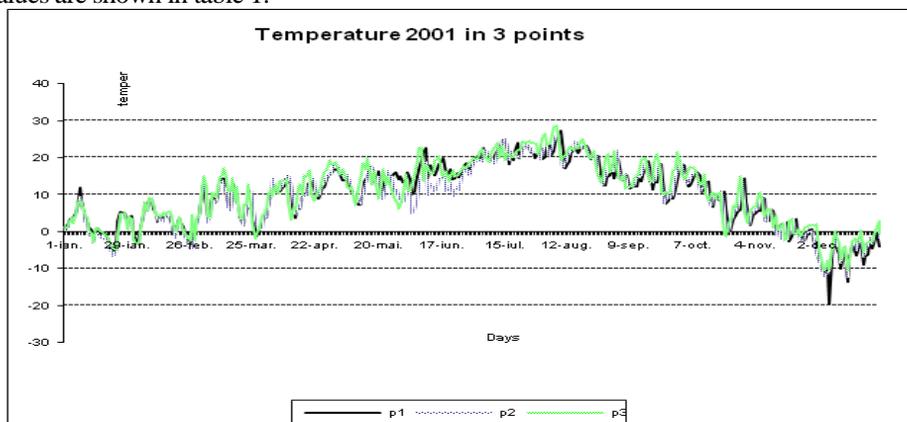


Fig.1 Annual values of temperature index

Table 1

Mean annual values of temperature regime in investigated areas (2001)

Meteorological conditions	Point 1.		Point 2		Point 3	
	Veg.per.	Year	Veg.per.	Year	Veg.per.	Year
Number of days with t 5° C	229	247	227	244	229	264
Number of days with positive temperatures	1	56	0	63	3	59
Sum of mean daily positive temperatures	3349	3403	3270.4	3383.1	3527.6	3687.3
Sum of mean daily negative temperatures	1.3	186.3	0	241.6	4	158.7

Rainfall. Weather data precipitations were collected at the meteorological station of the rezervatia „Codrii”. From 1999 – 2001 were noticed rainfall values corresponding to the normative index for Moldova – 662.9 mm (576.5 – 495.6 accordingly). Considering plants water supply from soil reserve, most frequently accumulated in autumn-winter, sometimes

in early spring. It was found that in november-december of the previous year and in january-february of 2001, precipitations has accumulated as a result of rains and snow, 184.2 mm and 144.4 mm. Precipitations in the year of study proved to be quite favorable – 506.0 mm, in march - may – 143.0 mm. Summer precipitations (163.6 mm) has been marked by strong rainfalls on June 5th (72.7 mm), in autumn exceeded summer by 110.7 mm. The variation of rainfalls contributed to the growth and development of herbaceous layer.

Characteristics of vegetation and soils

The three forest types, chosen as stationary, belong to the European ecosystem – hardwood forest and differ according to composition, structure, specific and numerical range.

The vegetation of the hornbeam oak forest (forest A) belongs to *Quercetum* (*Quercus robur*), with two associations (900 m2 of territorial rehearsals for each type of forest) *Carpineto-Quercetum* and *Fraxineto-Quercetum*. The vegetation of the durmast linden and ash forest (forest B), also belongs to *Quercetum* with a single *Fraxineto-Quercetum* association; the vegetation of beech with durmast oak forest (forest C) belongs to *Fagetum* (*Fagus sylvatica*) including two vegetal associations - *Carpineto-Fagetum* and *Querceto-Fagetum*, described in previous works (Cojuhari *et al.*, 2009; Grati *et al.*, 2012).

Here are some floristic aspects of ecological importance, without including a more detailed description of later research fields.

Oak with hornbeam forest is highlighted by *Quercus robur*, *Quercus petraea* followed by *Tilia cordata*, *Fraxinus excelsior*, *Ulmus minor* and *Acer campestre*, all belonging to 7 genera and 6 families.

The layer of shrubs is poorly developed, predominantly consisting of horn (*Cornus mas*) with hawthorn and wayfarer elements.

The herb layer includes 59 species of herbaceous vascular plants (55 and 42 corresponding to the years 2000 and 2009), belonging to 47 genera (45 and 36) of 21 families (21 and 19) and a wood species (*Hedera helix*) of which *Asparagus Convallaria majalis*, *Corydalis bulbosa (cava)* and *Corydalis marschalliana*, are characterized by Negru (2007) as rare species because of constantly diminishing populations, under the influence of anthropogenic factors.

Typical gray clay forest soil over clay-sandy loam is characterized by low eluvial and iluvial horizons. Reaction of the mildly acidic soil at the surface is maintained throughout the profile (strongly acidic in the Ae horizon), the concentration of humus is more intense at the surface, suddenly decreasing in the eluvial horizon. Saturation level at basic layer is high. This soil has an optimal structural capacity.

Phytocenosis corresponding to **durmast oak with linden and ash forest** (B), is marked by wooden species like *Quercus petraea*, *Tilia cordata*, *Fraxinus excelsior*, *Acer campestre*, *Ulmus minor*, *Sorbus torminalis*, belonging to 6 families and 6 genera. The subsurface layer is well developed and consists of a single species - *Cornus mas*. Natural regeneration is marked by the emergence of *Quercus robur* and *Acer campestre* seedlings. The herb layer consists of 36 species included in 32 genera and 20 families, of which climbing wooden species *Hedera helix* (Cojuhari *et al.*, 2009; Grati *et al.*, 2012).

Brown clay soil over deeply gleyed clay is marked by a high level of gleyzation in Bi2g horizon, the superficial layers are loose, less compact. The humus content is very high and high (11.1-5.6%), up to 32cm, deeper low and very low - 2.7-1.3%. This soil is

characterized by a high level of saturation in bases, containing from high to moderate P and K, and very low N-NO₃.

The forest biocenosis being delimited in the frame of **beech with durmast oak forest (C)**, covers wooden species from 3 families, 4 genera: trees - *Fagus sylvatica* and *Quercus petraea* (Fagaceae family), *Carpinus betulus* (Corilaceae family) and a climbind plant *Hedera helix* (Araliaceae family).

In the poorly developed shrub layer there are solitary specimens of *Cornus australis* and silvoforming trees - *Fagus sylvatica*, *Quercus petraea*, which are also present in the herbaceous carpet, amongst *Acer platanoides*, *A. campestre*, *Carpinus betulus*, *Fraxinus excelsior*, *Tilia cordata*, *Viburnum lantana*, *Euonymus verrucosa*.

Compositional and low specific diversity of the wooden layer is compensated by a vigorous mass of beech and durmast oak trees. The herb layer consists of 31 species corresponding to 16 families and 27 genera (Cojuhari *et al.*, 2002; 2009).

Brown sandy loam soil over clay-sand is distinguished by the more even distribution of all the analyzed indices, with slighter and homogeneous granulometric composition: the humus content at 0-50 cm, holds values within the limits of 4.6-1.4%; pH_{H2O} is within the range of 7.0-6.7; the sum of the exchangeable bases and the total cation exchange capacity supports medium values; mobile phosphorus maintains moderate and optimal, exchangeable potassium, which falls into the high value category.

In order to determine the diversity and similarity of the analyzed phytocoenoses, the Sorensen (S) homogeneity index was calculated. The specific composition of trees in the comparison of phytocenosis associations in the study is quite homogeneous, the given index is marked with values close to 1 unit. Comparing the diversity of forest types with regard to tree species: the greatest floral diversity of tree species is mentioned while comparing oak forest with hornbeam beech with durmast oak forest, durmast oak with linden and ash forest – durmast with beech forest, where $S = 0.37 - 0.20$ accordingly. The relations between oak and hornbeam oak forests – durmast oak with linden and ash forest have the homogeneity index $S = 0.8$, so both forests have a close floristic spectrum.

Table 2

Homogeneity of grassy layer, Sorensen index

Forest type	march	april	may	june	september
	richness		floristry	total	
A	0.86	0.86	0.86	0.85	0.75
B	0.95	0.95	0.63	0.79	0.98
C	0.9	0.90	0.61	0.75	0.5
	richness		floristry	mean	
A	0.73	0.63	0.71	0.67	0.53
B	0.62	0.86	0.54	0.9	0.57
C	0.40	0.70	0.53	0.71	0.5
	richness		floristry	total	
AB	0.52	0.52	0.38	0.61	0.6
BC	0.47	0.47	0.43	0.48	0.41
AC	0.64	0.64	0.60	0.75	0.7
	richness		floristry	mean	
AB	0.75	0.73	0.38	0.42	0.4
BC	0.39	0.35	0.25	0.07	0.17
AC	0.61	0.57	0.65	0.52	0.53

The floristic homogeneity of the herb layer was calculated on the basis of the total floral richness (1800 m²) and the mean floral richness (1 m² areas) of the species found in each type of vegetation, which shows the similarity and divergence between them, evaluated in seasonal dynamics (tab. 2).

Comparing floristic diversity regarding types of associations we found the following:

- During the vegetation period, based on the analysis of the total floral richness of the species, it was found that the grassy layer of the hornbeam with oak forest is quite homogeneous until autumn. According to average specific richness calculation in autumn the Sorensen index (0.5) is geared towards increasing diversity.

- According to the calculation of the total floristic richness the *durmast oak with linden and ash forest* is homogeneous, regarding spring and autumn grass species. The Sorensen index, based on the average floral richness, indicates lower values in May and September, so there is a greater diversity in both the 900 m² land rehearsals of the indicated forest.

- According to the calculation of the total floristic richness *beech with durmast forest* is homogeneous, regarding spring and summer grass species. In autumn, at the same time with reduction of the specific diversity of the summer species and the organic mass of the grassy layer, remain summer and autumn species which increase its diversity. Specific diversity is more pronounced in intensive work areas (medium floral richness), where soil-plant interdependencies can be more clearly observed.

The diversity of species regarding the comparison of the forest types is marked with low values of the Sorensen index in AB reports in may (both cases) and may - september in the case of average specific richness; BC reports in all cases. Herbaceous layer in AC forests is homogeneous for all vegetation period, with few exceptions in summer and autumn on average floral richness calculations.

Dynamics of biocenotic indices

Humus. One of the most important item on determining soil stability. As a biocenotic component, is the main soil fertility index. Humus, as a reservoir of organic matter and minerals, creates optimal conditions for the growth and development of plants, conditioning biological, hydro, physical and chemical processes of the soil (Andrieș, 2007; Ганенко, 1987; Карпачевский, 1977, Крупеников, 1967). The character of the humus distribution in the soils of the analyzed biocenoses allows us to make a concrete assessment of each ecotope in the study of the bioproductive process, directly supplying ecological niches.

The structure and composition of humus are decisive factors in creating the soil's reaction, hydrolytic acidity, which determines the composition and the structure of the vegetation, in particular the specific and numerical indices of the grassy layer.

The dynamics of humus in terms of variation of the soil cover for each type of association and in depth was analyzed in the 0-40 cm (10 cm) layer in 24 semiprophytes, which can give more concrete indications of floral diversity during the vegetation period in the ratio with the soil cover.

The results presented have allowed us to reveal a high diversity of humus for the soils of each type of forest, ranging from very small to very high: maximum - 8.6% (state 0-10 cm) corresponds to the brown clay soil over deeply gleyed clay (*durmast oak with linden and ash forest*), minimal (0.30% layer (30-40 cm) layer) – brown sandy loam soil over clay-sand of *beech with durmast forest*.

Typical gray clay forest soil over clay-sandy loam (A) and durmast oak with linden and ash forest soil (B) are more supplied with organic substances (tab. 3). The humus content in layer 0-10 in the soils of forests A and B is in large limits, corresponding to 4.8-8.5% (average 6.3%) and 3.8% -8.6% (average 5.9%). Index variations in the soils of forests A and B within their frames are significant, which corresponds to the direct dependencies with the vegetation indices - the structure and the composition of the wood and grass layers. Starting at 20 cm depth, humus concentration decreases quite suddenly. This distribution is mostly conditioned by the accumulation of the clay fraction (Cojuhari *et al.*, 2002). The soil of oak with hornbeam forest at level 20-40 cm contains higher values than other soils.

The coefficient of variation determined for each layer and horizontally (area, forest type) includes medium and small values for the soils of the A and B forests and very small for the soil of the beech with durmast forest. Most significant variations (average one) are noted in the 0-30 cm layer of the typical gray clay forest soil over clay-sandy loam, 0-40cm of the brown clay soil over deeply gleyed clay and 10-40 cm in the brown sandy loam soil over clay-sand (tab. 3).

An obvious stability on the humus accumulation is specific for the 0-10 cm layer in each association. The analysis of the herbaceous layer during this period allowed us to reveal a direct interdependence of the humus with floral and numerical diversity indices in the analyzed 1m² microparticles.

Table 3

% Humus content (% of soil dry weight) and (%) in soils of forest types A, B, C

Mean, %				Variation coefficient, %			
Depth	A	B	C	Depth	A	B	C
0-10	6.25	5.93	2.73	0-10	25.68	29.90	19.90
10-20	3.30	3.45	1.14	10-20	31.97	31.14	37.28
20-30	2.48	2.01	0.79	20-30	41.39	27.14	62.00
30-40	1.48	1.24	0.56	30-40	19.47	21.13	32.83
Media, %				Variation coefficient, %			
Depth	A	B	C	Depth	A	B	C
0-40	2.50	2.10	0.87	0-40	23.13	27.50	25.50

pH. Research done in natural ecosystems including forestry found that the pedocentical index dynamics, including soil pH, reflects the action of the complex of biocenotic factors on the soil.

Current acidity, pH_{H2O}. of the studied soils ranged from moderately acid to neutral (tab. 4).

Typical gray clay forest soils over clay-sandy loam and brown clay soil over deeply gleyed clay on Spring and Summer period, are characterized by neutral reaction in the 0-10 cm layer and slightly acidic in herewith layers for both soils. Brown sandy loam soil over clay-sand, in the period indicated above, it is slightly acidic in the superficial layer 0-10 cm and moderately acid in the 10-60 cm layers. In autumn, researched soils showed that there was a decrease in the current acidity values.

According to the variation coefficient, changes at the soil type and subtype level, during the vegetation period indicate minimal and moderate values. Seasonal and deep variations for each type of forest are noted in the low and very high values (tab. 5).

Table 4

Current acidity, pH _{H2O}				
Depth, cm	Forest	Spring	Summer	Autumn
0-10	A	7.0	6.8	7.3
	B	6.9	7.1	7.3
	C	6.1	6.3	6.6
10-20	A	6.3	6.4	6.5
	B	6.8	6.9	7.0
	C	5.2	5.5	6.1
20-30	A	6.1	6.4	6.6
	B	6.7	6.7	6.9
	C	5.4	5.7	5.9
30-40	A	6.2	6.3	6.2
	B	6.6	6.5	6.8
	C	5.7	6.0	5.9
40-50	A	6.1		
	B	6.6		
	C	5.8		
50-60	A	6.1		
	B	6.9		
	C	6.0		

Table 5

Variation coefficient, pH _{H2O} %				
Depth, cm	Forest	Spring	Summer	Autumn
0-10	A	4.3	2.9	4.9
	B	5.2	3.9	5.6
	C	11.6	9.7	10.5
10-20	A	9.3	2.7	11.3
	B	2.2	1.3	6.7
	C	6.8	15.9	12.6
20-30	A	7.2	4.5	8.8
	B	5.0	6.8	7.7
	C	8.7	14.2	6.9
30-40	A	6.1	5.0	7.6
	B	10.6	14.5	9.2
	C	11.5	13.2	10.6
40-50	A	11.4		
	B	10.1		
	C	12.4		
50-60	A	14.2		
	B	12.3		
	C	13.7		

pH_{KCl} exchangeable acidity. During the vegetation period, exchangeable acidity is characterized by a fairly large amplitude of the pH_{K1} values in the analyzed soils. During vegetation period, oak with hornbeam forest is highlighted on the surface with neutral reaction, in a moderately acidic depth, with an exception in the 10-20 cm layer in spring. Durmast oak with linden and ash forest soil is characterized by a neutral reaction in the layer 0-10 cm (10-20 cm in summer) and slightly acidic in the adjacent ones throughout the

vegetation period. (tab. 5). Exchangeable acidity in beech with durmast soil forest is classified from low acid to strongly acid, being conditioned by eluvial-iluvial processes and also accumulation and distribution of vegetal rubbish.

Table 5

Exchangeable acidity, pH_{KCl}				
Depth, cm	Forest	Spring	Summer	Autumn
0-10	A	6.5	6.3	6.3
	B	6.4	6.6	6.3
	C	5.2	4.9	5.4
10-20	A	5.3	4.9	5.0
	B	6.0	6.2	5.9
	C	4.1	4.0	4.7
20-30	A	4.9	4.6	4.9
	B	5.7	5.5	5.5
	C	4.2	4.1	4.1
30-40	A	4.8	4.5	4.4
	B	5.5	5.2	5.4
	C	4.4	4.2	4.2
40-50	A	4.8		
	B	5.4		
	C	4.5		
50-60	A	4.8		
	B	5.7		
	C	4.7		

The variation coefficient (tab. 6) receives lower values on surface and deeper layers of A and B forest soils, except for the 30-40 cm layer of B forest, in summer and autumn. The soil of the forest C in all layers contains average values, with differences in the 10-20cm and 20-30cm layers, small variations during the spring period.

Table 6

Variation coefficient, pH_{KCl} , %				
Depth, cm	Forest	Spring	Summer	Autumn
0-10	A	4.8	4.9	4.9
	B	7.0	6.1	6.1
	C	15.9	20.0	20.0
10-20	A	16.0	8.4	8.4
	B	4.0	3.5	3.5
	C	8.5	21.8	21.8
20-30	A	12.5	12.3	12.3
	B	9.8	20.4	20.4
	C	7.5	21.6	21.6
30-40	A	11.1	10.6	10.6
	B	18.9	28.4	28.4
	C	11.8	18.8	18.8
40-50	A	16.3		
	B	14.0		
	C	13.5		
50-60	A	16.6		
	B	16.4		
	C	15.6		

Hydrolytic acidity, H⁺. Changing hydrogen values are the expression of the extent to which the colloidal soil complex contains H⁺. The results presented (tab. 7) show very small limits of the value classes regarding the distribution of the given index: oak with hornbeam forest soil denotes small and medium values of hydrolytic acidity (2.3-4.3 me / 100g soil); beech with durmast forest soil also shows medium values (3.6-5.8 me / 100g soil); small for the soil of gouna forests with ash and ash (summer and autumn in the layer 0-10cm, very small); low values for durmast oak with linden and ash forest soil (in summer and autumn on 0-10 cm layer, very low).

Table 7

Depth, cm	Forest	Spring	Summer	Autumn
0-10	A	2.1	2.3	2.3
	B	2.1	1.7	1.7
	C	4.1	4.1	4.1
10-20	A	3.9	4.3	4.3
	B	2.1	2.2	2.2
	C	5.8	5.8	5.8
20-30	A	4.0	4.3	4.3
	B	2.3	2.8	2.8
	C	4.7	5.2	5.2
30-40	A	3.2	4.1	4.1
	B	2.4	3.5	3.5
	C	4.0	4.7	4.7
40-50	A	3.4		
	B	2.6		
	C	4.1		
50-60	A	3.6		
	B	2.5		
	C	3.6		

Table 8

Depth, cm	Forest	Spring	Summer	Autumn
0-10	A	28.3	33.2	66.1
	B	50.4	58.3	41.3
	C	50.5	47.2	65.2
10-20	A	46.3	21.7	46.6
	B	26.9	9.7	34.0
	C	34.7	39.8	67.7
20-30	A	34.7	29.3	46.9
	B	48.1	72.5	37.4
	C	51.0	59.79	40.64
30-40	A	23.4	23.9	34.2
	B	69.0	87.9	45.7
	C	68.3	66.7	50.8
40-50	A	54.6		
	B	81.0		
	C	69.1		
50-60	A	62.1		
	B	87.3		
	C	71.9		

The distribution of H + values in depth is not homogeneous for the typical gray clay forest soil over clay-sandy loam (A). Although the limits of H + values are rather small, seasonal variations in depths, in vegetal associations and forest types (tab. 8), indicate high values for variation coefficient in all layers.

CONCLUSIONS

1. The climatic conditions in the indicated year and in the autumn of the previous year were quite favorable for vegetation growth and development. Essential differences in the analyzed biotopes were not recorded. The temperature and water reserves accumulation in the soil have facilitated the maintenance of pedogenetic processes regarding organic matter accumulation indices, soil reaction, in rather slow dynamic regimes.

2. Typical gray clay forest over clay-sandy loam soil (A) and brown clay soil over deeply gleyed clay (B) are much more supplied with organic matter, compared to brown sandy loam soil over clay – sand (C). The minimum and maximum humus values fall within the range of 1.1-8.5%, 0.9-8.6%, 0.3-3.5%. The variation coefficient of variation includes medium and high values in the 10-40 cm layers, depending on the type of association (forest type) confirming direct dependence on vegetation indices - the structure and composition of woody and herbaceous layers.

3. The actual acidity of the studied soils pH_{H_2O} is characterized by neutral to low acid values for A and B forest soils and low acid to moderate acid for C forest soil. According to the variation coefficient, during the vegetation period, the current acidity variations at the soil type and subtype level indicate minimal and moderate values. Seasonal and deep variations for each type of forest are set within the limits of small and very high values.

4. During the vegetation period, exchangeable acidity is characterized by a fairly large amplitude of the $pH K_1$ values in the brown sandy loam over clay-sand soil (from low acidity to high acidity) and typical gray clay forest soil over clay-sandy loam (neutral-moderately acidic reaction), lower for brown clay soil over deeply gleyed clay. The 0-20 cm superficial layers of forest soil A and B denote smaller variations in pH_{KCL} . In depth the variation coefficient shows average values. C forest soil shows large variation in all layers, except spring period in 0-20 cm layer. The vegetation of the A and B forest is similar, the coefficient of homogeneity Sorensen is 0.8. The diversity of the flora, referring to the vegetation ratios in the AC and BC forests, conditions the temporal and spatial variations of the pedocenotic indices compared to the AB ratio.

5. Researched soils show low value limits of H+: 2.3-4.3 me/100g for A forest soil, 1.7- 3.5 me/100g soil (B) and 3,6-5,8 me/100g soil (C), which frames into low-medium values for A and C soils; low (1.7-3.5 me/100g soil) for B forest soil, except 0-10 cm layer, which in summer and autumn has a very low H+ value. The dynamics of hydrolytic acidity is an index that guides the natural eluvial-iluvial processes, contributes to the ecosystem stability, reflected in the soil and vegetation parameters.

Acknowledgments: Thanks for the consultations provided by Prof. I. Krupenicov, doc. Șabanov Galina, doc. Smirnova Olga., doc. Filipciuc V. and "Soros" Foundation for the financial support granted during this period.

REFERENCES

1. **Andrieș S., 2007-** *Optimizarea regimurilor nutritive ale solurilor și productivitatea plantelor de cultură*. Pontos, Chișinău, 374 p.
2. **Cojuhari T., Jordan N., Sturza N., 2009** – *Cercetări privind starea ecologică a florei erbacee în biocenozele de supraveghere din Rezervația „Codrii”* . În: Buletin Științific. Revistă de Etnografie, Științele Naturii și Muzeologie. Științele Naturii. Nr. 10 (23). Chișinău, p. 6-19.
3. **Cojuhari T., Dediu I., Stratulat P. et al., 2002** – *Schimbările sezoniere ale ecosistemului forestier sub aspectul potențialului productiv* În: Fiziologia și biochimia plantelor la început de mileniu: realizări și perspective. Materialele Congresului II al Societății de Fiziologie și Biochimie Vegetală din Republica Moldova. Chișinău, p. 114-128.
4. **Cojuhari T., Vrabie T., Pană S. 2009** - *Manganul (Mn) și molibdenul (Mo) în solul și plantele de pădure*. În: Buletin Științific. Revistă de Etnografie, Științele Naturii și Muzeologie. Științele Naturii. Nr. 22 (35). Chișinău, p. 96-110.
5. **Cojuhari T., Vrabie T., Pana S., Koterneak P., 2016** - *Calcium end magnezium in plants and soils, „Codri” Rezervation*. În : Jurnal of Botany, Vol. VIII, nr. 1 (12), Chișinău, p. 121-130.
6. **Cojuhari T., Vrabie T., Pana S., Maslov E., 2017** - *Nutritive elements (P, K) in typical forest biocenoses, reserve “Codrii”*. International Scientific Symposium „Conservation of plant diversity” 5th edition, 1-3 June 2017. Botanical Garden of ASM. Chișinău, Republic of Moldova, p.128
7. **Grati V., Krupenikov I., Cojuhari T., Roșca Z., 2012** - *Caracteristici ale solurilor din biocenozele de supraveghere din rezervația „Codrii”*. În: *Lucrările Conferinței științifice cu participare internațională „Eficiența utilizării și problemele protejării solurilor. 28-29 iunie, 2012”*. Chișinău, p. 126-137.
8. **Postolache Gh., 1995** - *Vegetația Republicii Moldova*. Știința, Chișinău, 332 p.
9. **Vrabie T., Cojuhari T., 2015** - *Azotul în solul și plantele ierboase de pădure, rezervația „Codrii”*. *Aspecte statistice*. În: *Lucrările Conferinței științifice a tineretului studios dedicată Zilei Internaționale a Studenților cu participare internațională, 13 noiembrie, 2015 „Homo sapiens și raporturile dintre sistemele naturale și factorii de mediu”*. Chișinău, p. 100-109.
10. **Аринушкина Е.В., 1970** - *Руководство по химическому анализу почв*. МГУ, Москва, 487 с.
11. **Ганенко В.П., 1987** - *Гумус почв Молдавии и его трансформация при их сельскохозяйственном использовании*. Академия наук Азербайджанской ССР, Баку, 21с.
12. **Гейдеман Т., 1986** - *Определитель высших растений Молдавской ССР*. Штиинца, Кишинев, 636 с.
13. **Горя С., 1978** - *Алгоритмы математической обработке результатов исследований*. Штиинца, Кишинев, с. 21-22.
14. **Карпачевский Л., 1977** - *Динамика свойств почвы*. М.. 170 с.
15. **Крупеников И.А., 1967** - *Черноземы Молдавии*. Из-во « Картя молдовеняскэ», Кишинэу, 428 с.

INFLUENCE OF CULTIVATION SYSTEMS ON PRODUCTION AND CONTENT OF HEAVY METALS IN EGGPLANT

INFLUENȚA SISTEMELOR DE CULTIVARE ASUPRA PRODUCȚIEI ȘI CONȚINUTULUI DE METALE GRELE LA PĂTLĂGELELE VINETE

STOLERU V.¹, TELIBAN G.C.¹, COJOCARU A.¹,
CIURARU M.C.¹, CIUBOTĂRIȚĂ Anamaria¹

e-mail: vstoleru@uaiasi.ro

Abstract: *The present paper was carried out in the Vegetable research field of the "V. Adamachi" Farm regarding the interaction of eggplant cultivars with fertilization regime. The determination of the heavy metal content was carried out by atomic absorption spectrophotometry, using the Shimadzu GC-2100.*

Following the conduct of the analyses, they were detected in both conventional and organic cultivation systems, both in soil and in vegetables, containing CR, Ni, with, Zn, Cd and Pb. The CR, Ni, and Zn content of the conventional system exceeded the maximum permissible limit By Regulation EC No 1/2003. 396/2005, whereas the heavy metal content of the organic system has not exceeded for any chemical element the maximum limits permitted by Regulation EC No 1/2003. 396/2005.

Key words: eggplant, fertilizers, yield, heavy metals

Rezumat: *Lucrarea de față s-a realizat în câmpul de cercetare legumicol al fermei „V. Adamachi” din Iași și urmărește interacțiunea cultivarelor de pătlăgele vinete cu regimul de fertilizare. Determinarea conținutului de metale grele s-a efectuat prin spectrofotometrie cu absorbție atomică, utilizând echipamentul Shimadzu GC-2100. În urma efectuării analizelor, au fost detectate în ambele sisteme de cultură (convențional și organic), atât în sol, cât și în legume un conținut de Cr, Ni, Cu, Zn, Cd și Pb. Conținutul de Cr, Ni, Cu și Zn din cadrul sistemului convențional a depășit limita maximă admisă de Regulamentul CE nr. 396/2005, în timp ce conținutul de metale grele din cadrul sistemului organic nu a depășit pentru niciun element chimic limitele maxime admise de Regulamentul CE nr. 396/2005.*

Cuvinte cheie: pătlăgele vinete, fertilizanți, producție, metale grele

INTRODUCTION

Organic farming involves the lifting of soil content in organic matter, using natural organic fertilizers (manure, compost, green fertilizers, slurry, urine + manure, etc.) and aims to achieve Agri-food products with a high content in biologically active substances, free of synthetic chemical substances which can seriously damage human health, in the circumstances of a durable, healthy and potentially high productivity ecosystem (Munteanu *et al.*, 2008; Stoleru *et al.*, 2014).

¹University of Agricultural Sciences and Veterinary Medicine Iași, Romania

In our country, the eggplant culture expanded after World War I, the current cultivation area being over 10.3 thousand hectares, with a total output of 144 thousand tonnes, in areas with the highest thermal Gradietul (Munteanu, 2003; Munteanu *et al.*, 2010; Popescu and Zăvoianu, 2013).

The overall objective is to highlight the cultivation that best lends itself to the cultivation conditions, but also to that which is not influenced by the concentration of chemical substances in the soil.

MATERIAL AND METHODS

The experience was carried out in a tunnel of 125 m² located in the vegetable field of the "V. Adamachi" Farm in Iasi.



Fig.1 The area of study UASVM Iasi

In order to achieve the proposed objectives, the best biological material of eggplant was used, which would perfectly adapt to the conditions within the field of experimentation. The choice of cultivation is one of the main principles for achieving production that satisfies human needs and is based on the adaptation of the variety to the region's climatic conditions (Indrea *et al.*, 2009; Munteanu, 2003; Munteanu *et al.*, 2011).

To achieve personal experience, four cultivars of Eggplants were worked, which adapted perfectly to climate and soil conditions within the culture environment, presenting a high resistance to the attack of pathogens. Thus, the varieties used were the following: Miraval F1, Aragon F1, Black Beauty and Raven Feather.

In order to obtain high harvests of each plant of *Solanum Melongena* L. Was given, in a single dose, the following quantity of fertilizer:

- 4 g Orgevit on the plant, together with appropriate irrigation (110,8 kg/ha);
- 2 g Nutrispore on the plant, together with appropriate irrigation (55,4 kg/ha);
- 5 g Micoseed per plant (138,5 kg/ha);
- 200 ml Veramin / 100 l water (6l/ha).

The working methods used to carry out research on cultivation under the conditions of a natural and organizational framework were the following: documentation (based on the principle of literature), the observation carried out in field, agrochemical analyses conducted in the laboratory, Case study and comparative

analysis (Stoleru *et al.*, 2015). Therefore, 10 samples were taken from the culture environment, from the base of 10 plants randomly located and analyzed in the laboratory.

The extraction and preparation of samples for the analysis carried out in the laboratory was carried out on the basis of compliance with the standards in force imposed by our country by the NSVFSA order – the National Health and Veterinary Authority and food safety No. 147/23/2005.

RESULTS AND DISCUSSION

The data presented in table 1. The fact that fruit develops much better in conventional system than the ecological system.

Table 1

Experimental results on some biometric characters of eggplant fruit (2016)

No.	Cultivars	Crop system	Fruit average (g)	Fruit height (cm)	No of fruits per plant
1.	Aragon F1	Intensiv	671	21	7-8
		Organic	617	20	7-8
2.	Black Beauty	Intensiv	519	23	6-7
		Organic	478	22	6-7
3.	Mirval F1	Intensiv	566	20	7-8
		Organic	521	18	7-8
4.	Pana Corbului	Intensiv	478	24	6-7
		Organic	440	20	6-7

With regard to the average weight of the fruit, results between 440 and 671 g/fruit were obtained. The fruits of the hybrid Aragon F1 were noted which in the conventional system had an average weight of 671 g and in the ecological system 617 g, far above the average of the control sample (Pana Corbului), the weight of which was 478 g in the conventional system and 440 g in organic system.

Early production obtained in the eggplant crop

The results of early production of eggplant aubergines are shown in table 2. It is considered to be early production, production achieved in protected spaces (tunnel) until fruit is opened in the open field.

Early production in the case of experimental variants was different from cultivar to cultivar, thus remarking the hybrid Aragon F1 with an average of 58.31 t/ha within the conventional system and 53.64 t/ha within the ecological system, obtaining a positively significant production of the witness sample, which was ranked in last place, totaling a quantity of 41.36 t/ha in conventional system and 38.05 t/ha in the ecological system.

Table 2

Early production of eggplant and the significance of differences to control (2016)

No.	Cultivars	Crop system	Early yield (t/ha)	Relative production (%)	Difference to the control (t/ha)	Significance of differences
1.	Aragon F1	Intensiv	58.31	140.98	16.95	***
		Organic	53.64	140.97	15.59	***
2.	Black Beauty	Intensiv	44.96	108.70	3.6	-
		Organic	41.36	108.69	3.31	-
3.	Mirval F1	Intensiv	50.06	121.03	8.7	**
		Organic	46.05	121.02	8	**
4.	Pana Corbului	Intensiv	41.36	100	0	-
		Organic	38.05	100	0	-

LSD 5% = 3.89 t/ha;

LSD 1% = 5.90 t/ha;

LSD 0.1% = 9.48 t/ha.

*** positively very significant; ** positively distinctly significant; - insignificant

The second hybrid in terms of production was Mirval F1, where an average of 50.06 t/ha was achieved in conventional system and 46.05 t/ha in the ecological system.

Total production obtained in the eggplant crop

The total production of eggplant obtained in the experience in both cultivation systems is shown in table 3.

Table 3

Total production of eggplant and the significance of differences to control (2016)

No.	Cultivars	Crop system	Total yield (t/ha)	Relative production (%)	Difference to the control (t/ha)	Significance of differences
1.	Aragon F1	Intensiv	139.34	140.251	39.99	***
		Organic	128.19	140.251	36.79	***
2.	Black Beauty	Intensiv	107.99	108.696	8.64	*
		Organic	99.35	108.698	7.95	-
3.	Mirval F1	Intensiv	117.77	118.540	18.42	**
		Organic	108.34	118.533	16.94	**
4.	Pana Corbului	Intensiv	99.35	100	0	-
		Organic	91.40	100	0	-

LSD 5% = 8.10 t/ha;

LSD 1% = 12.24 t/ha;

LSD 0.1% = 19.66 t/ha.

*** positively very significant; ** positively distinctly significant; - insignificant

Too, in the case of early production, the hybrid Aragon F1 was again remarked, with a production in the conventional system of 139.34 t/ha, compared to the witness sample, the raven variety, the production of which was 99.35 t/ha, the difference between the two cultivations being Approximately 40 t/ha. Within the ecological system, the difference compared to the witness sample of the hybrid Aragon F1 was 36.79 t/ha.

In the conventional system, the hybrid Mirval F1 obtained a production of 117.77 t/ha, and the Black Beauty variety production of 107.99 t/ha, the difference from the witness sample being 18.42 t/ha, respectively 8.64 t/ha. The production within the organic system of hybrid Mirval was 108.43 t/ha, and the Black Beauty variety of 99.35 t/ha, and the difference in production was 16.94 t/ha, respectively 7.95 t/ha.

Heavy metal content in eggplant fruits

In table 4, the content of contaminants in the eggplant fruit has been assessed and determined in accordance with the maximum permitted limits laid down by the legislation in force.

Table 4

The content of heavy metals in the fruits of eggplant (2016)

No.	Cultivars	Crop system	Cr (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	Cd (ppm)	Pb (ppm)
1.	Pana Corbului	Intensiv	71	43	58	153	<10	33
		Organic	46	27	28	112	<10	24
2.	Aragon F1	Intensiv	68	53	32	185	<10	43
		Organic	28	28	34	97	<10	15
3.	Mirval F1	Intensiv	58	40	48	150	<10	31
		Organic	32	30	40	78	<10	28
4.	Black Beauty	Intensiv	50	37	39	147	<10	22
		Organic	46	32	37	121	<10	18

As part of the experience, the minimum Cr content was determined by the hybrid Aragon F1 cultivated under the ecological system, while the maximum content was determined within the raven-feathered variety, cultivated under the conventional system.

In the cultivation there were no traces of Cd, the appliance recorded only concentrations greater than or equal to 10 ppm.

In general, in chemically fertilized variants the heavy metal content is higher than in organic variants.

CONCLUSIONS

Based on the results of the experience, the following were found:

The highest quantitative productions were obtained in the conventional system, regardless of the cultivation used.

The hybrid Aragon F1 was best suited, obtaining a production of 139.34 t/ha in conventional system, with approximately 40 tonnes over the production obtained under control.

Within the ecological system, the largest production of the 128.19 t/ha hybrid of Aragon F1, with 36.76 tonnes above the witness sample, proved that it was best suited to the ecological system.

The ecological culture system, although gaining lower productions compared to the conventional system, is an alternative because it causes healthy products to be obtained.

Generally, the content of heavy metals following way:
Zn>Cr>Cu>Ni>Pb>Cd.

REFERENCES

1. **Indrea D., Apahidean S., Apahidean Maria, Măniuțiu D.N., Sima Rodica, 2009** – *Cultura legumelor*. Editura Ceres, București.
2. **Munteanu N., 2003** – *Tomatele, ardeii și pătlăgelele vinete*. Editura Ion Ionescu de la Brad”, Iași.
3. **Munteanu N., Stoleru V., Stoian L., Fălticeanu Marcela, 2008** – *Baze tehnologice ale legumiculturii ecologice*. Editura „Ion Ionescu de la Brad”, Iași.
4. **Munteanu N., Birescu L., Bulgariu D., Hura Carmen, Stoian L., Stoleru V., 2010** – *Monografia producției legumicole ecologice din nord-estul României: posibilități și riscuri*. Editura „Ion Ionescu de la Brad”, Iași.
5. **Muntenu N., Birescu L., Bulgariu D., Călin Maria, Hura Carmen, Stoleru V., 2011** – *Flux tehnologic optimizat în legumicultura ecologică pentru siguranța alimentară și sustenabilitate*. Editura „Ion Ionescu de la Brad”, Iași.
6. **Popescu V., Zăvoianu R., 2013** – *Cultura tomatelor, ardeiului și vinetelor*. Editura M.A.S.T., București.
7. **Stoleru V., Munteanu N., Hura Carmen, 2015** – *Organophosphorus pesticide residues in soil and vegetable, through different growing systems*. Environmental Engineering and Management Journal, 14 (6).
8. **Stoleru V., Munteanu N., Sellitto V. M., 2014** – *New approach of organic vegetable systems*. Aracnee Editrice, Italy. ISBN 978-88-548-7847-1.

STUDY REGARDING THE RELATIONSHIP BETWEEN DIET AND BABY BOTTLE TOOTH DECAY

STUDIU PRIVIND INTERRELATIA DIETA-CARIE DE BIBERON LA COPIL

*HALITCHI Liliana-Gabriela¹, TOMIȚĂ Daniela Ivona¹,
ILIESCU Codruța²*

e-mail: gabriella_halitchi@yahoo.com

Abstract. *In the case of temporary teeth, a marked increase in all caries indicators was noted. Baby bottle tooth decay is a serious form of temporary teeth lesion that leads to rapid and accentuated tooth destruction. The studie scope is determining the Incidence and Etiopathogenic Algorithm in Baby Bottle tooth decay in Children. We proposed to characterize epidemiologically a heterogeneous group of 140 children 64 girls and 75 boys from 18 months to 5 years and to provide valid data on (number and location of BBTD lesions, general clinical aspects, data on rbirth and nutrition). In terms of nutrition, 99 babies with baby bottle tooth decay were artificially fed, 38 sucked mother brest; 110 of the children receive a sweetened night bottle, 90 babies prefer sweetened beverages. Dietary bottle feeding accurately increases the risk of bottle-feeding. No etiological study was able to demonstrate the unique cause of nipple caries syndrome. An effective preventive action, early introduced by professionals, parents and children, is required.*

Key words: baby bottle tooth decay, decay, child, sucking habits, bottle content

Rezumat. *În cazul dinților temporari s-a remarcat o creștere marcantă a tuturor indicatorilor de carie. Caria de biberon este o formă gravă de leziune pe dinți temporari care duce la distrugerea rapidă și la vârste mici a dinților. Scopul studiului este stabilirea incidenței și a unui algoritm etiopatogenic în caria de biberon la copii. Ne-am propus să caracterizăm epidemiologic un lot eterogen de 140 copii 64 fete și 75 băieți, între 18 luni și 5 ani, și să oferim date valide privind numărul și localizarea cariilor de biberon, aspecte clinice generale, date cu privire la erupție și alimentație. În ceea ce privește alimentația 99 copii cu carie de biberon au fost hrăniți artificial, 38 au supt la sân; 110 dintre copii primesc un biberon de noapte cu un conținut îndulcit, 90 de copii preferă băuturile îndulcite. Alimentarea cu biberonul fără orar precis crește riscul de carie de biberon. Nici un studiu etiologic nu a putut demonstra cauza unică a sindromului cariei de biberon. Este necesară o acțiune preventivă eficientă, devreme introdusă, realizată de profesioniști, părinți și copil.*

Cuvinte cheie: carie de biberon, carie, copil, obiceiuri de sugere, conținutul biberonului

INTRODUCTION

BB TD is a severe form of cavity injury on temporary teeth, characterized by anarchic localization, onset on immune surfaces, with the simultaneous

¹ "Apollonia" University, Faculty of Dental Medicine, Iasi, Romania

² "Grigore T. Popa" University of Medicine and Pharmacy, Iasi, Romania

damage of all dental groups, with rapid evolution in the surface and in depth which leads to the rapid destruction of all teeth. This type of lesion, formerly referred to as the circular decay of the upper fronts due to the characteristic localization, may be of simultaneous interest of all dental groups and is described under varied names: early acute caries, acute caries, baby bottle tooth decays.

Located on the vestibular faces in the cervical third of the upper frontals, BBTD is an acute, rampant, unsightly cavity that begins with the small white lesion immediately after the teeth eruption on the arcade. At the onset it has the aspect of a white spot located in the cervical third of the upper temporal incisors. The BBTD evolves rapidly in the surface, including the rough and deep faces, and differs from yellowish to black. The acute character and palliative regression phenomena lead to coronary fractures and periapical complications with repeated abscesses and fistula (fig.1).



Fig.1 Intraoral image of a patient with BBTD

We purpose of the study: determining the incidence of BBTD in children; to identify of the clinical aspects of BBTD following rigorous clinical and paraclinical examinations; establishing an etiopathogenic algorithm in the BBTD.

MATERIAL AND METHOD

We proposed ourselves to epidemiologically characterize a heterogeneous group of 140 preschool children presented to dental assistance with a diagnosis of BBTD and to provide valid data related to 7 epidemiological variables (age, gender, number and location of caries BBTD, general clinical aspects, birth data, dental eruption and nutrition). The study was conducted on a group of preschool children composed of 140 children, 64 girls and 75 boys aged 18 months to 5 years from the records of the Apollonia Orthodontic-Paedodontics Clinic during 2009-2017. For the statistical processing of the data in this research we used the specialized statistical software: SPSS version 13.0, Statistics version 6.0, as well as the Microsoft Office XP software package. The dental surfaces were examined with the probe and the mirror, and the incipient cavities, the detectable manifestations of the cervical enamel and the cervical enamel stains were identified. The gingival condition was examined, taking into account the inflammatory signs of the papillae and the free gingival margin. Oral hygiene was assessed by the presence / absence of the bacterial plaque during examination.

Distribution of the study group by age and sex

As regards to the distribution of the study group by gender, there is a predominance of male sex (45%) versus feminine (37%). Age distribution is heterogeneous, as can be seen in the chart, with maximum values around the age of 18 months. The frequencies of

the age of patients registered by us vary as follows: 16% 20 months, 14% 19 months 8% aged 3 years, 7% aged 2 and respectively, and for small ages the frequency is sensitively equal to the lowest value in the lot 4%. 51.5%

RESULTS AND DISCUSSIONS

Thus, 37.8% of the children with BBTD came from births with medical problems, 28.4% were born prematurely, 36.1% had birth defects and stayed under neonatological surveillance for a maximum of one week, 42.6% were treated for various conditions in the infancy. Most often children were diagnosed and treated for: varicella 5.9%, measles 2.6%, otitis 27.8%, 24% bronchitis (Acs *et al.*, 1992; Ayhan *et al.*, 1996; AAPD Guide, 2006) (fig. 2). For the assessment of growth and general development, a number of parameters related to acquired skills were investigated: the age at which the child went, ate alone, drank with a cup, talked, and eating preferences (AAPD Guide, 2006; Guide AAP, 2001, AAP Guide, 2011; Drury *et al.*, 1999).

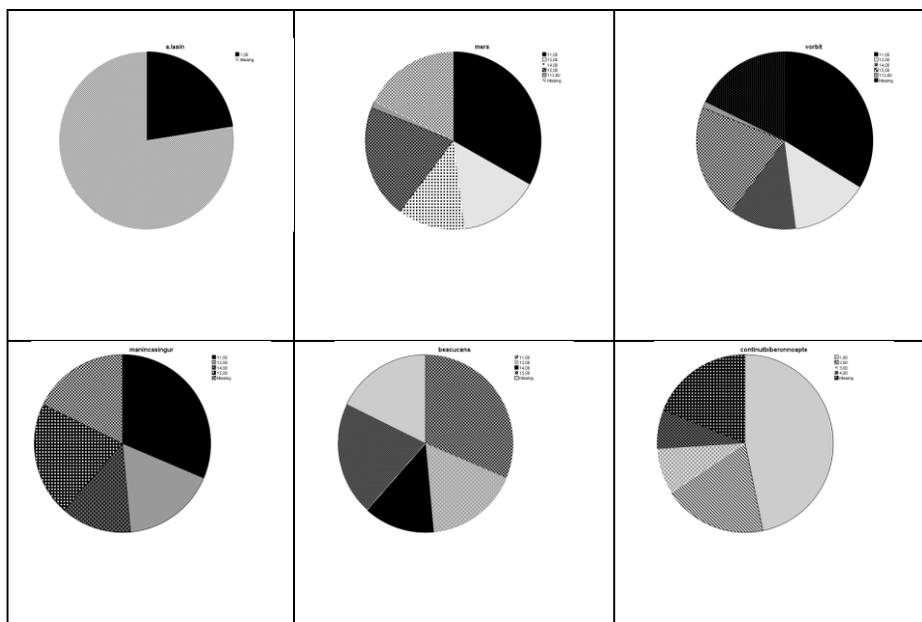


Fig.2 Diagrams of growth assessment parameters studied in the studio group: the age at which the children went, they spoke, the food, ate alone and drank

On average, the children in our study group went around 14 months, talked at 14 months, ate alone and drank with cup at 12 months, and the dental eruption began at 5.7 months, all values falling within normal (AAPD Guide, 2006; AAP Guide, 2001; Fillstrup *et al.*, 2003; Tinanoff *et al.*, 2002; Tinanoff and Reisine, 2009) (fig.2,3, tab.1).

Table 1

Statistical indicators for small child acquisitions

	N	Minimal	Maximal	Average	Standard Deviation
Walk	139	11.00	112.00	14.0935	11.99208
Talkingt	139	11.00	112.00	14.0863	11.99365
Eat alone	139	11.00	15.00	12.6906	1.68045
Drink with cup	139	11.00	15.00	12.6906	1.68045
Dental eruption	139	4.00	12.00	5.7050	1.55318

In terms of nutrition, 99 BBTD babies were artificially fed, 38 sucked at mother breast, 135 started dental brushing, over 110 children continued to receive a snight baby bottle, over 90 of the children preferred sweetened drinks (Tinanoff *et al.*, 2002; Tinanoff and Reisine, 2009) (tab. 2, 3).

Table 2

Descriptive nutrition indicators in the studygroup

	N	Minim	Maxim	Medium values	Standard Deviation
Succion	135	.00	1.00	.4000	.49172
Brushing teeth	135	6.00	24.00	17.9704	4.11938
Artificial fed	99	1.00	1.00	1.0000	.00000
Sucking to the breast	38	1.00	1.00	1.0000	.00000
Night bottle	113	1.00	1.00	1.0000	.00000
Bottle content noapte	137	1.00	4.00	1.7007	.97290
Sweet solid table	0				
Sweet soft drinks	96	1.00	1.00	1.0000	.00000

There is a net trend in the group asking the bottle without the precise timetable to be touched by the BBTD.

Table 3

Tendency of cavity damage according to the frequency of bottle nipple sugars

Frequency of baby bottle	Whitout decay	BBS
All nights and daily rests	90.2%	57.9%
All daily rests	0.6%	0%
All night	13.4%	21.1%
4-5 times/week	1%	5.3%
ocasionaly	5.3%	5.3%
never	36.6%	10.5%

The habit of consuming a bottle during siesta and sleeping with the bottle most often leads to a BBTD. 36.6% of the cavity-free group does not lie with the bottle as compared to only 10% of the cavity group. More than 40% of healthy babies suck the bottle but are not affected by the caries. Even 30 children surveyed in one study remained prone to caries while holding a bottle in their mouth for 8 hours a day, which shows that other factors predispose to BBTD caries. Keeping the baby bottle in the mouth all night is more common in the group of affected children. The prolonged use of the bottle during the day is also the most common in the group of patients affected by nipple caries (Tinanoff *et al.*, 2002; Tinanoff and Reisine, 2009) (tab. 3).

The bivariate T student test demonstrates that there are statistically significant correlations with p less than 0.05 between age and normal acquisition of walking, speaking, brushing their teeth, and especially between the presence of sucking ticks, artificial food and baby bottle nourishment. The parents have some idea of the excessive amount of sugars they give to their children: only 36% of parents indicate a high consumption of sweets, and 59% of them think that children drink plenty of sweetened liquids. The liquid most often used in the bottle is the milk alone or with the addition of sweet, flour and fruit juices.

CONCLUSIONS

No etiological study has been able to demonstrate the unique cause of bottle feeding syndrome, and BBTD should be considered as a multifactorial disease difficult to treat.

In order to increase the volume of dental care for babies effectively. Sustained, early preventive action is required, carried out by professionals, parents and children. No therapeutic method is better than another, but the therapeutic methodology differs.

If we balance the oral hygiene from the first days of life and the costs associated with the lack of hygiene, the final balance is beneficial for the preventive patients in all social categories.

REFERENCES

1. Acs G., Lodolini G., Kaminsky S., Cisneros G.J., 1992 - *Effect of nursing caries on body weight in a pediatric population.* *Pediatr Dent*; 14(5):302-5.
2. Ayhan H., Suskan E., Yildirim S., 1996 - *The effect of nursing or rampant caries on height, body weight, and head circumference.* *J Clin Pediatr Dent*; 20(3):209-12.
3. Drury T.F., Horowitz A.M., Ismail A.I. et al., 1999 - *Diagnosing and reporting early childhood caries for research purposes.* *J Public Health Dent* 1; 59(3):192-7.
4. Filstrup S.L., Briskie D., daFonseca M., Lawrence L., Wandera A., Inglehart M.R., 2003 - *The effects on early childhood caries (ECC) and restorative treatment on children's oral health-related quality of life (OHRQOL).* *Pediatr Dent*; 25(5):431-40.
5. Tinanoff N.T., Kanellis M.J., Vargas C.M., 2002 - *Current understanding of the epidemiology, mechanism, and prevention of dental caries in preschool children.* *Pediatr Dent*; 24(6):543-51.

6. **Tinanoff N., Reisine S., 2009** - *Update on early childhood caries since the Surgeon General's Report*. Academic Pediatr; 9(6):396-403.
7. *****, 2006, American Academy of Pediatric Dentistry**, *Symposium on the prevention of oral disease in children and adolescents*. Chicago. Ill; November 11-12. 2005: Conference papers. Pediatr Dent 28(2); 96-198.
8. *****, 2006, American Academy of Pediatrics Committee on Nutrition**, *Policy statement: The use and misuse of fruit juices in pediatrics*. Pediatrics 2001; 107(5):1210-3. Reaffirmed October, 2006.
9. *****, 2011, American Academy of Pediatrics**, *Patient education on line: Weaning to a cup*. Available at: "<http://patiented.aap.org/content.aspx?aid=6662>". Accessed July 6

THE ROLE OF FRUIT AND VEGETABLE CONSUMPTION IN MAINTAINING NORMAL ORAL PH

ROLUL CONSUMULUI DE FRUCTE ȘI LEGUME ÎN MENȚINEREA PH-ULUI ORAL NORMAL

*TOMIȚA Daniela Ivona¹, VASILIU Mihela Papușa¹,
SACHELARIE Liliana¹, DELEU G.¹, STADOLEANU Carmen¹*

e-mail: daniela.tomita@yahoo.com

Abstract. Salivar pH, an important indicator of a person's health, is measured in the morning, immediately after awakening, because throughout the day it may vary depending on the foods consumed. Average values should be 6.7 (with wide variations between 5, 6 - 8). Fruits and green vegetables have an alkaline effect once they get into the stomach. For the present study, we have comprised a group of 31 patients with general illness (HTA-associated diabetes), which we compared with a control group of 25 patients, aged 50-85 years, to whom we measured the pH salivary. In the study group, low pH values were recorded due to the general diseases associated with the medication used, to restrict the consumption of fruits and vegetables, compared to the control group where the recorded pH has higher values.

Key words: pH salivary, oral health, vegetables, fruits, vitamins

Rezumat. pH-ul salivar, un indicator important asupra stării de sănătate a unei persoane, se măsoară dimineața, imediat după trezire pentru că pe parcursul zilei poate varia în funcție de alimentele consumate. Valorile medii ar trebui să fie de 6,7 (cu variații largi între 5,6-8). Fructele și legumele verzi (salata verde, urzici, stevie, loboda) au efect alcalinizant odată ajunse în stomac. Pentru studiul de față am constituit un lot 31 de pacienți cu boli generale (HTA-diabet asociate), care l-am comparat cu un lot martor de 25 pacienți, cu vârste cuprinse între 50 și 85 ani, cărora le-am măsurat pH-ul salivar. La lotul de studiu s-au înregistrat valori scăzute al pH-ului, datorită bolilor generale asociate, medicației administrate, restricționării consumului de fructe și legume, în comparație cu lotul martor unde pH-ul înregistrat are valori mai ridicate.

Cuvinte cheie: pH salivar, sănătate orală, legume, fructe, vitamine

INTRODUCTION

Oral cavity is the environment in which oral fluids and odontal and prosthetic restorative materials coexist, even though they have a variety of chemical and physical compositions. This medium represents a complex ecosystem within which

¹ "Apollonia" University, Faculty of Dental Medicine, Iasi, Romania

the oral fluid is one of the main compartments (adjacent to the oral mucosa and numerous bacteria), and any disturbance that occurs, disrupts the equilibrium that is installed, a balance that re-creates to create a new homeostasis, but to another level. Oral fluids, interstitial fluid and saliva, are saline solutions maintained at a constant temperature of approximately 36.5 ° C, which creates a very aggressive environment in the oral cavity where various biochemical reactions are initiated.

Saliva has a high capacity of phosphate and carbonate buffer, but also mucin composition, low pH values can cause chemical and electrochemical corrosion at the level of prosthetic restorations (Ursache *et al.*, 2006).

Saliva pH may be more acidic due to certain types of foods such as orange juice, candy sugar, pastry, smoking or general illnesses that could cause an acid saliva (Sjögren's Syndrome, chemotherapy) (Minich and Bland, 2007).

Saliva, often referred to as the body's health mirror, has been shown to reflect tissue levels of several biomolecules. Therefore, saliva analysis, like blood, gives us useful information for health assessment and monitoring, as well as disease states (Aguirre *et al.*, 1993).

MATERIAL AND METHOD

The study material comprises a group of 31 patients with general disease (HTA-associated diabetes) who compared it with a control group of 25 aged 50-85 years to whom we measured salivary pH. These patients presented themselves during the three years (2012-2015) in the Clinic of Dental Prosthetics, the Faculty of Dental Medicine of Apollonia University in Iasi, for the restoration of physiological, disturbed phonetic functions for prosthetic treatment.

The selected patients were informed and agreed on the conduct of the study. The patients underwent a clinical and paraclinical examination, following which a treatment plan was established for each subject. Also, all patients completed a general health questionnaire, as well as a food essayist.

Saliva testing aims to identify saliva as the causal factor of the changes that occurred and later to motivate the patient to improve their oro-dental status.

As a working method, we used the Saliva-Check BUFFER (fig.1) in vitro test to check the salivary quality, saliva pH and saliva buffer capacity (Coulter and Walsh, 2006; Oner Ozdas *et al.*, 2010).

Patients in the study group were advised not to smoke, to perform dental brushing for the last 24 hours, not to consume food or beverages, not to use mouthwash at least one hour before the salivary diagnostic procedure is performed. Testing has two distinct stages, namely: the first step consists in examining the saliva of rest, and in the second stage the stimulated saliva is examined.



Fig. 1 Saliva Check BUFFER Kit

Saliva testing involves visually inspecting the salivary level by assessing salivary gland secretion, saliva consistency, as indicated by the test company, and salivary pH measurement. This test includes specific paper for salivary pH testing and a graduated specific saliva collection tray. The normal salivary pH indicating a healthy saliva is between 6.8-7.8 (Aleksėjuniene *et al.*, 2007; Coulter and Walsh, 2006).

RESULTS AND DISCUSSIONS

Accumulating clinical data with paraclinical data and using descriptive and correlational statistical studies, significant outcomes have been outlined for the proposed study. The study lot (group A) consists of 19 women and 12 men and the control group (group B) of 15 women and 10 men. Their origin is 65% of urban areas in both study groups. Both the age of the patients in the study group and that of the control group were ranked the same; in lot A ranges between 55-64 years in a proportion of 22.58%, the interval 65-74 years being 35.49%, the batch segment aged 75-84 years reaching a 25.8%, the age category over 85 years holds 16.13%.

Table 1

Distribution of the batch by age group

Age groups	Nr. cases A		Nr. cases B	
	Nr.	%	Nr.	%
55-64 years	7	22.58 %	11	44 %
65-74 years	11	35.49 %	7	28 %
75-84 years	8	25.80 %	5	20 %
< 85 years	5	16.13 %	2	8 %
TOTAL	31	100%	25	100%

To assess the stimulated salivary flow rate, the steps are:

- The patient chews and soaks a 1 gram paraffin cube for 30-60 sec. (fig. 2), after which the secreted saliva will be swallowed. Stimulating salivary secretion can also be done chemically by applying a 2% citric acid solution to the tongue.

- Start the stopwatch and for 5 minutes. the patient still chews paraffin and removes saliva in the graduated container (fig. 2) of the Saliva-Check BUFFER Kit. To remove the foam add a drop of octanol.
- The amount of saliva harvested is divided by the number of minutes and RFS is obtained.



Fig. 2 The paraffin cube and the graduated container

Salivary flow is the result of the salivary secretion rate that we can distinguish in:

- Rare salivary flow rate (RFR), which averages 0.30 mL / min with a caution threshold when it falls below 0.10 mL / min;
- Stimulated salivary flow rate (RFS) that averages 2 mL / min with a caution threshold when the value falls below 0.70 mL / min; more than 50% of this secretion is provided by the parotid gland.

Saliva of rest is permanently present in the form of a thin layer of 1-10 micron thickness on all oral surfaces, mainly having a protective role. Through its action, stimulated salivary flow plays an important role in self-cleansing and provides adequate clearance time. Thus, food debris and microbial flora are dispersed throughout the oral cavity, preventing the bacterial plaque from forming on only some sites, thereby providing cleansing (oral stagnation) of oral bacteria, glucose from diet, fluoride and anti-plaque and antibacterial chemical agents.

By comparing the sex distribution of salivary buffer capacity (tab. 2, fig. 3a, b), we can observe almost identical percentages of the three categories (low, medium and increased pH) in both genders.

We meet lower salivary pH (M pH = 5.20) in patients with general illness because some drugs (corticoids, antihypertensives) may decrease pH salivary. In other

situations like diabetes, acid pH is the result of high glucose concentration in the saliva, and thus can be correlated with decreased salivary flow in these patients.

Table2

		Lot A (study)		Lot B (witness)	
		Men		Men	
		Frequency	Percent	Frequency	Percent
pH	low	4	33.33 %	1	10 %
	increased	3	25 %	3	30 %
	normal	5	41.66 %	6	60 %
	TOTAL	12	100%	10	100%
		Women		Women	
		Frequency	Percent	Frequency	Percent
pH	low	5	26.32 %	3	19.98 %
	increased	6	31.58 %	4	26.67 %
	normal	8	42.10 %	8	53.35 %
	TOTAL	19	100%	15	100%

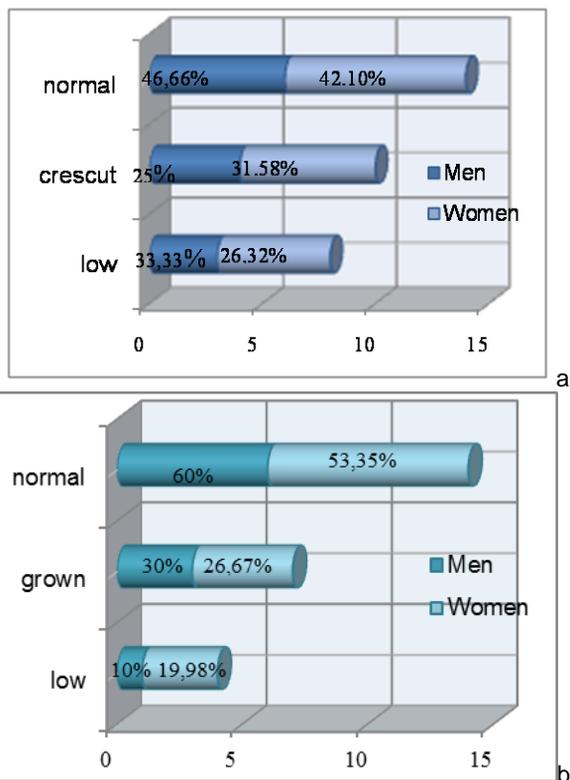


Fig. 3 Graphical representation of gender distribution of salivary pH

Saliva's buffering capacity is the ability to reduce acidity. There are two salivary buffered systems of phosphates in unstimulated saliva and bicarbonates in stimulated saliva. A salivary pH lower or equal to 4 denotes a reduced saliva buffering capacity.

The extent to which the pH will decrease is influenced by the amount and location of the bacterial plaque, prevailing flora, salivary production, and the type and concentration of the substrate (fermentable carbohydrate) introduced into the oral environment.



a.



b.

Fig. 4 Values of salivary pH in the patients of the group: a. Lot A; b. Lot B

Acid in food most often produces dental erosions. Acid beverages that can cause erosion include carbonated beverages, some fruit juices (especially citrus); a diet rich in hydrocarbon may also favor dental erosion. It is important to note that the frequency of consumption of acidic foods plays a more important role in the occurrence of dental erosion than the ingested amount.

Acid erosion is irreversible and only the dentist can identify the early signs of it on the teeth: vulnerable enamel, thin, translucent or transparent appearance, color change (yellowing) and lack of brilliance. In case of acid pH, the color changes of the acrylic mobile dentures present in the oral cavity, as well as higher deposits of tartar, are also found.

An important role of the saliva is to neutralize acid pH and thus contributes to enamel protection against demineralisation (enamel demineralization occurs after repeated acid attacks on the tooth). If these acidic attacks are very common on enamel, it does not have time to recover, and over time, teeth will lose their surface enamel.

The food questionnaire revealed that patients whose pH is increased regularly consume acidic foods (meat and meat products, industrially processed dairy products, eggs, nuts, dried beans, soy beans). Therefore, in patients whose pH is acidic, it would be advisable to consume alkaline fruits and vegetables to protect, not just odonto-periodontal units, but also the rest of the oral cavity structures. Among the recommended vegetables are cucumbers, cabbage, broccoli, celery, parsley, pasta, asparagus, red beet, spinach, pumpkin, onions, but and nettles, stevia, loboda, apples, apricots, apples, apricots, peaches, cherries, avocados, grapes, ripe bananas, strawberries, grapefruit, mango, melon / red , nectarines, black olives, papaya, pear.

CONCLUSIONS

The salivary PH in normal range was recorded in people with a good general health status and with a frequent consumption of fruits and vegetables.

Increased consumption of citrus and carbonated beverages explains the higher frequency of erosion in adult teeth as well as color changes of acrylic dentures.

Salivary determinations indicate a change in salivary pH to acid in patients with gastric disease and diabetes, sometimes reaching very low values of about 3.1, which greatly influences the demineralisation process of the dental structures with the formation caries, tartar deposition.

In diabetic patients, saliva buffering capacity is significantly lower, falling within the saliva buffer capacity category, and the salivary pH recorded is significantly lower compared to the pH of non-diabetic patients. The mean salivary pH was 6.55 for patients with diabetes representing an acid saliva while the rest of the patients had a saliva with an average of 7.

REFERENCES

1. Aguirre A., Testa-Weintraub L.A., Banderas J.A., Haraszthy G.G., Reddy M.S., Levine M.J., 1993 - *Sialochemistry: a diagnostic tool?*. Critical Reviews in Oral Biology and Medicine, 4, 343–350.
2. Aleksejuniene J., Kim M., Chan A., Clark C., 2007 - *Standardization effect on reliability of salivary measurements – a methodological study*. Abstract 1108 – IADR, New Orleans USA.
3. Coulter C., Walsh L.J., 2006 - *Saliva testing – Good practice, good sense!* NZDA NEWS, (Extract from the manual Saliva testing: Good practice, good sense by LJ Walsh, published by GC Asia 2002. (129).
4. Minich D.M., Bland J.S., 2007 - *Acid-alkaline balance: role in chronic disease and detoxification*. Alternative Therapies in Health and Medicine; 13: 62-5.
5. Oner Ozdas D., Yamac Yilmaz E., Aren G., Aytepe Z., 2010 - *Comparison of saliva buffering capacity by commercial (colorimetric) and conservative tests*. Abstract 4271 – IADR, Barcelona, Spain.
6. Ursache Maria, Cherciu Ciobotaru A. D., Armencia Adina Oana, Simion Catinca. 2006 - *Influența compoziției chimice a salivei asupra stabilității unor aliaje utilizate în stomatologie*. Comunicat și publicată în rezumat la International Conference on Biomaterials & Medical Devices, p. 273, Iasi.

CONSUMPTION OF FRUIT AND VEGETABLES AND QUALITY OF LIFE

CONSUMUL DE FRUCTE ȘI LEGUME ȘI CALITATEA VIEȚII

VASILIU Mihela Papușa¹, TOMIȚĂ Daniela Ivona¹, SACHELARIE
Liliana¹, FUIOAGĂ P.C.¹, SHARDI Manahedji Ardeshir¹, COSTIN G.¹
e-mail: mihapay@yahoo.com

Abstract. A major public oral health problem with considerable social and economic cost is oral diseases such as dental caries, periodontal disease, tooth loss, oral mucosal lesions, dental traumas that have a major impact on individuals, and Society with reduced quality of life. The diet rich in sugar and fat and low in fiber, vitamins and essential minerals are associated with dental caries and premature tooth loss. The study was carried out with the help of own questionnaires containing questions that refer to different aspects of the quality of life, such as satisfaction with personal life, food risk factors and behavior towards oral health, the impact of oral affairs. From the data obtained, we noticed that at a young age the aesthetic aspects are considered impervious to the perception of the quality of life, whereas in the adult population the diet and the quality of the consumed food are the first.

Key words: life quality, oral health, vegetables, fruits, minerals, vitamins

Rezumat. O problemă majoră de sănătate publică orală, cu un cost social și economic considerabil, sunt afecțiunile orale, precum caria dentară, bolile parodontale, pierderea dinților, leziunile mucoasei orale, stomatita ulcerativă necrozantă sau traumatismele oro-dentare ce au un impact major asupra indivizilor și societății cu reducerea calității vieții. Dieta bogată în zahăr și grăsimi și săracă în fibre, vitamine și minerale esențiale se asociază cu carii dentare și pierderea prematură a dinților. Studiul a fost realizat cu ajutorul unor chestionare proprii care cuprind întrebări ce fac referire la diferite aspecte ale calității vieții, precum: satisfacția față de viața personală, factorii de risc alimentari și comportamentul față de sănătatea orală, impactul afecțiunilor orale asupra vieții sociale. Din datele obținute am observat că la vârsta tânără aspectele estetice sunt considerate impoartante în percepția calității vieții, pe când la persoanele adulte, pe primul loc sunt dieta și calitatea alimentelor consumate.

Cuvinte cheie: calitatea vieții, sănătate orală, legume, fructe, minerale, vitamine

INTRODUCTION

One of the fundamental human rights is the general feeling of happiness and satisfaction in relation to life and the environment, including aspects such as health, leisure time, culture, rights, values and beliefs, aspirations and basic living conditions of these elements (Watt, 2000). Another definition (Wilson and Cleary, 1995) puts the quality of life in relation to "the harmonious and simultaneous

¹ "Apollonia" University, Faculty of Dental Medicine, Iasi, Romania

satisfying of all human needs: health, civilized living conditions, economic and social security, free time, culture, education, dignified, supportive and positive interpersonal relationships, a rationally organized society based on freedom, democracy and constructive morality. "

From a health point of view, the quality of life reflects physical and mental health, but also the ability to react to factors in physical and social environments, and has a higher degree of subjectivity compared to life expectancy, and can therefore be difficult to measure (Watt, 2000). Life quality assessments of oral health and its development over time are particularly important for practitioners.

For this purpose various health questionnaires were designed, and the resulting data could be included in analytical studies that follow the factors involved (Leao and Sheiham, 1995; Locker, 1997; Mahler, 1998), or how the individual perceives his or her state of health (Inglehart *et al.*, 2002; Sadana, 2002).

An integral part of the general health, oral health with the usual tools for measuring quality of life in relation to health, does not cover the specific impact of oral health problems on the quality of life of individuals, and specific tools are needed.

Individual and population health is related to the well-being of the community, its living standards, everything that experts call the "quality of life" existing in a particular society. In this context, illness is not only a problem of human biology, but also an important social problem dependent on social behaviors, norms or values, habits, habits and lifestyles of a particular population and its constituent groups.

MATERIAL AND METHOD

In this study we selected a group of 65 patients aged between 20 and 70 who presented themselves in the Dental Prosthesis Clinic with functional disorders. In addition to the usual clinical examination, patients have received a series of questionnaires on general health, socioeconomic status, medication, food consumption, preferences and eating habits that have established nutritional deficiencies. At the same time each patient gave his written consent to participate in this study.

The risk factors of a deficient nutritional status to be analyzed are: psychosocial (loneliness and isolation, lack of financial resources, loss of appetite and interest in feeding, depression), physical (changes in absorption capacity and use of nutrients, changes in the metabolic capacity of nutrients, changes in the energy and activity process, the effects of medication on appetite and the absorption of nutrients and their use), functional (disorders of vital functions: sight and hearing, physical disabilities: arthritis, stroke lead to inability to buy and carry), oral (changes in food chewing, taste and smell changes, drug-induced xerostomia)

The questionnaire method is one of the more commonly used methods because it is easier to achieve, a skilled person can investigate an appreciable number of people. Sometimes important aspects of a person's life may influence the state of nutrition and identify important clues in this regard, playing an important role in collecting information necessary to establish a link with the person concerned.

RESULTS AND DISCUSSIONS

From the processing and analysis of the data obtained from the questionnaires we have obtained a series of data that led us to the quality of life lost by the interviewed subjects.

Depending on the socio-demographic variables, we obtained the following results:

- patients over 28 years of age are more satisfied with personal life at a rate of 24.61% (tab. 1);

- women are more satisfied than men, with 35.38% and 13.85% respectively (tab. 2);

- middle school subjects are more satisfied than those with higher education (tab. 3, fig. 3).

Most of the respondents perceive the level of pay as good and very good (52.3%), while 47.7% characterize it as weak and very weak, considering the salary benefits a significant part of motivation in the workplace (fig.1,2).

Table 1

Distribution of patients satisfied with personal life by age group

Age groups	Number of patients	The degree of satisfaction with personal life		
		YES	NO	Percentage
20-28 years	8	YES	3	4.61%
		NO	5	7.70%
28-30 years	11	YES	8	12.30%
		NO	3	4.61%
30-40 years	16	YES	13	20.02%
		NO	3	4.61%
40-45 years	13	YES	7	10.77%
		NO	6	9.23%
45-65 years	8	YES	3	4.61%
		NO	5	7.70%
< 65 years	9	YES	3	4.61%
		NO	6	9.23%

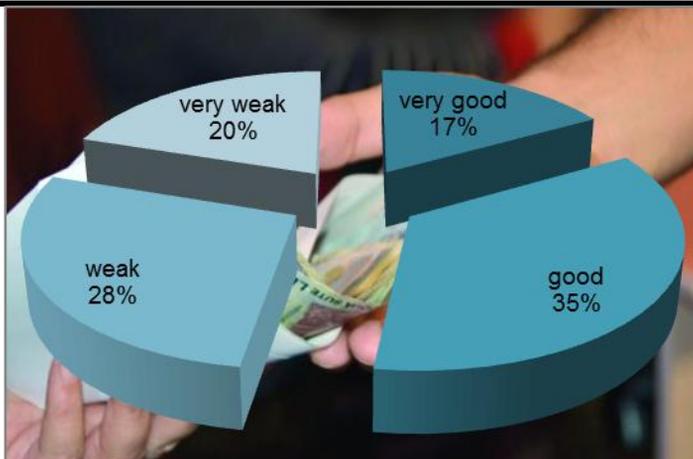


Fig. 1 Satisfaction based on salary level

Satisfaction with the workplace and the income achieved is more than 50% (work - 60%, salary - 53.85%), (fig. 2).

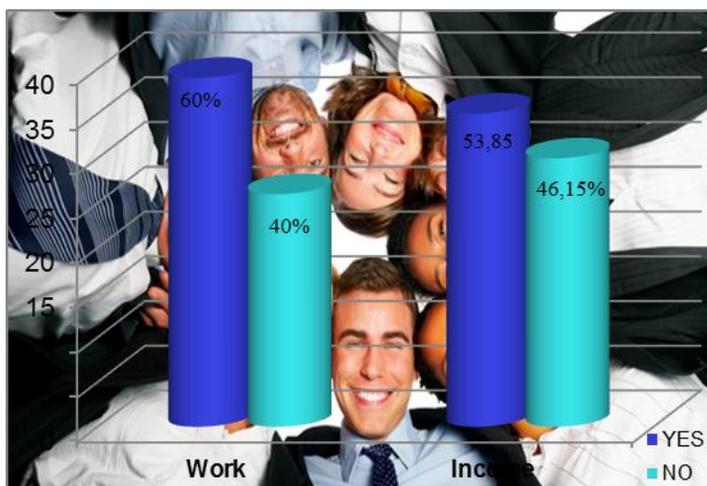


Fig. 2 Satisfaction with work and earnings

Table 2

The distribution of patients satisfied with their personal life by sex

The sex of the patients	Number of patients	The degree of satisfaction with personal life		
		YES	NO	Percentage
Women	37	YES	23	35.38%
		NO	14	21.54%
Men	28	YES	9	13.85%
		NO	19	29.23%

The flexibility of social norms on femininity and masculinity as well as the reality of the current society require different management tailored to the current needs of women and men. Balancing professional and personal life programs are a response to these different needs (Harvard Business Review on Work and Life Balance, 2000).

Depending on the social variables, the studies show that the satisfaction with the personal and professional life of the subjects with higher education is 20%, compared to those with secondary education, 13.85% and primary, 9.23% (tab. 3, fig. 3).

Table 3

The distribution of patients satisfied with their personal lives according to their studies

Patient studies	Number of patients	The degree of satisfaction with personal life		
		YES	NO	
Primary education	17	YES	6	9.23%
		NO	11	16.92%
Secondary education	26	YES	9	13.85%
		NO	17	26.15%
University studies	22	YES	13	20%
		NO	9	13.85%

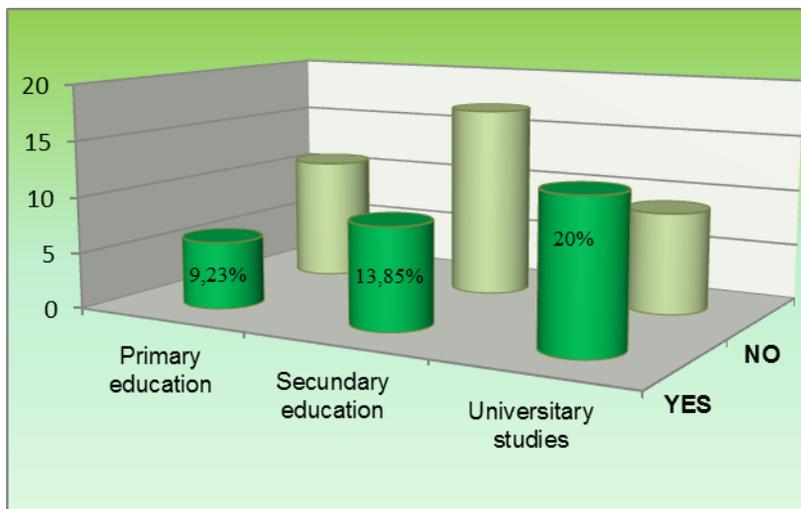


Fig. 3 Distribution of patients according to the educational level and contentment to personal life

Food is usually understood as the variety of foods consumed, while nutrition means the consumption and absorption of nutrients. Nutrition and nutrition influence the teeth in 3 ways:

- ℞ teeth structure,
- ℞ dental caries,
- ℞ dental erosion.

There are many causes of defects in the teeth structure, and nutrition is just one of them.

From the point of view of the prevention of oro-dental disease, the problem of rational nutrition in the civilized man has two aspects:

- food consistency,
- the chemical composition of foods.

Consistency of foods determines the health of teeth. Consumption of hard, hard, crunchy foods like raw vegetables and fruits (carrot, bell pepper, radishes, jelly, apples, pears, quinces) contributes to the cleaning and self-cleaning of dental surfaces as well as soft tissue massage surrounding, stimulating action on gingival circulation.

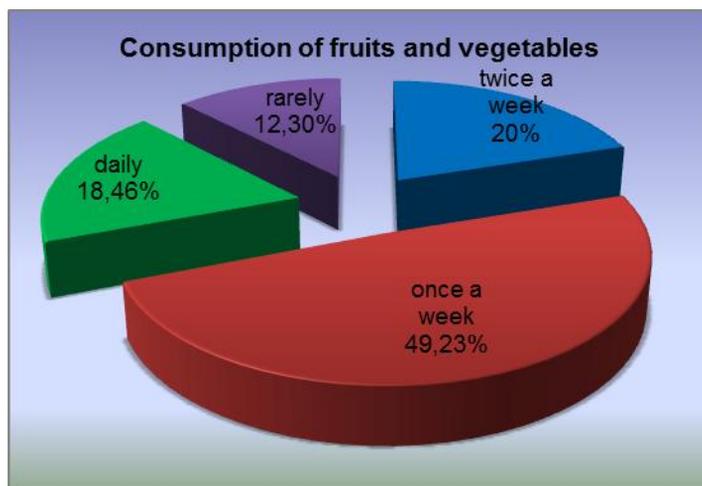


Fig. 4 Distribution of patients according to the frequency of fruit and vegetable consumption

Daily consumption of hard fruits (apples, pears) and vegetables is mandatory because they have a high water content that diminishes the effect of sugars contained in saliva. An important aspect is that acid foods (citrus and tomatoes) should be consumed as part of a large meal (lunch, dinner) minimize acid in the oral cavity.

Taking into account the aforementioned considerations, we also included in the questionnaire the analysis of the consumption of fruit and vegetables.

In the studied group, unfortunately the consumption of fruits and vegetables is low, only 18.46% of the patients declared that they consume fruits and vegetables daily and 20% consume 2 times a week or more (fig. 4).

At the same time, we know that acids and sugar in food can destroy the enamel, and this has to be compensated for with phosphorus and calcium-containing foods that contribute to the remineralization of teeth. Foods containing essential minerals help maintain the healthy tooth enamel and these can also be found in plant sources: cabbage, snapac, broccoli.

It is also necessary to consume vitamin-rich foods because the body needs vitamin D to absorb calcium, which also helps to strengthen the teeth and keep them healthy. Deficiency of vitamin D can affect the bones and make them brittle. In the oral cavity, lack of vitamin D can cause gum disease and even jaw fracture. At an early age, deficiency may affect the formation of teeth. The most important source of vitamin D is the sun, but can also be taken from vegetables and fruits: mushrooms, whole grains, nuts, apples.

Patient-patient communication plays an important role in the patient's treatment of odontal, periodontal, prosthetic. Patience, understanding as a necessary thing for the psychic stability of the patient, explaining health awareness, discussing treatment alternatives, physician skills, organizing working time, trust, speed and professionalism are the means to improve quality the life of any patient.

Of particular importance is the result of dental treatment and the quality of life of the patient, the fact that the physician must understand the psychosocial and emotional status of the patient, especially when restoring lost functions of the stomatognomate system, this being the role of prosthetic treatment. That is why it is advisable for the doctor and the patient to discuss the treatment plan and the changes it will have on the patient's quality of life.

CONCLUSIONS

1. The quality of life in relation to oral health is a relatively new concept, but growing in the field of dental medicine. This concept has enjoyed much attention from researchers over the past two decades. There has been much progress in measuring the quality of life in relation to oral health, initially among adults.

2. Oral health has affected young people's quality of life mainly by reflecting on food consumption, oral hygiene, emotional stability and aesthetic function.

3. Presenting the assessments / perceptions that adults make of the conditions in which they live: analyzing components of the adult's personal life (income, living conditions, family relationships, personal health, workplace) and social life (the chance to have a job, proper housing, access to the desired education, conditions for family formation, corruption in society).

4. Assessments of quality of life are predominantly positive or positive, and its perception in the near future is in a favorable light: thus, almost half of young people (57%) perceive the quality of life as compared to last year and 23% perceive an improvement.

REFERENCES

1. **Leao A., Sheiham A.L., 1995** - *Relation between clinical status and subjective impacts on daily living*. J Dental Research, 74, 1408-13.
2. **Locker D., 1997** - *Concepts of oral health, disease and quality of life, in Slade GD (ed). Measuring Oral Health and Quality of Life*. Chaper Hill: University of North Carolina - Dental Ecology, 11-24.
3. **Inglehart R I., Marita R and Bagramian, Robert A., 2002** - *Oral Health-Related Quality of Life*, Quintessence.
4. **Mahler H., 1998** - *The meaning of health for all by the year 2000*, World Health Forum, 1, 5-22.
5. **Sadana R., 2002** - *Describing population health in six domains: comparable results from 66 household surveys*. Geneva: World Health Organization.
6. **Watt R.G., 2000** - *Emerging theories into the social determinants of health: implication for oral health promotion*. Community Dent Oral Epidemiology, 30, 241-7.
7. **Wilson I., Cleary P., 1995** - *Linking clinical variables with health-related quality of life: A conceptual model of patient-outcomes*. JAMA, 273: 59-65.
8. *****, Harvard Business School Press. 2000** - *Harvard Business Review on Work and Life Balance*, Harvard Business Review Paperback Series.

INCREASING THE RISK OF TORNADES IN ROMANIA DUE TO CLIMATE CHANGE

CREȘTEREA RISCULUI DE APARIȚIE A TORNADELOR ÎN ROMÂNIA DATORITĂ SCHIMBĂRILOR CLIMATICE

BODALE I.¹, CAZACU Ana, ENEA Elena-Andreea, OANCEA Servilia
e-mail: ilie.bodale@uaiasi.ro

Abstract. *The aim of this paper is to analyze the causes that lead to the emergence of tornadoes in very low risk areas (Romanian territory) in the conditions of the climatic changes of the last 100 years. This extremely violent meteorological phenomenon is generated by very specific metrology conditions which make the likelihood of their occurrence to be low. The relationship between the occurrence of tornadoes in tornado-free areas and global warming is still unclear. In the present paper we have made a comparative study to established if the whether condition which generated the Făcăeni tornado, in 2002, was random occurrence or was generated by the warming of the atmosphere in terms of climate change. The study is based on the analysis of the factors that generated the tornado, the geographic position, the climate of the region and the warming athmosphere over the last 55 years. Our analysis established that Făcăeni tornado was EF3 intensity and represents a turning point in the study of tornadoes in Romania.*

Keywords: tornadoes, extreme phenomena, Făcăeni tornado, global warming, climate change

Rezumat. *Scopul acestei lucrări este de a analiza cauzele care duc la apariția tornadelor în zone cu risc foarte scăzut (teritoriul României), în condițiile schimbărilor climatice din ultimii 100 de ani. Acest fenomen meteorologic deosebit de violent este generat de niște condiții metorologie foarte specifice ceea ce face ca probabilitatea apariției lor să fie scăzută. Relația dintre apariția tornadelor în zone considerate lipsite de tornade și încălzirea globală sunt încă neclare. În prezenta lucrare am făcut un studiu comparativ pentru a stabili dacă apariția tornadei în Făcăeni, din 2002, este o întâmplare sau apariția a fost generată de încălzirea atmosferei în condițiile schimbărilor climatice. Studiul se bazează pe analiza factorilor care au generat tornada, poziția geografică, clima regiunii și modificarea temperaturii aerului în ultimii 55 ani. Analiza noastră a stabilit ca la Făcăeni în 2002 tornada a fost cu intensitatea EF3 ceea ce reprezintă un punct de cotitură în cea ce privește studiul torndatelor în România.*

Cuvintecheie: tornade, fenomene extreme, tornada Făcăeni, încălzire globală, schimbări climatice

¹ University of Agricultural Sciences and Veterinary Medicine Iasi, Romania

INTRODUCTION

In the last years, extremely weather phenomena become a permanent threat to the security of the population and property. From 1980 till 2000 the estimation is that 75% of population of whole world would be affected at least once by such phenomenon (tropical cyclone, tornado, flood, drought etc) (Teodorescu *et al.*, 2007). The numbers of irregular winds have increased cause material damage and loss of life. This type of winds can be classified as: tropical cyclones, hurricanes, typhoons or tornadoes (Colda and Ardelean, 2004). These winds are caused by large temperature differences between the air mass and the Earth surface. Where the wind is formed above a large stretch of water is called: *hurricane* (Povară, 2004) and if it's generated above the terrestrial surface is *tornado* (Wurman, 2008). The tornado is a vertical column of air from Earth surface till a *Cumulonimbus Clouds* which moves with high speed and counter clockwise rotating, in Northern Hemisphere (Garrison, 2012). The most tornadoes in the world form a spiraling funnel-shaped wind current, about 80 m diameter, with moves at least with 180 km/h, several kilometers. However, few of them can attain F5, with 480 km/h wind speed, a funnel larger than 2 km diameter and travels on the ground more than 100 km.

Tornadoes occur due to excessive warming of the air from the ground surface which is training them in a swirling motion upwards. At vertical climbing, the air is getting cold and part of water vapors condense into *Cumulonimbus Cloud*.

From a climatological point of view, tornadoes occur across the globe less at the poles. In Europe, tornadoes can occur in central-west part (Grünwald and Brooks 2011). The European countries where annual tornadoes can appear, even F4-F5 intensity, are France, Belgium, the Netherlands, Germany and Poland. In Romania, the Czech Republic, Bulgaria, the Republic of Moldova, Greece and Spain are countries where tornadoes can reach the F2 intensity. Instead, in Serbia, Macedonia and Bosnia Herzegovina are areas in Europe where tornadoes do not appear or they have very low intensities (fig. 1).

During the day, the most frequent tornadoes occur afternoon around 5.30 PM or the violent tornado later one hour (Snow 2009). In figure 2, we included a tornado season map during the year in Europe, where in central and northern has the maximum in mid-summer (July) and in the mid-autumn (October) in the south (Groenemeijer and Kühne, 2014).

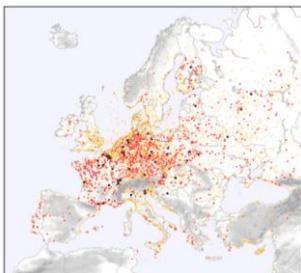


Fig.1 Tornadoes in Europe (F0-F1 yellow, F2-F3 red and F4-F5 black spots)

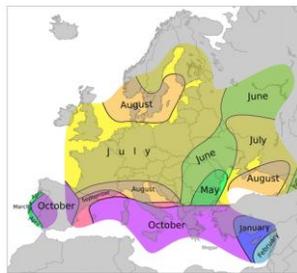


Fig.2 Month of maximum number of tornado in Europe

In 1971, Theodore Fujita proposed a classification system of tornadoes based on destruction of construction (Fujita, 1971). Started from 2007, USA adopted Enhanced Fujita Scale (EFS) classification which describes better than the Fujita scale the impact on the environment. This scale uses 28 indicators for storm damage and changes the speed values for different degrees of storm (Dotzek, *et al.*, 2009).

In the last years, in scientific community there is a debate regarding the relation between increasing the incidence of tornadoes and the whether climate change (Hurricanes, 2015). After 2000, it was reported an increasing number of tornados in regions considered with risk of occurrence. Moreover, tornadoes with F3 intensity were reported in country where they did not meet, like Romania, the Czech Republic and Spain (Lacinová *et al.*, 2007).

MATERIALS AND METHOD

We performed a climatological analysis of tornado occurrence in the conditions of climate change by using the European Severe Weather database and European Climate Assessment & Dataset in Romania. We developed a program in FORTRAN language able to calculate the annual and half-decade averages in each of the 5 metrological stations and used OriginPro for data processing.

RESULTS AND DISCUIONS

In this paper, we studied if high-intensity tornadoes occurred in regions with limited risk of emergence, like Facaeni in 2002 (Balteanu *et al.* 2004, Lemon *et al.*, 2003) was caused by global warming or climatic hazard. In this way, we analyzed the natural condition where the tornado blow and compared the occurrence of tornadoes with the change of average air temperatures from 1961 to 2017, in Romania (Ivanescu *et al.*, 2016).

This tornado had a maximum impact in Facaeni (coordonate: 44°33'46"N, 27°53'38"E) that is a small commune in the East of Ialomita county. The relief in this region is dominated by tabular plain (Baragan Plain) and meadow of Borcea branch of Danube. The maximum altitude does not exceed 100 m (Hagien Plateau) and the lower is 3 m at the confluence of Danube and Ialomita rivers. The position of this locality makes a harsh climate, with hot and dry summers but with cold and bizzard winters. The annually average value of temperatures is around 11.5°C.

The air temperature changed in Romania was analized for recorded values from 1961 to 2017, using date from five weather stations in the country (Bucharest, Constanta, Iasi, Cluj-Napoca and Arad) measured by *Administrația Națională de Meteorologie* (ANM) (Tank *et al.* 2002). The annually, respectively half-decade avarage air temperature is increasing in the last decade with 0.72°C compared to 55 years ago (Ivanescu *et al.*, 2016).

From 1950 to 2013, European Severe Weather Database (ESWD) contains reports of 9529 tornadoes in Europe (Figure 1), where the numbers of them strongly increasing after the mid of 1990s, reaching a peak (680 tornados) in 2006 (Dotzek *et al.*, 2009, Groenemeijer and Kühne, 2014). In Romania, the first reported

tornado was in 1822 (Timisoara) and today we have 126 reported from which 89 after 1990. This represents an increasing of 7 times over the last quarter of a century.

Meteorological conditions which have produced the tornado

In Facaeni, the dominate wind is Crivat that blows from North–Este (Fig.1) but in the last 15 years there were reported two strong thunderstorms (August 2002 and May 2017). In this paper, we focused on thunderstorm from August 2002 (Figure 4) with become a tornado in Facaeni and represent a turning point regarding tornado activity in Romania.

Analysis of the synoptic and the mesoscale state

Synoptical analysed of extremly whether phenomena associated with tornadoes was performed base on the numerical mesoscale ALADIN model.

During the analyzed period a large part of Europe was affected by storms, torrential rains and floods, included Romania. The synoptic outlook on Europe was characterized by a quasi-stationary depression and a middle-level blocking ridge in Eastern Europe.

Below the middle-level blocking ridge there was a low-level counter cyclone that created an air stream in South-Eastern across the Eastern regions of the Balkan Peninsula. Meanwhile, a surface depression over Western Europe had a slower movement to South-East, reaching the Slovak Republic on August 12th. In Bulgaria and Romania, this phenomenon has produced a warm advection structure which has also transported high humidity.

Mesoscale features also played an important role in determining the evolution and convection type. The basic components were moisture, instability, heightening mechanism and others.

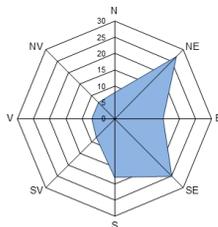


Fig.1 Annual Windrose in Facaeni



(a)

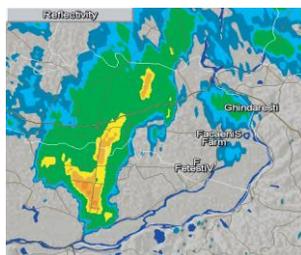


(b)

Fig.4 Tornado Facaeni, August 2002



RADAR image: at 4.00PM



at 4.10PM



at 4.20PM

Fig.5 State of the atmosphere in Facaeni region recorded by ANM radar

Above South-Eastern Romania, the interaction between air current and topography created a specific convergence zone. The result was an unstable, warm and wet air cleat on Earth surface extending up to the 850 mb isobar. Convergence persisted for more than 12 hours and result a thermal gradient with moisture along this convergence line. The warm and wet air mass remained stationary in front of the approaching cold front. Moreover, when the short wave approached from Western Europe the atmospheric flow, called *Convective Available Potential Energy* (CAPE), ranged from 2000 to 3000 J/Kg along the convergence line. This low-level destabilization and the near-coming short wave initiated the tropospheric shear.

Similarly, the atmosphere in Bulgaria was unstable with a CAPE of about 3300 J/Kg or even more. Whereupon, it was resulted a medium and superior wind with speed more than 30m/s which creating shearing for super-cells. Besides this, a higher level dry intrusion formed above wet area. All these meteorological events have generated the super-cell storm from Facaeni.

Until 4.00PM, the storm has developed a "hook echo" as described in figure 5, recorded by ANM radar. Our analyse estimated that the shape of the funnel of tornado, surprised by Marius Paun photograph (fig. 4b), touch the ground between 4.10PM to 4.20PM (fig. 5). However, until 16.20 it is almost certain that the tornado was on the ground in the form of "hook echo".

Our results claim that the tornado from Facaeni, on 12th August 2002, was F3 grade on Fujita scale. Tornada had wind speed 252-330 km/h, lasted about 2 minutes, with 1 km diameter of funnel and traveled 74 km. During the tornado, 33 houses were completely destroyed, 395 houses were partially destroyed, 14 people were seriously injured, 3 people died and 120 ha of acacia forest was destroyed by breaking trees.

Wind speed for several degrees of damage (DODs) was performed using below relation able to convert the wind speed from Fujita scale (FS) into Enhanced Fujita scale (EFS):

$$EFS = 0.6246 FS + 36.393 \quad (\text{McDonald and Mehta 2006}).$$

The EFS wind speed of EF3 tornado from Facaeni (2002) was calculated by us at 194-243 km/h based on above formula and impact of tornado on each element.

Our analysis shows that global warming increases the intensity and frequency of extremely weather phenomena. We calculate that in Romania the temperature avavage of last decade increasing to 1960s decade with 0.72°C. Moreover, these can occure in areas that did not have climate risk before the 1990s.

CONCLUSIONS

We performed a climatological analysis of tornado occurrence in the conditions of climate change by using the European Severe Weather database and European Climate Assessment & Dataset in Romania. Tornado from Facaeni, on 12th August 2002, was F3 grade on Fujita scale lasted about 2 minutes, 1 km

diameter, wind speed was 194-243 km/h and traveled 74 km. Tornado affected one fifth of total population of locality.

The complex meteorological conditions needed to generate a tornado with high intensity (bigger the F2) can be repeated in Romania, especially Dobrogea and the Romanian Plain.

REFERENCES

1. Balteanu D., Stan-Sion A., Cheval S., Trandafir P., Dobre B., Râmniceanu V., Dragne, D., Micu, M., Damian, N., Costache, A., 2004 - *Hazarde naturale și tehnologice în România. Tornada de la Făcăeni din 12.08.2002*, Bucharest.
2. Colda I., Ardelean F., 2004, - *Meteorologie și climatologie*, Bucharest, Conspress Publisher.
3. Dotzek N., Groenemeijer P., Feuerstein B., Holzer A.M., 2009 - *Overview of ESSLS's severe convective storms research using the European Severe Weather Database ESWD*, Atmospheric Research, 93(1): 575-586.
4. Groenemeijer P., Kühne T., 2014 - *A Climatology of Tornadoes in Europe: Results from the European Severe Weather Database*, Monthly Weather Review, 142(12): 4775-4790.
5. Grünwald S., Brooks H., 2011 - *Relationship between sounding derived parameters and the strength of tornadoes in Europe and the USA from reanalysis data*, Atmospheric Research 100 (2011) 479–488.
6. Ivanescu L., Bodale I., Florescu S.A, Roman C., Acatrinei D., Miron L., 2016 - *Climate Change Is Increasing the Risk of the Reemergence of Malaria in Romania*, BioMed Research International, vol 2016, 1-7.
7. Tank A.K., Wijngaard J.B., Konnen G.P., Bohm R., Demaree G., Gocheva A., Mileta M., Pashiardis S., Hejkrlik L., Kern-Hansen C., Heino R., Bessemoulin P., Muller-Westermeier G., Tzanakou M., Szalai S., Ottir T.P., Fitzgerald D., Rubin S., Capaldo M., Maugeri M, Leitass A., Bukantis A., Aberfeld R., Van Engelen A.F., Forland E., Mietus M., Coelho F., Mares C., Razuvaev V., Nieplova E., Cegnar T., Lopez J.A., Dahlstrom B., Moberg A., Kirchhofer W., Ceylan A., Pachaliuk O., Alexander L.V., Petrovic P., 2002 - *Daily dataset of 20th-century surface air temperature and precipitation series for the European Climate Assessment*, International Journal of Climatology, 22(12): 1441-1453.
8. Lacinová M., Munzar J., Franc M., 2007, - *Newly identified historical tornadoes in the Czech Republic from 16th to the 20th centuries*, Atmospheric Research 83(2): 488-492.
9. Lemon L.R., Stan-Sion A., Soci C., Cordoneanu E., 2003 - *A strong, long-track, Romanian tornado*, Atmospheric Research, 67-68, pp. 391-416.
10. McDonald J., Mehta K. C., 2006, - *A recommendation for an Enhanced Fujita Scale (EF-Scale)*, Wind Science and Engineering Center, Lubbock-USA.
11. Povară R., 2004 - *Climatologie generală*, Fundatiei Romania de Maine, Bucharest.
12. Snow J., 2009 - *Tornado: Global occurrence*, Encyclopædia Britannica Online.
13. Teodorescu E., Andrei L., Manafu A., Ciucă A., Butnariu C., 2007 - *Managementul riscului de dezastru*, Bucharest.
14. Wurman J., 2008 - *Doppler On Wheels*, Center for Severe Weather Research, Boulder USA
15. **, 2015, *Hurricanes and Climate - Hurricanes: Science and Society*, University of Rhode Island.

BIOLOGICAL EFFECTS OF CYANIDES ON GROWTH DYNAMICS OF CORN AND WHEAT PLANTS

EFECTE BIOLOGICE ALE CIANURILOR ÎN DINAMICA CREȘTERERII PLANTELOR DE PORUMB ȘI DE GRAU

CAZACU Ana¹, BODALE I.², ILCU Florina-Raluca¹, OANCEA Servilia¹
e-mail: liaoancea@yahoo.com

Abstract. *The aim of this paper is to evaluate the effects of cyanides on corn and wheat plant growth. Seeds of corn (Zea mais) and wheat (Triticum aestivum) were put into Petri dishes on double filter paper together with solutions of cyanides of different concentrations. The dynamics of germination and root growth have been monitored. After that, the germinated seeds were planted in soil where they continued to growth. Two weeks later the content of photosynthetic pigments has been obtained spectrophotometrically. The negative effect from point of view of plant germination has been established for these cyanides, these effects depending on concentration of cyanide solutions. However, the content of some photosynthetic pigments increased, as a response of plants to the chemical stress.*

Key words: cyanides, root growth, photosynthetic pigments

Rezumat. *Scopul acestei lucrări este de a evalua efectul cianurilor în creșterea plantelor de porumb și grâu. Semințele de porumb și grâu au fost puse în sticle Petri cu hârtie de filtru și soluții de cianuri cu diferite concentrații. Dinamica germinării și creșterea rădăcinilor a fost monitorizată. Apoi semințele de porumb germinate au fost plantate în sol, unde acestea au continuat să crească. După circa 2 săptămâni a fost determinat conținutul de pigmenți fotosintetici din frunze printr-o metoda spectrofotometrică. Din punct de vedere al germinării plantelor a fost stabilit un efect negativ al cianurilor, depinzând de concentrație. Pe de altă parte, conținutul unor pigmenți fotosintetici a crescut, ca răspuns al plantelor la stresul chimic.*

Cuvinte cheie: cianuri, creșterea rădăcinilor, pigmenți fotosintetici

INTRODUCTION

The environmental pollution is the major problem of humanity today when we are surrounded by numerous physical and chemical sources with devastating effects on the environment. Many studies related to the chemical contamination revealed the mechanism of contaminant action on plant growth and the relationship between these effects on human health. Some of these studies show that the toxicity is not tied to chemical compound quantity. Among the studied chemical compounds, the heavy metals and cyanides have the most important effects. The cyanides are used in gold mining holding, especially in Roșia Montană (Ballhorn, 2005; Eisler, 2004; Craig, 2015). This is the reason for analyzing the impact of cyanides on plant growth. The aim of this

¹ University of Agricultural Sciences and Veterinary Medicine Iasi, Romania

paper is to evaluate the effects of cyanides on corn (*Zea Mays*) and wheat (*Triticum aestivum*) plant growth.

MATERIAL AND METHODS

To study the effect of cyanides on plant growth, the following variants were used: 1. Control; 2. Na(CN) 0.1%; 3. Na(CN) 0.2%; 4. $K_4 [Fe(CN)_6]$ 0.2%; 5. $K_4 [Fe(CN)_6]$ 5%.

50 seeds of corn and wheat were put into Petri dishes on double filter paper together with 5 mL treatment solution. Four days, the seeds have been kept in dark and at optimal temperature (20-23°C). Every day was poured bidistilled water for control and treatment solution for the other variants to determine seed germination. After that, the germinated seed were planted in soil where they developed in optimal conditions. The dynamics of germination and the growth has been monitored during the first phenophase of growth, in accordance with the specialty literature (Wang, 2001). The photosynthetic pigments have been extracted in acetone (Foca N. et al, 2004), (Oancea S. et al, 2005), measured spectrophotometrically using a spectrophotometer SPECORD 200 produced by Analytik lena and calculated according to Lichtenthaler formula (Lichtenthaler H.K., Wellburn A.R., 1983).

To analyse the effects of cyanides on plant growth the following measurements were performed: 1. the dynamics of seed germination; 2. biometric measurements on plant roots and plantlets; 3. measurements of photosynthetic pigments.

RESULTS AND DISCUSSIONS

Figure 1 shows a picture of corn germination after five days. The dynamics of corn germination is given in figure 2. A comparable dynamics for seeds treated with small concentration can be seen, but for the variant with 5% concentration in K cyanide, the germination is absent.



Fig.1. Corn seed germination after 5 days

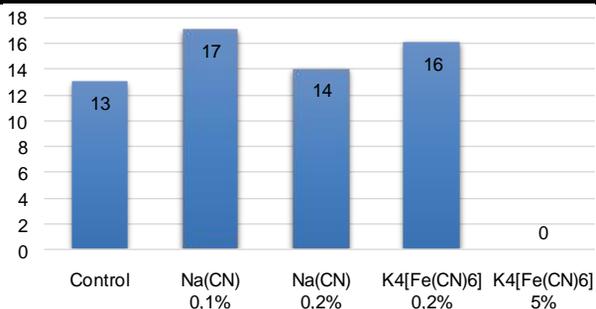


Fig. 2 Number of germinated corn seeds after 5 days

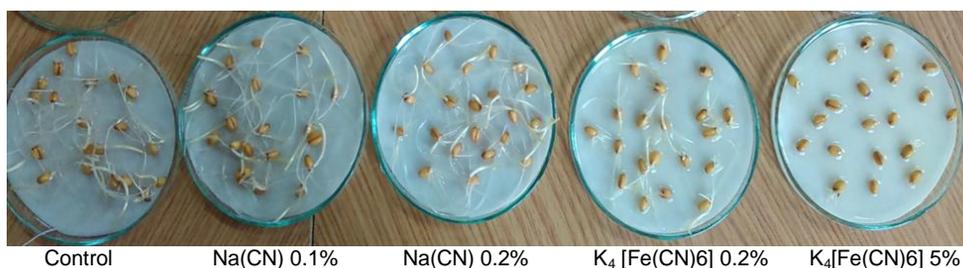


Fig. 3. Wheat seed germination after 8 days

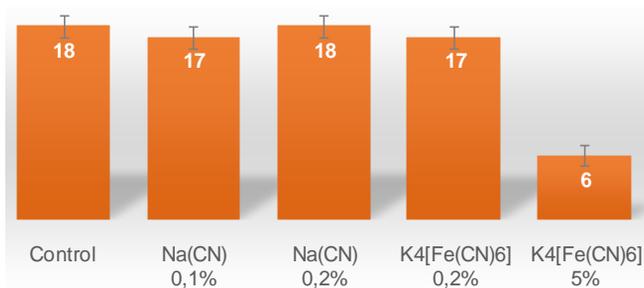


Fig. 4 Number of germinated wheat seeds after 5 days

Wheat germinated seeds can be seen in fig. 3 and germination dynamics in fig. 4.

Similar to the corn seeds, from figure 4 can be seen a comparable dynamics for seeds treated with small concentration of cyanides and control. In the variant case treated with 5% concentration in K cyanide, the germination is slowed down. After 8 days, all wheat seeds from the control variant germinated, but from the treated variants the strongest negative effect on germination was observed for K cyanide of 5% concentration.

The mean root length after five days for corn is given in fig. 5 and for wheat in fig. 6.

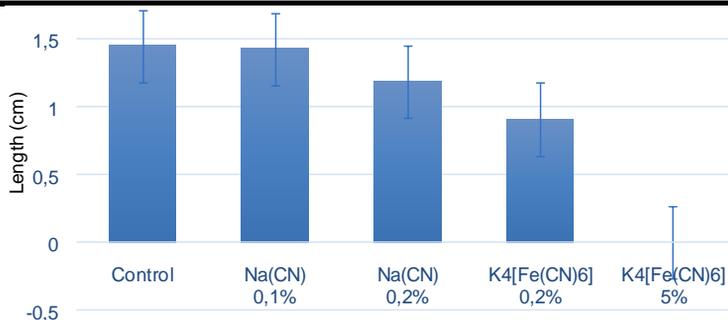


Fig. 5 Total corn root dimensions after 5 days of cyanide treatments. Error bars are confidence intervals as in (Oancea S., 2007), where n=20.

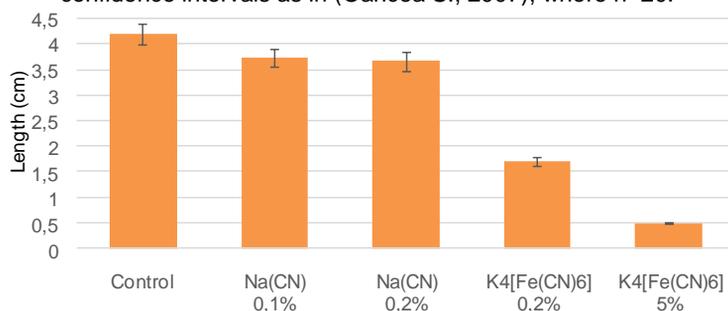


Fig. 6 Total wheat root dimensions after 5 days of cyanide treatments. Error bars are confidence intervals as in (Oancea S., 2007), where n=20.

From figure 5 and 6, a reduction of root dimension of the variants as compared with the control can be observed.

The content of photosynthetic pigments, chlorophyll a (Cha), chlorophyll b (Chb) and carotenoids (Car) from corn leaves is presented in figs. 7, 8 and 9.

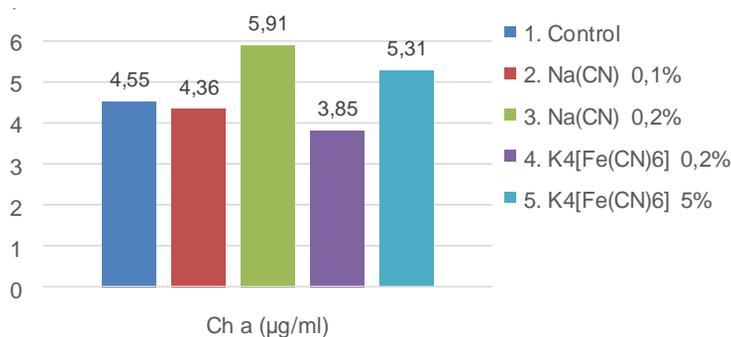


Fig. 7. The content of chlorophyll a from corn leaves (Cha)

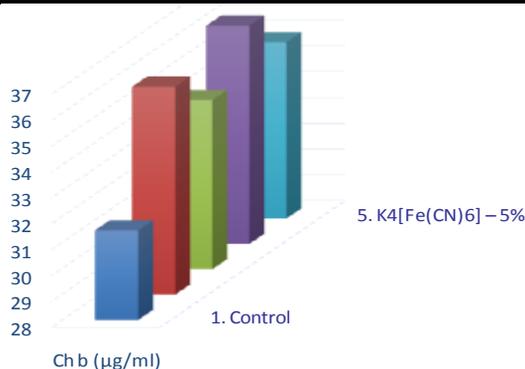


Fig. 8 The content of chlorophyll b from corn leaves (Chb)

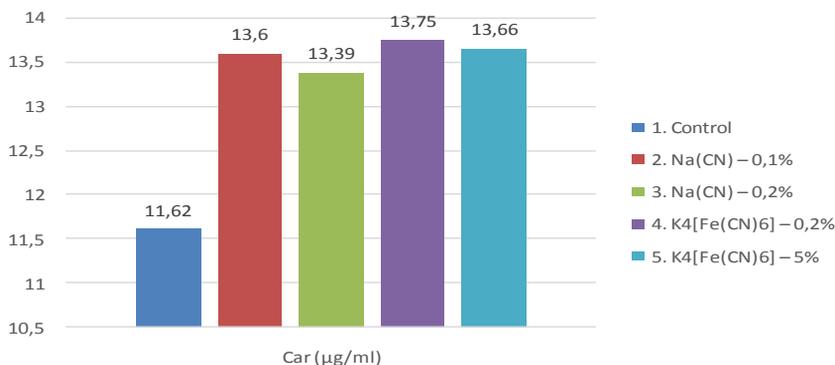


Fig. 9 The content of carotenoids from corn leaves (Car)

The ratio between $(Cha+Chb)/Car$ is given in figure 10.

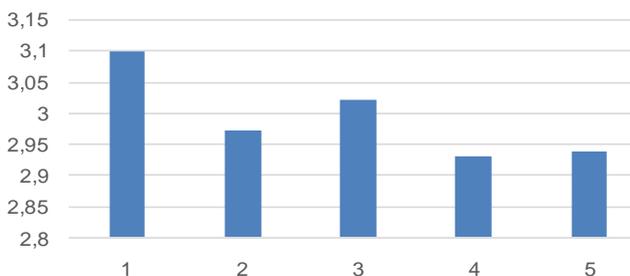


Fig. 10 The ration between $(Cha+Chb)/Car$

From fig. 10, can be noticed that the ratio $(Cha + Chb)/Car$ is lower for treatment variants than for control and lower than 4, which is the optimal value for plant growth. These values are justified by the increase of carotenoid content, the carotenoids being involved in the resistance of plants to the chemical stress (Demming-Adams, 1996).

CONCLUSIONS

The effects of cyanides on plant growth for *Zea Mays* and *Triticum aestivum* are as follows.

For *Zea Mays* and *Triticum aestivum* species, an inhibition of germination can be observed and the highest negative effect was for K cyanide of 5% concentration. The same effect is registered on root dimension of plantlets.

Regarding the content of photosynthetic pigments, the response to the chemical stress is highlighted by increase of the Cha content and the decrease of Chb content.

The content of carotenoids is higher for treated plants than for the control plants, which means that the carotenoids assure the resistance of plants to the chemical stress. The carotenoids protect the plants against photo-oxidation produced in secondary reactions.

The ratio (Cha + Chb)/Car is lower for treatment variants than for control variant and lower than 4 (the optimal value for plant growth). These values are justified by the increase of carotenoid content, the carotenoids being involved in resistance of plants to the chemical stress.

These results shows that, beside the fact that $K_4[Fe(CN)_6]$ is considered to be non-toxic, at high concentration (5%) it has a strong negative effect on germination in root growth.

Because of these effects of cyanides on plant growth, these chemical compounds that show a great interest, require new tests in this domain. Concerning the cyanide effect on human health, it is very important to know the content of cyanide found in the fruits of these plants that are consumed.

REFERENCES

1. Ballhorn J. D., Lieberei R., Ganzhorn U. J., 2005 - *Plant cyanogenesis*. Journal of Chemical Ecology, 31, p. 1446-1447.
2. Craig A. J., 2015 - *The fate of cyanide in leach wastes at gold mines: An environmental Perspective*. Applied Geochemistry, 57, p. 195-200.
3. Demming-Adams B., Adams W. W., 1996 - *The rol of xanthophyll cycle carotenoids in the protection of photosynthesis*. Trends in Plant Science, 1, p. 21-26.
4. Eisler R., Wiemeyer S. N., 2004 - *Cyanide hazard to plant and animals from gold mining and related water issues*. Environ Contam Toxicol, 183: 21-54, p. 27-29.
5. Foca N., Oancea S., Condurache D., 2004 - *Growth and photosynthetic activity for tomato plants treated with different cations*. Molecular crystals and Liquid crystals Journal, 418, p. 971-981.
6. Lichtenthaler H.K., Wellburn A.R., 1983 - *Determinations of total carotenoids and chlorophylls a and b of leaf extracts in different solvents*. Biochemical Society Transactions, 11, p. 591 – 592.
7. Oancea Servilia, 2007 - *Ghid de prelucrare rapidă a datelor experimentale*. Editura Performantica, Iasi.
8. Oancea Servilia, Foca N., Airinei A., 2005 - *Effects of heavy metals on plant growth and photosynthetic activity*. Analele Univ. Al. I. Cuza, Tom I, s, Biofizica, Fizică medicală și Fizica mediului, p. 107-110.
9. Wang X., Sun C., Gao S., Wang L., Shuokui H., 2001 - *Validation of germination rate and root elongation as indicator to assess phytotoxicity with Cucumis sativus*, Chemosphere, 44(8), p. 1711-1721.

RESEARCH ON THE WEAR AND RELIABILITY OF MACHINES FOR COMBATING DISEASES AND PESTS IN VINEYARDS

CERCETĂRI PRIVIND UZURA ȘI FIABILITATEA MAȘINILOR PENTRU COMBATAREA BOLILOR ȘI DĂUNĂTORILOR DIN PLANTAȚILE VITICOLE

RITTNER T.¹, ARSENOAIA V.¹, CÂRLESCU P.¹, ȚENU I.¹

e-mail: itenu@uaiasi.ro

Abstract. The HERBST ED-900 stand functioning is based on the liquid collection on each nozzle of the herbicide sprayer in vineyards and orchards by means of collectors that are mounted on each nozzle of the machine. Using this stand one can test sprayers for vineyards and orchards with 10 nozzles each, on a ramp. After the measurements made on the herbicide sprayer in vineyards and orchards, the liquid quantities collected in each cylinder are partially transmitted to the computer through the wireless system and are stored in a data basis. From here they may be either accessed as absolute values and sent in a text file, or a graph of the distribution variation may immediately be visualized.

Key words: nozzle, herbicide sprayer, vineyards and orchards

Rezumat. Funcționarea standului HERBST ED-900 se bazează pe colectarea lichidului pe fiecare duză a mașinii de erbicidat în vii și livezi prin intermediul unor captatoare care se montează pe fiecare duză a mașinii. Cu acest stand se pot testa mașini de stropit în vii și livezi cu câte 10 duze pe o rampă. În urma măsurărilor efectuate pe mașina de erbicidat în vii și livezi, cantitățile de lichid recolate în fiecare cilindru în parte sunt transmise la calculator prin sistemul wireless și sunt stocate într-o bază de date. De aici pot fi accesate fie sub formă de valori absolute și exportate într-un fișier text sau se poate vizualiza imediat graficul de variație a distribuției.

Cuvinte cheie: duză, mașină de erbicidat, vii și livezi

INTRODUCTION

The test and experimental ensemble is made up of a portable spraying machine, **ATOM-300**, produced by S.C. TEHNOFAVORIT S.A. Bonțida-Cluj and a Stand for testing the distribution uniformity of the spayers in vineyards and orchards, **Herbst ED 20-900**, produced by Ernst Herbst Prüftechnik e. K. Hirschbach-Germany. The HERBST ED-900 stand functioning is based on the liquid collection on each nozzle of the herbicide sprayer in vineyards and orchards

¹ University of Agricultural Sciences and Veterinary Medicine Iasi, Romania

by means of collectors that are mounted on each nozzle of the machine. Using this stand one can test sprayers for vineyards and orchards with 10 nozzles each, on a ramp (in the case of the measurements made, 12 nozzles) (Tenu *et al.*, 2004; Tenu *et al.*, 2015).

MATERIAL AND METHOD

The stand (fig. 1) is provided with ultrasonic sensors for level measurement in glasses and a 12 V battery.



Fig. 1 Stand for testing the distribution uniformity of the sprayers, Herbst ED 20-900

1 – framework; 2 – water collection basin during the measurements; 3 – supports for collector installing; 4 – collectors that are mounted on the nozzles of the sprayer to measure the flow; 5 – wireless transmission device for the data measured on the stand; 6 – collector graduated cylinders for flow measurement ; 7 – the liquid transfer tubes from the nozzles to the collector graduated cylinders.

The solution thus collected from each nozzle will get to the collector cylinders. Each cylinder is equipped with an ultrasonic sensor by means of which the level of the collected liquid is determined, and by means of the soft delivered with the stand, the liquid level in the cylinders is converted into a volume of liquid (fig. 2).

After the measurements made on the herbicide sprayer in vineyards and orchards, the liquid quantities collected in each cylinder (fig. 3) are partially transmitted to the computer through the wireless system and are stored in a data basis. From here they may be either accessed as absolute values and sent in a text file, or a graph of the distribution variation may immediately be visualized.



Fig.2 Measuring ramp in the liquid leak position



Fig.3 Ramp with the liquid collector cylinders

The measurements were made as following: on both ramps of the sprayer 12 identical nozzles were mounted; the sprayer was coupled to the stand for testing the distribution uniformity; the tank of the sprayer was filled with clean tap water; calgon was administered in water; the working pressure was adjusted; the electromotor was coupled, putting the sprayer into operation; the tightness of collectors was checked; after a period of leakage uniformity, the first basic measurement was made; then, periodically, every 12

hours, the measurements were repeated, making 3 measurements each time, in order to check the accuracy of the measurements; the measurement period of a nozzle set lasted from 2 to 2 weeks, generating a period of exploitation, equivalent to a working campaign; periodically, the water quality was checked and the tank water level was completed with clean water; after each measurement, the results were recorded and stored in the computer memory, creating the data basis for processing and interpretation.

The nozzles used during the measurements were: ceramic nozzles made by Lechler-Germany, LC 1,0 and LC 1,2 from the series equipment (fig. 4), nozzles TR 80-030 made by Lechler – Germany (fig. 5) and Nozzles ITR 80-015 made by Lechler – Germany (fig. 6) (Diaconu *et al.*, 2015; Diaconu *et al.*, 2016; Naghiu L., 2009;).



Fig.4 Construction of the LC nozzle:

1 – screw cap; 2 – ceramic nozzle;
3 – swirling device; 4 – gasket; 5 – sieve.

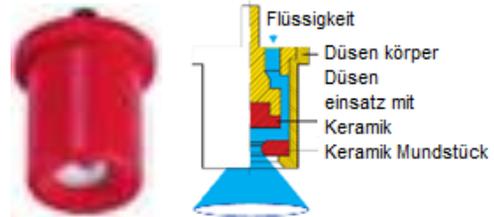


Fig.5 Nozzles TR 80-030
a. nozzle construction;
b. functional scheme.

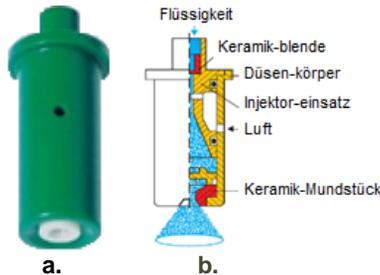


Fig.6 Nozzles ITR 80-015
a. nozzle construction; b. functional scheme.

RESULTS AND DISCUSSIONS

The flow constancy of the LC12 S1/D1-S6/D6 nozzles is variable depending on the position to the product supply source (fig. 7). LC12 S6/D6 nozzle has the most constant flow being also a supplying line end, with the best grouped values reported to the normal curve. Despite all these, the flow variation, reported to the confidence interval of 95% is of ± 0.15 L/min, phenomenon to be seen at the LC12 S2/D2 and LC12 S5/D5 nozzles too. The LC12 S1/D1 and S4/D4 nozzles have flows with variations of 0.2 L/min, generally situated above the normal curve, while the LC12 S3/D3 nozzles have a position predominantly below it. The temporal dynamics of the flows, irrespective of the position on the machine ramp, indicates an upward curve of

the flow, with lower variations on the measurement interval 10-30 (50 – 150 hours) and 40-55 (200 – 275 hours) (fig. 8).

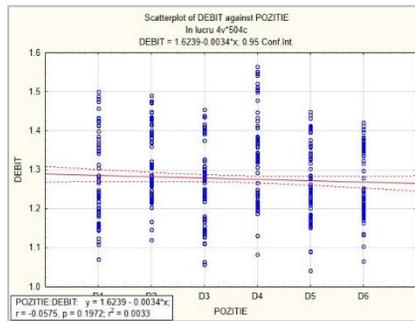


Fig. 7 Influence of the position on the ramp on the average flow S/D

On the measurement interval of 30-40 (150 – hours), the flow is generally below the normal level, which is due to narrowing modifications of the nozzle holes as a consequence of the wear. After this time slot, the nozzles enlarge their holes, but the deformation keeps the flow constantly upward.

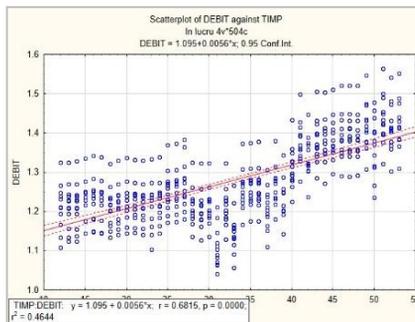


Fig. 8 Influence of the time of use on the average flow S/D

At a global level (fig. 9), the flow changes are due both to the position on the ramp and mostly to the time of use.

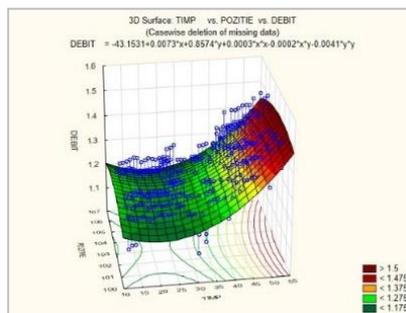


Fig. 9 Influence of the time of use and of the position on the ramp on the average flow

In the measurement interval of 15-25 (75 – 125 hours of working), the flow is lower compared to the initial one due to a slight nozzle deformation, after this time slot the wear being more evident and with an upward trend, until reaching a flow of more than 1.5 L/min, faster in the nozzles placed in the middle of the ramp than in those placed on the exterior side.

Compared to LC1,2 type, in the case of LC1 nozzles, the flow has a rising curve much more evident on short periods of time, with initial flows bigger at the ramp extremities (S1/D1 and S6/D6). An interesting phenomenon is the radial distribution of the flow and the moderate decrease of this parameter at the extremities during the use, concomitantly with a slight rise in the inside of the ramp. Overall, one can say that at a working duration of 117 hours, the pressure exercised by the treatment solution will balance the way of using nozzles and will normalize the way of the ramp working.

The placement of the nozzles on the ramp is determinant in the flow recorded in the whole treatment machine. The flow curve is downward, which indicates a flow decrease as the nozzle moves away from the supply source. The most constant nozzles are ITR80-015 S2/D2 and ITR80-015 S6/D6, with flows having fluctuations more reduced in time and more homogeneous as a distribution. The highest flow rates are recorded at the ITR80-015 S1/D1 nozzles, most of the determinations being above the normal curve.

The flow distribution in time indicates a reduced number of determinations placed within the limits of the confidence interval of 95% (fig. 10).

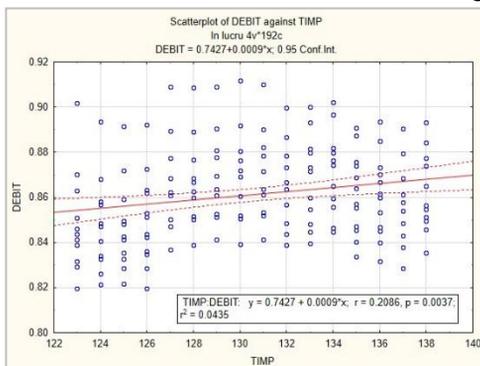


Fig. 10 Influence of the time of use on the average flow S/D

The position of the nozzles on the ramp strongly influences the studied flow (fig. 11), at all the nozzles being observed a slightly upward curve of the flow in the first half of the time of use, than a slightly downward curve in the second half of the interval. The ITR80-015 S1/D1 and ITR80-015 S2/D2 nozzles reach the maximum flows at the level of the whole treatment machine, while the

ITR80-015 S4/D4 and ITR80-015 S5/D5 nozzles maintain the flow below the level of 0.85 L/min on the whole time of use.

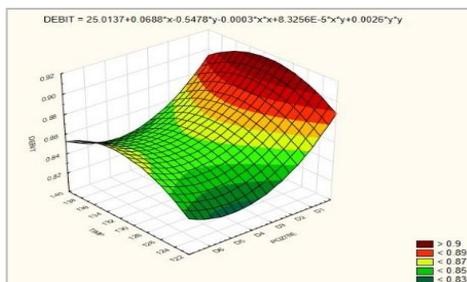


Fig. 11 Influence of the time of use and of the position on the ramp on the average flow

CONCLUSIONS

The most stable nozzles are S3/D3 and S5/D5, but in these two cases it is possible to have at a certain time a flow with 0.15 L/min higher or lower than the values of the flow distribution normal curve. An interesting aspect is the approach of the minimum flows registered at the S2/D2-S5/D5 nozzles to the normal curve which indicates a lower risk of not applying a sufficient quantity of products.

At the TR80-030 S3/D3 and TR80-030 S4/D4 nozzles one can observe the most combined flows indicating a better stability of this parameter on the arched curves of the sprayer ramp. The flow regression starts from a value of 0.7499, with a coefficient of -0.0195, but without statistical insurance.

REFERENCES

1. Diaconu A., Țenu I., Cârlescu P., Roșca R., 2015 – *Cercetări privind reducerea gradului de poluare a solului în plantațiile viticole prin folosirea unui echipament de recuperare a lichidului pesticid dispersat și a duzelor cu absorbție de aer*. Simpozionul științific-practic interanțional „Realizări și perspective în ingineria agrară și transport auto”, Universitatea Agrară de Stat din Moldova.
2. Diaconu A., Țenu I., Cârlescu P., Roșca R., Arsenoiaia V., Corduneanu O., 2016 – *CFD modeling of the operating process for sprayers in vine plantations, with recovery of the dispersed pesticide liquid*. Proceedings of 2016 International Conference on Hydraulics and Pneumatics – HERVEX, Baile Govora, Romania.
3. Naghiu L., 2009 – *Mașini și instalații horticole*. Ed. Risoprint, Cluj-Napoca.
4. Țenu I., Karamousantas D., Stamate V., 2004 – *The new conceptions in manufacturing of sprinkling machine for orchards and vineyards*. Bult. Inst. Polit. Tomul L (LIV), Iași.
5. Țenu I., Diaconu A., Roșca R., Cârlescu P., 2015 – *Researches regarding the reduction of pesticide soil pollution in vineyards*. 8th International conference on environmental engineering and management – ICEEM08, 9 - 12 september 2015, Iași, Romania.

CFD SIMULATION OF THE MUST FLOW IN A HYDROCYCLON

SIMULAREA CFD A CURGERII MUSTULUI ÎNTR-UN HIDROCIKLON

BĂETU M.¹, CÂRLESCU P.¹, ROȘCA R.¹, FILIMON R.²,
RITTNER T.¹, ȚENU I.¹

e-mail: itenu@uaiasi.ro

Abstract. *The hydrocyclone is an equipment for clarification and separation of the solid particles, in suspension in a liquid, based on the density difference. The flow description in a hydrocyclone is much more complex compared to a cyclone for gaseous dispersions, as it appears three liquid-gas-solid components (the appearance of the air core), although the overall separation mechanisms are similar. Over time, many experiments have been carried out to determine the flow in a hydrocyclone. The proposed experimental methods are expensive and difficult to implement in technical terms, being limited to a dispersed liquid phase. Given these deficiencies, in the last two decades, have been developed models of fluid flow dynamics (CFD) based on flow fundamentals. The paper aims is to CFD simulate the flow of must during the working process of a hydrocyclone.*

Key words: CFD simulation, must, hydrocyclone

Rezumat. *Hidrociclonul este un aparat de clarificare sau de separare a particulelor solide, aflate în suspensie într-un lichid, pe baza diferenței de masă volumică. Descrierea curgerii într-un hidrociclon este mult mai complexă comparativ cu un ciclon pentru dispersii gazoase, deoarece apar trei componente lichid-gaz-solid (apariția nucleului de aer), deși mecanismele globale de separare sunt similare. În decursul timpului, au fost realizate multe experimente pentru a determina curgerea într-un hidrociclon. Metodele experimentale propuse sunt costisitoare și dificil de aplicat din punct de vedere tehnic, fiind limitate la o fază lichidă dispersată. Ținând cont de aceste deficiențe, în ultimele două decenii, au fost dezvoltate modele de dinamica curgerii fluidelor (CFD) bazate pe fundamentele curgerii. Lucrarea are ca scop simularea CFD a curgerii mustului din struguri în timpul procesului de lucru al unui hidrociclon.*

Cuvinte cheie: simulare CFD, must, hidrociclon

INTRODUCTION

Simultaneously with the experimental efforts, different analytical models have been established in order to control and establish the flow characteristics of a hydrocyclone (Nageswararao *et al.*, 2004; Plitt, 1976; Chen *et al.* 2000). However, the models have limited applicability due to empiricism and difficulty in solving.

Given these deficiencies, in the last two decades, have been developed models of fluid flow dynamics (CFD) based on flow fundamentals. Boysan *et al.*

¹ University of Agricultural Sciences and Veterinary Medicine Iasi, Romania

² Research - Development Station for Viticulture and Winemaking Iasi, Romania

(1982) developed one of the first CFD models and showed that the k-ε turbulence model is not appropriate to simulate the flow in a hydrocyclone, resulting in tangential velocities and excessive and unrealistic turbulence viscosities. A number of papers suggest that the CFD models (Reynolds Stress Model - RSM) can improve the numerical accuracy of solutions (Sommerfeld and Ho, 2003; Schuetz *et al.*, 2004; Cârlescu, 2005).

MATERIAL AND METHOD

The accurate description of must flow in a hydrocyclone through simplified relations is more difficult to capture when velocity and pressure gradients are large in radial direction. In order to characterize the turbulent flow due to the needle rotation within the hydrocyclone, it is necessary to apply a suitable turbulence model. The RSM (Reynolds Stress Model) turbulence model describes with good accuracy the anisotropic turbulence.

The RSM model chosen proves to be a suitable turbulence model for hydrocyclone flow, although it requires higher computing resources compared to other simplified turbulence models (Wang and Yu, 2008; Xu *et al.*, 2009).

General mediated equations which govern the flow of an incompressible fluid can be written as follows:

- the continuity equation:

$$\frac{\partial \rho}{\partial t} + \frac{\partial}{\partial x_i}(\rho u_i) = 0 \quad (1)$$

- the momentum equation:

$$\frac{\partial}{\partial t}(\rho u_i) + \frac{\partial}{\partial x_j}(\rho u_i u_j) = -\frac{\partial p}{\partial x_i} + \frac{\partial}{\partial x_j} \left[\mu \left(\frac{\partial u_i}{\partial x_j} + \frac{\partial u_j}{\partial x_i} \right) \right] + \frac{\partial}{\partial x_j}(-\rho \overline{u_i u_j}) + \rho \cdot g_i \quad (2)$$

where: ρ - density of the liquid, μ - viscosity of the fluid, p - pressure, g - acceleration of gravity, $x_{i,j,k}$ - position considered as distance, t - time, u - velocity of the liquid.

The RSM model offers the possibility of modeling the flow in a much more rigorous manner than the k-ε or other models derived from it, for example taking the effect of curvature of the current lines due to turbulence at the top of the cyclone, as well as rapid changes by "deformations" that appear. The „Reynolds stress” model accurately reflects the potential of the complex flow field inside the hydrocyclone.

The geometry and components of the hydrocyclone used in CFD simulation are shown in figure 1.

Experimental and calculation contour conditions are required as numerical values for running the simulation (tab. 1).

Table 1

Experimental contour conditions

Pump speed n [RPM]	Velocity		Flow	
	u [m/s]	u _P [m/s]	Q _t [kg/s]	Q _P [kg/s]
1200	2.62	2.62	0.358	0.0372
1500	3.10	3.10	0.423	0.0441
1800	3.63	3.63	0.488	0.0508
2100	3.93	3.93	0.531	0.0553

Note: u- must velocity, u_p- particle velocity, Q_t – must flow, Q_p – particle flow

The must entering the hydrocyclone has the following physical parameters: must viscosity $\eta = 0.0018 \text{ Pa/s}$, must density $\rho_t = 1085 \text{ kg/m}^3$, particle density $\rho_p = 1130 \text{ kg/m}^3$.

The flow rate of particles supplied to the hydrocyclone in the simulation is 10 % of the flow rate of must, thus being in agreement with Fluent recommendations according to which it should not exceed 10-12% (ANSYS-Fluent User Guide, 2010).

Several experimental tests were performed in which the speed of the hydrocyclone feed pump was modified, thus resulting in several flows and input speeds.

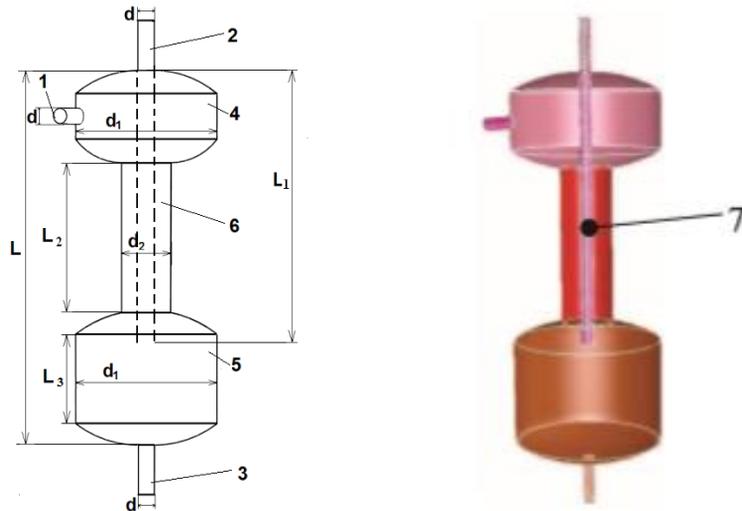


Fig. 1 Construction of hydrocyclone: 1 –suspension supply pipe; 2 – partially clarified liquid evacuation pipe; 3 – pipe for purging solid particles; 4 – superior body of centrifugation;5 – inferior body of sedimentation; 6 – intermediate body; 7- median inner pipe.

The partial sequence equation system, consisting of the continuity equation, the momentum equation, the „Reynolds stress” (RSM) and the turbulent energy dissipation of rate ϵ , was solved using a segregated solver (the equations are calculated so that the continuity equation is satisfied also locally) with the ANSYS - FLUENT V 6.3.26 software. The software is based on the finite volume method, which includes a differential formulation of all conservation equations in a control volume. In the control volume, a balance of the diffusion and convection fluxes is generated, reproducing the flow pattern, which is intensified by the turbulence described by the applied turbulent model, in this case the RSM model.

RSM model processing is complex and requires 50-60% more CPU time per iteration and approximately 15-20% more memory than the $k-\epsilon$ simplified turbulence model. The simulation ran on a TYAN workstation (2XCPU-Intel Xeon 3,33GHz; RAM – 16 Gb DDR3).

RESULTS AND DISCUSSIONS

For the three variants of the must considered in this study, the nephelometric turbidity unit was measured at the beginning and at the end of the separation process. The speed variation threshold, due to the requirements of the machine manufacturer, was comprised between 1200 and 2100 rpm.

The processing results are presented in the form of velocity fields, Reynolds turbulence and current lines.

The representation of the speed field in fig. 2 shows an increase in the velocity of the must in the upper body where the field of the centrifugal forces prevails with the increase of the inlet flow of the must, and in the lower body the speed is maintained at a low level for the three flows introduced in the simulation.

The identification of the Reynolds number distribution field (fig. 3) shows qualitatively the turbulent regime. In the lower body of the hydrocyclone the Reynolds number has higher values, ranging from 978 to 1140 in the region of the clarified must outlet pipe of the sedimentation body.

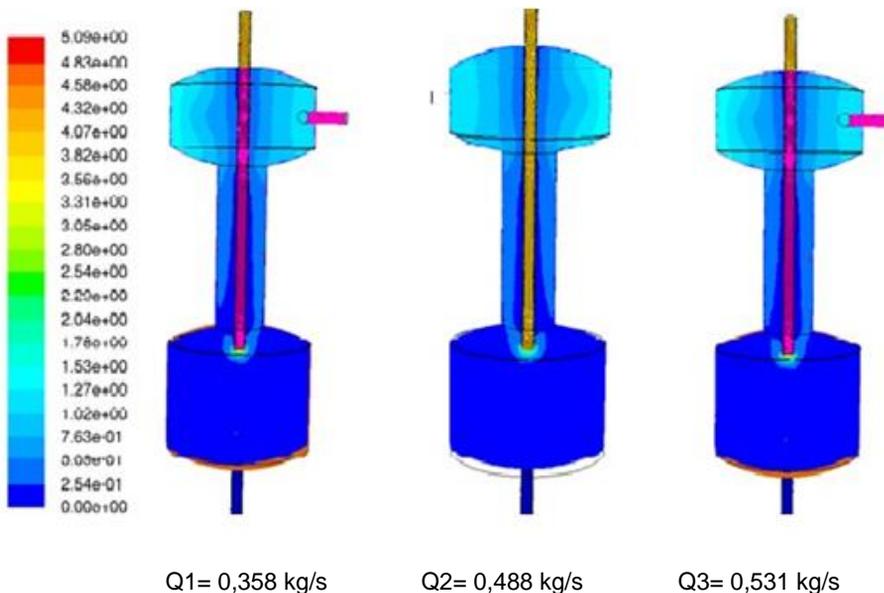


Fig. 2 Representation of the velocity field in hydrocyclone in the OY median plane, with purging pipe closed, at three different must supply flow rates

As a result of the fluctuating velocities that occur in the flow of must inside the hydrocyclone and of the significant variation of kinetic energy, it is difficult to perform the analytical calculation to determine the value of the Reynolds number in order to make a comparison with the simulated value. Such a calculation would lead to a qualitative alteration of the result. Therefore, CFD simulation of the must flow makes this calculation of Reynolds number much quicker and more accurate.

The flow lines in the lower body of the hydrocyclone (fig. 4), after the flow stabilization, concentrate towards the upper part of the lower sedimentation body, in the area of the drain must be clarified at a flow $Q_2 = 0.488 \text{ kg/s}$. At the rate of 0.358 kg/s and 0.531 kg/s respectively, the flow lines get close to the purge line.

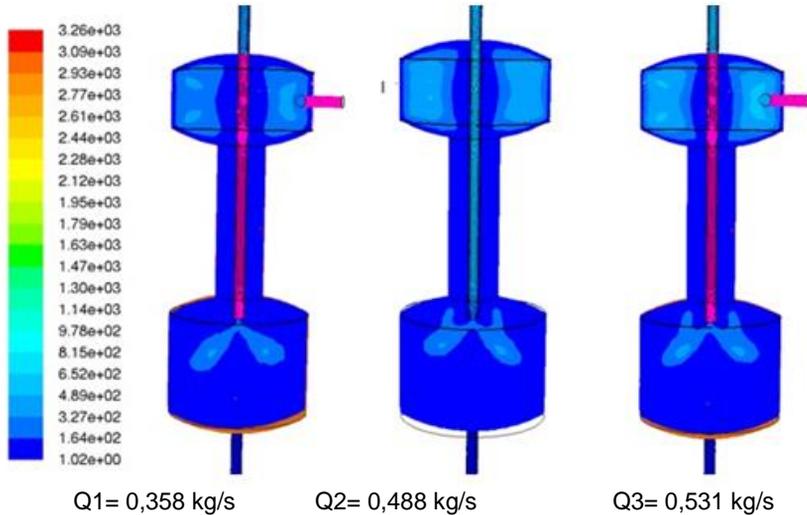


Fig. 3 Representation of the Reynolds turbulence field in hydrocyclone in the median plane OY, with purging pipe closed, at three different must supply flow rates

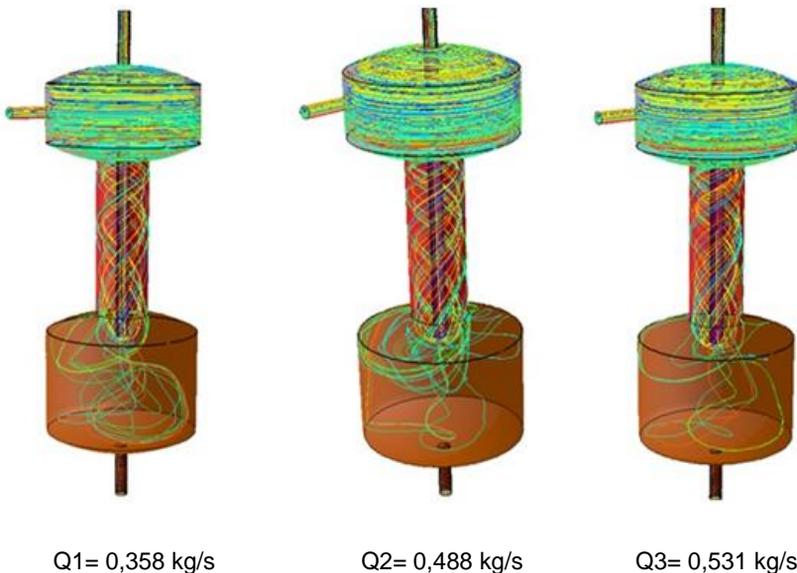


Fig. 4 Representation of the trajectory current lines in hydrocyclone with purging pipe closed, at three different must supply flow rates

CONCLUSIONS

1. Through the mathematical modeling and the CFD simulation (Computational Fluid Dynamic) of the must flowing in the hydrocyclone, one can observe how the flow regime follows inside the equipment, as well as the trajectories of the fluid current lines.

2. The advantages of using CFD simulation on a hydrocyclone are saving time and material resources, when using high performance programs and hardware (FLUENT, TYAN workstation).

3. By using the CFD simulation, which is based on experimental data new types of hydrocyclone may be designed, in order to obtain optimal variants to increase the efficiency of separation

REFERENCES

1. **Boysan F., Ayers W. H., Swithenbank J., 1982** – *Fundamental mathematical-modelling approach to cyclone design*, Trans. Inst. Chem. Eng., 60.
2. **Cârlescu P., 2005** – *Modelarea și simularea numerică a proceselor fizice industriale*. Edit. Performantica, Iași.
3. **Chen W., Zydek Chen W. N., Parma F., 2000** - *Evaluation of hydrocyclone models for practical applications*, Chem. Eng. J., 80.
4. **Nageswararao K., Wiseman D.M., Napier-Munn T.J., 2004** – *Two empirical hydrocyclone models revisited*, Miner. Eng.
5. **Plitt L.R., 1976** – *A mathematical model of the hydrocyclone classifier*, CIM Bull., 69.
6. **Schuetz S., Mayer G., Bierdel M., Piesche M., 2004** – *Investigations on the flow and separation behavior of hydrocyclones using computational fluid dynamics*, Int. J. Miner. Process., 73.
7. **Sommerfeld M., Ho C.A., 2003** – *Numerical calculation of particle transport in turbulent wall bounded flows*, Powder Technol., 131.
8. **Wang B., Yu A.B., 2008** – *Numerical Study of the Gas-Liquid-Solid Flow in Hydrocyclones with Different Configuration of Vortex Finder*, Chem Eng J., Vol. 135.
9. **Xu P., Wu Z., Mujumdar A.S., Yu A. B., 2009** – *Innovative Hydrocyclone Inlet Designs to Reduce Erosion-Induced Wear in Mineral Dewatering Processes*, Drying Tech., Vol. 27.
10. *** **2010** - *Ansys-Fluent – User Guide*.

CHEMICAL CHARACTERISTICS OF SOME COMMERCIAL SUNFLOWER AND CORN OILS

CARACTERISTICI CHIMICE ALE UNOR ULEIURI COMERCIALE DE FLOAREA - SOARELUI ȘI PORUMB

*PATRAȘ Antoanela*¹

e-mail: apatras@uaiasi.ro

Abstract. *There were studied eight sunflower oils and one corn oil, packed in polyethylene terephthalate (PET) and commercialised in Romania, in supermarkets. The main studied characteristics were saponification, iodine, acid and peroxide values. Although the colourless-transparent PET bottle allows photo-oxidation phenomena, the analysed oils presented good and very good quality, in concordance with the standards. The analysed parameters support the information marked on labels, as composition in unsaturated fatty acids.*

Key words: refined sunflower oils, cold pressed corn oil, saponification value, iodine value, acid value, peroxide value

Rezumat. *Au fost studiate opt tipuri de ulei de floarea-soarelui și unul de porumb, ambalate în polietilenterestalat (PET) și comercializate în România, în supermarketuri. Principalele caracteristici studiate au fost indicii de saponificare, iod, aciditate și peroxid. Deși ambalajul din PET incolor-transparent permite fenomenele de foto-oxidare, uleiurile analizate au prezentat calitate bună și foarte bună, în concordanță cu standardele. Parametrii analizați susțin informațiile de pe etichete, cum ar fi compoziția în acizi grași nesaturați.*

Cuvinte cheie: uleiuri de floarea-soarelui rafinate, ulei de porumb presat la rece, indice de saponificare, indice de iod, indice de aciditate, indice peroxidic

INTRODUCTION

Edible oils are widespread because of their traditional use in different food preparation, and also, being a valuable source of essential macro and micronutrients. They are recommended by nutritionists as substitutes of animal fats, because of their unsaturated character, in order to avoid some diseases as atherosclerosis. Most vegetable oils are predominantly composed of triacylglycerols (98–99%) and a small percent of phospholipids and micronutrients. Their unsaponifiable matter contains tocopherols, sterols and waxes (Gunstone, 2011).

Sunflower oil is preferred by most consumers in the countries without olive plantations, because of its taste, price and physicochemical properties. There are other sources for vegetal oil, as corn, pumpkin, soybean, palm, coconut, peanut, rapeseed.

Sunflower oil has a light amber colour (or pale yellow if refined) and a mild and pleasant flavour, possessing good preservation qualities. It contains 9-13% saturated fatty acids, 80-90% unsaturated fatty acids (a mixture of mono- and

¹University of Agricultural Sciences and Veterinary Medicine Iasi, Romania

polyunsaturated, in ratio depending of the type of sunflower oil: traditional or standard, high-oleic, mid-oleic), and appreciable quantities of vitamin E, phosphatides (0.1-0.2%) - represented by lecithin and cephalin, sterols, carotenoids, waxes, squalene, and other aliphatic hydrocarbons (Balme *et al.*, 1997).

Corn oil has a yellowish-red colour, with a typical, fresh milled corn smell and is appreciated for its role in reducing cholesterol (Howell *et al.*, 1998). It contains 12-13% saturated fatty acids, 85-90% unsaturated (25-30% monounsaturated, 57-62% polyunsaturated), vitamins: A, D, E and lecithin (Firestone, 1999).

The crude oils are usually refined in order to improve some properties (especially the smoke point) and to obtain the final product, yellow-type coloured, clear, with specific taste and smell. The smoke point is the temperature at which, under specific conditions, the oil begins to produce a visible bluish smoke and transforms into toxic compounds. Refining increases the smoke point of sunflower oil from about 107°C to 227°C and of corn oil from 160°C to 236°C (American Oil Chemists' Society, 2011).

The objective of present study was to characterize vegetable oils commercialized in Romania, in order to improve understanding of the oil quality, stability and applicability.

MATERIAL AND METHOD

There were studied 9 samples of oil commercialised in Romania, in supermarkets, eight refined sunflower oils and one cold pressed corn oil: *Unisol* (Us), *Raza soarelui* (Rs), *Vitae d'oro* (Vo), *Natur* (N), *Ulvex* (Ux), *Clever* (C), *Untdelemn de la bunica* (Ubs) – recommended for salad, *Untdelemn de la bunica pentru prăjit* (Ubp) which is a blend of 80% standard sunflower refined oil and 20% high-oleic sunflower oil, and *Ulei de porumb pentru prăjit* (Upp) – produced by Arpis, cold pressed. All oils have a total shelf life of 12 months and the expiry dates are similar among samples. They were purchased from local supermarkets at 4-5 months after production date and were analysed within 2 weeks.

The oils were commercialized in 1L colourless and transparent polyethylene terephthalate (PET) bottles.

In table 1 is presented the oils' composition in fatty acids, as it is shown on the label (only for the oils that have this information on the label).

Table 1

Oils' content in fatty acids (expressed in g/100g)

Oil	saturated	monounsa turated	polyunsatura ted	total unsaturated
Unisol	12	26	62	88
Raza soarelui	11	33	56	89
Vitae d'oro	12	26	62	88
Natur	11	27	62	89
Ulvex	12	26	62	88
Ulei de porumb pentru prăjit	12	33	55	88

The saponification value (SV) was determined by AOAC method 920.160 (2000); iodine value (IV), according to Zahir *et al.* (2017); acid value (AV), according to Savu *et al.* (2000) and peroxide value (PV), according to the official method NF T60-220 of the Association Française de Normalisation (AFNOR, 1988) – French Normalization Association, as described by Sadoudi and Ahmed (2017). Analyses were performed in triplicate and the presented values represent means \pm SD.

RESULTS AND DISCUSSIONS

Saponification value (SV) of studied oils ranges between 192.2 for Untdelemn de la bunica pentru prăjit and 209.2 for Unisol (fig. 1). SV reflects the composition of the oils. It represents the quantity of potassium hydroxide (mg KOH) required for the saponification of 1g of oil. Saponification process breaks ester bonds of acylglycerols, and since every fatty acid is attached to glycerol with an ester bond, SV reflects the number of ester bonds per gram sample. Saponification value indicates the mean molecular weight of the esterified fatty acids. The smaller the SV, the longer the fatty acids' chain and bigger their molecular weight and contrary, a high SV indicates shorter fatty acids. In our case, Unisol oil contains the smallest fatty acids and the mean molecular weight of fatty acids increases in the order: Unisol, Raza soarelui, Vitae d'oro, Ulvex, Natur, Clever, Ulei de porumb pentru prăjit, Untdelemn de la bunica (Ubs), and Untdelemn de la bunica pentru prăjit (Ubp) contains the biggest fatty acids.

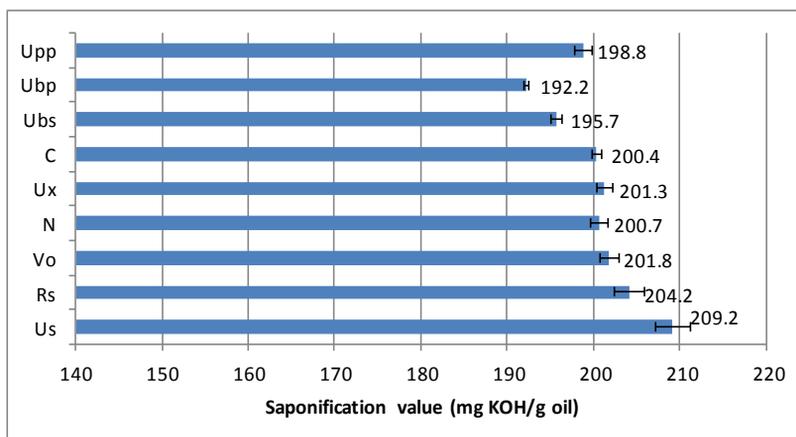


Fig. 1 Saponification values of studied oils

Iodine value (IV) indicates the degree of unsaturation of the oils. It is represented by the mass of iodine (g) absorbed by 100g oil through addition reactions at the double bonds of unsaturated fatty acids. As a measure of oils unsaturation, IV should direct correlate with the content in double bonds of the unsaturated fatty acids. Indeed, from fig. 2 we notice that the highest IVs were registered for Ulvex (127.7 g/100g) and Unisol (127.1 g/100g) and their labels indicate a high content of polyunsaturated fatty acids (62g/100g for both oils) –

tab. 1. Iodine value also correlates with the stability of oils to oxidation. Our results for IV fall within the ranges mentioned in the specialised literature: 119 – 134 for sunflower oil and 111 – 130 for corn oil (Savu *et al.*, 2000).

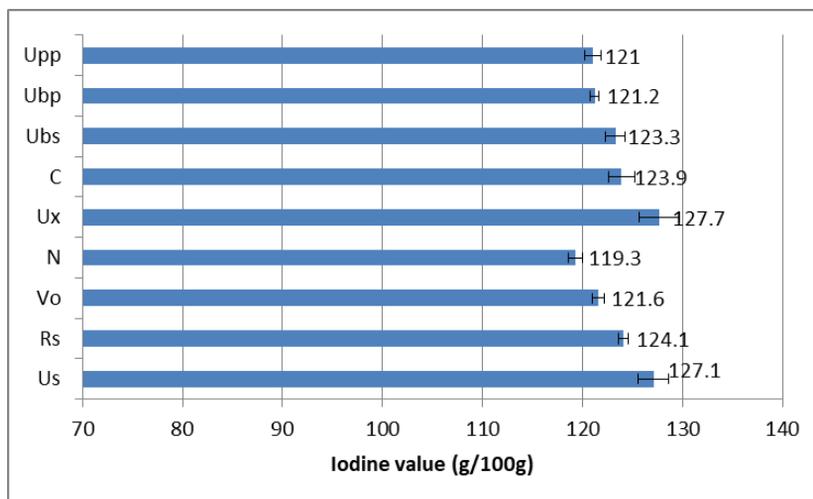


Fig. 2 Iodine values of studied oils

Acid value (AV) is an important indicator of vegetable oil quality, expressing its freshness or rancidity. It represents the weight of KOH (mg) necessary to neutralize free acids contained in 1 g of oil. The main source of free acids is the triglyceride hydrolysis, which releases glycerol and free fatty acids and occurs during processing and preservation, especially in case of high temperature and humidity. This reaction is catalysed by lipase and may be considered an indicator of inadequate processing and storage. Acid phosphates and, eventually, amino acids can also contribute to the AV.

Free fatty acids, especially with long chain, affect the oil quality because of increased susceptibility to oxidation in their free form, and can cause the decrease of smoke point. Also, their breakdown products (aldehydes, aldehydo-acids, organic acids, ketones) provide characteristic flavours and aromas, which are considered defects of oils.

The studied corn oil (Upp), which is a crude oil obtained through cold pressing technique, has AV = 3.188, which indicates its freshness, being an appropriate value for cold pressed oils, which should have AV < 4.0 (CODEX-STAN 210 - 1999). Oil refining process removes most of free fatty acids and decreases the acid value. All the studied sunflower oils, which are refined, revealed AV between 0.09 for Untdelemn de la bunica (Ubs) and 0.195 for Clever (fig. 3). As acid value for refined oils must be less than 0.6 (CODEX-STAN 210 - 1999) and in present cases, AV < 0.2, oils are very fresh and of good quality.

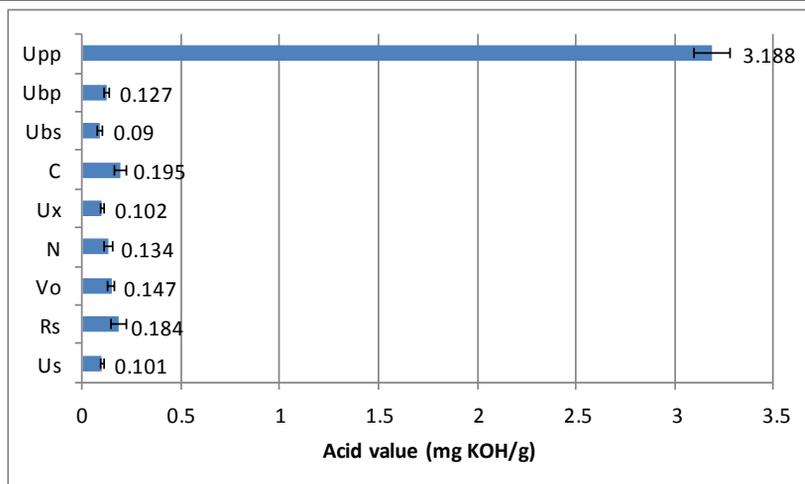


Fig. 3 Acid value for studied oils

Peroxide value (PV) is a measure of concentration of peroxides and hydroperoxides, which are the initial products of lipid oxidation. They can be formed during processing or due to rancidity, by the interaction of fatty acids with atmospheric oxygen. PV is expressed as milliequivalents of active oxygen (peroxides, hydroperoxides) per kg of oil (mEq/kg). PV is an indicator of oils' oxidative changes. The quality of the oil is influenced by the storage conditions and type of package, especially by its transparency and oxygen permeability. Previous studies (Kaya *et al.*, 1993) estimated that the shelf-life of sunflower oil in retail store conditions is 10.6 months, while the storage life of sunflower oil in polyethylene terephthalate (PET) under a 10 W fluorescence lamp was 10.4 months at 10°C and 4.8 months at 20°C.

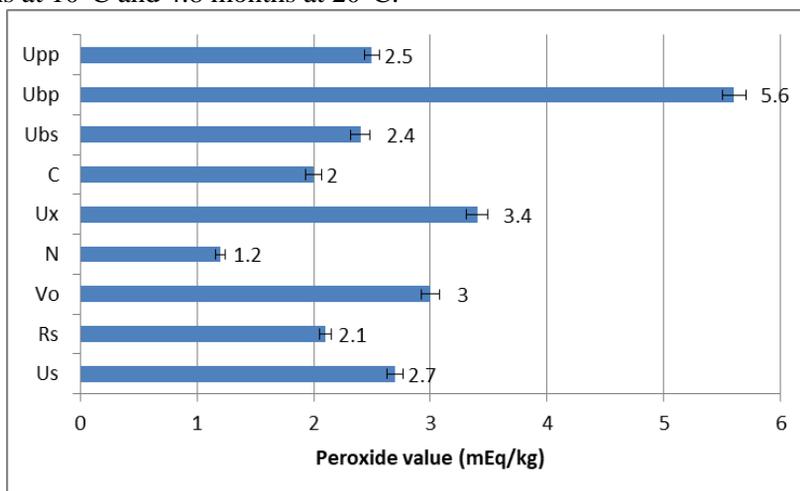


Fig. 4 Peroxide value for studied oils

The standard quality characteristics allow PV up to 10 mEq/kg for refined oils and up to 15 mEq/kg for cold pressed and virgin oils (CODEX-STAN 210 - 1999). The studied oils are in accordance with these limits (fig. 4), as refined sunflower oils have peroxide values between 1.2 mEq/kg - for Natur and 5.6 mEq/kg - for Untdelemn de la bunica pentru prăjit which is the most oxidized. The cold pressed Ulei de porumb pentru prăjit has PV 2.5 mEq/kg, which proves a very good quality.

CONCLUSIONS

1. There are no noticeable differences between cold pressed corn oil and refined sunflower oils regarding saponification, iodine and peroxide values. Only acid value is 16 – 35 folds smaller for refined sunflower oils.

2. The iodine value is in concordance with the oils' composition in unsaturated fatty acids, mentioned on the label.

3. All studied edible oils proved good and very good quality, considering the analysed parameters, which are in concordance with the standards.

REFERENCES

1. **Balmey F.P.C., Zollinger R.K., Schneiter A.A., 1997** - *Sunflower production and culture. Sunflower technology and production*, American Society of Agronomy Publication, p. 595-670.
2. **Firestone D., 1999** - *Corn oil*, in *Physical and Chemical Characteristics of Oils, Fats, and Waxes*, American Oil Chemists Society, Champaign, IL, p. 31–32.
3. **Gunstone F., 2011** - *Vegetable oils in food technology: composition, properties and uses*. Ed. John Wiley & Sons, p. 137-169, p. 273-291
4. **Howell T.J., MacDougall D.E. Jones P.J.H., 1998** - *Phytosterols partially explain differences in cholesterol metabolism caused by corn or olive oil feeding*. Journal of Lipid Research, 39, p. 892–900.
5. **Kaya A., Tekin A., Öner M., 1993** - *Oxidative Stability of Sunflower and Olive Oils: Comparison between a Modified Active Oxygen Method and Long Term Storage*. LWT - Food Science and Technology, 26, 5, p. 464-468
6. **Sadoudi R., Ahmed D.A., 2017** - *Studies on physico-chemical characteristics and fatty acid composition of commercially available Algerian frying edible oils*. International Food Research Journal, 24(1), p. 60-67
7. **Savu M., Afusoe I., Nechita Patraș A., Trofin A.E., Marcu I, 2000** - *Biochimie vegetală, lucrări practice*, USAMV. Iași, p. 74-78
8. **Zahir E., Saeed R., Hameed M.A., Yousuf A., 2017** - *Study of physicochemical properties of edible oil and evaluation of frying oil quality by Fourier Transform-Infrared (FT-IR) Spectroscopy*. Arabian Journal of Chemistry, 10, p. 3870-3876
9. *****, 1999** - *Codex Standard for Named Vegetable Oils (CODEX-STAN 210 - 1999)*, <http://www.fao.org>
10. *****, 2000** - *AOAC Official method of analysis 920.160 and 985.29*, Arlington, VA: Association of Official Analytical Chemists.
11. *****, 2011** - *American Oil Chemists' Society Official Method Cc 9a-48, Smoke, Flash and Fire Points Cleveland Open Cup Method*. Official methods and recommended practices of the AOCS - (6th ed.). Champaign, Ill.

THE INFLUENCE OF SOME FERTILIZERS ON ANATOMICAL STRUCTURE AND THE ASSIMILATING PIGMENTS OF *GAZANIA SPLENDENS* SPECIES – 'BIG KISS'

INFLUENȚA UNOR ÎNGRĂȘĂMINTE ASUPRA STRUCTURII ANATOMO MORFOLOGICE ȘI A CONȚINUTULUI ÎN PIGMENȚI ASIMILATORI LA SPECIA *GAZANIA SPLENDENS* - 'BIG KISS'

BRINZA Maria¹, DRAGHIA Lucia¹, CHELARIU Elena Liliana¹, BOZ Irina²
e-mail: mariabrinza2007@yahoo.com

Abstract. *This paper presents results of the research on the influence of the latest fertilizers on the growth and development of 'Big Kiss' which belongs to the Gazania splendens species. The research aimed to establish the influence of fertilizers Osmocote®Pro and Blutenzauber on the content of photosynthetic pigments and histo-anatomical structure of the 'Big Kiss'. The results obtained showed that samples that were fertilized presented an increase of photosynthetic pigments' content compared to the untreated sample. By analyzing the results of all samples, it was noted that the application of Pro Osmocote® fertilizer led to obtaining the greatest total content of assimilating pigments and also the increase of a,b chlorophyll content. Highlighting the structural differences due to the type of fertilizer was made by histo-anatomical sections at the level of the leaf lamina.*

Key words: *Gazania splendens, photosynthetic pigments, anatomy*

Rezumat. *Lucrarea de față prezintă rezultatele cercetărilor privind influența unor îngrășăminte de ultimă generație asupra creșterii și dezvoltării hibridului 'Big Kiss' ce aparține speciei Gazania splendens. Cercetările au vizat stabilirea influenței îngrășămintelor Osmocote®Pro și Blutenzauber asupra conținutului în pigmenți fotosintetici, și a structurii histo-anatomice la specia Gazania splendens, hibridul 'Big Kiss'. Rezultatele obținute au arătat că variantele care au fost tratate cu îngrășăminte au prezentat o creștere a conținutului în pigmenți fotosintetici comparativ cu varianta care nu a fost tratată. Prin analizarea rezultatelor tuturor variantelor s-a remarcat că aplicarea îngrășământului Osmocote® Pro a determinat obținerea celui mai mare conținut total de pigmenți asimilatori, dar și creșterea conținutului de clorofilă a, b. Evidențierea diferențelor structurale cauzate de tipul de îngrășământ s-a efectuat prin secțiuni histo-anatomice la nivelul limbului foliar.*

Cuvinte cheie: *Gazania splendens, pigmenți fotosintetici, anatomie*

¹University of Agricultural Sciences and Veterinary Medicine Iasi, Romania

²"Alexandru Ioan Cuza" University of Iasi, Romania

INTRODUCTION

The production of flower seedlings is based on the use of different substrates and the treatment with different professional controlled-release fertilizers (Nelson, 2003). The use of slow-release fertilizers influences both the seedling production in containers and pots, as well as the development of ornamental plants (Belger and Drach, 1989). Expert studies have highlighted the influence of controlled-release fertilizers on the quality of seedlings in different medicinal, aromatic or spice plant species (Beatović *et al.*, 2007 a, b, c) as well as on the quality of flower seedlings (Vujošević *et al.*, 2007). The advantage of using these fertilizers is represented by a long-term use that may satisfy the needs of all plants for mineral nutrients. These fertilizers release, in time, the necessary mineral elements, in very precise concentrations. Due to this fact, the production of high salts concentrations in the substrate can be avoided, this being the main cause of deterioration of plants that are grown in containers and pots (Hanić, 2000). *Gazania splendens* belongs to the group of annual floricultural species and it is very attractive for the local producers due to its ornamental characteristics. Besides other species of flowers, *Gazania splendens* represents one of the ornamental species that are important in landscape architecture (Ferant *et al.*, 2006; Vujošević *et al.*, 2007 b). This species is characterized by a long-term flowering period, from May up to late autumn. In order to ensure good conditions for this species, it is necessary to ensure sufficient food for the entire vegetation period.

MATERIAL AND METHOD

In order to achieve the objectives set out, we have studied the influence of some of the latest generation of fertilizers on the growth and development of the "Big Kiss" hybrid, which belongs to the *Gazania splendens* species. The experiment was carried out in the Field of the Floriculture Discipline, which is part of the "V. Adamachi" didactic farm of the University of Agricultural Sciences and Veterinary Medicine of Iași.

For the fertilization there were used the Osmocote®Pro and Blutenzauber fertilizers. The experiment was organized in 7 variants as follows: C - nonfertilized, V1- 4g Osmocote /plant; V2- 6g Osmocote /plant, V3- 8g Osmocote /plant, V4- 1g Blutenzauber/L ; V5- 2g Blutenzauber/L, V6- 3g Blutenzauber/L. The extraction and determination of the assimilatory pigments were carried out in accordance with the Current Protocols in Food Analytical Chemistry (Lichtenthaler and Buchmann, 2001). The tissues of the fresh leaves (0.1 g) were ground in the mortar in acetone (pure solvent) and then centrifuged at 10000 x g for 5 minutes. After centrifugation, the reading of the supernatant was done at the absorbance of 661.6 nm for chlorophyll a (Chl. a), at 644.8 nm for chlorophyll b (Chl. b) and at 470 nm for carotenoids (car.), using the T70 UV/VIS Spectrophotometer PG.

RESULTS AND DISCUSSIONS

The study has investigated the influence of the two fertilizers on the assimilatory pigments content. The experimental results (tab. 1) have shown differences regarding the total content of assimilatory pigments obtained within the seven experimental variants. The results obtained have highlighted a tendency of increase in the total content of assimilatory pigments, with the increase in the concentration of Osmocote and the concentration of Blutenzauber (tab. 1).

Within the seven variants, the total content of photosynthetic pigments has varied between $1.98 \text{ mg}\cdot\text{g}^{-1} \text{ d.w.}$ in the plants from the control variant and $2.49 \text{ mg}\cdot\text{g}^{-1} \text{ d.w.}$ in the plants from variant V_3 . By reporting the results obtained from the variants fertilized with Osmocote to the nonfertilized variant (control), an increase in the total content of assimilatory pigments was obtained, by $0.18 \text{ mg}\cdot\text{g}^{-1} \text{ d.w.}$ in variant V_2 , by $0.40 \text{ mg}\cdot\text{g}^{-1} \text{ d.w.}$ in variant V_3 and by $0.51 \text{ mg}\cdot\text{g}^{-1} \text{ d.w.}$ in variant V_4 . Regarding the results of the variants fertilized with Blutenzauber, the increase in the content of photosynthetic pigments compared to the control variant was by $0.02 \text{ mg}\cdot\text{g}^{-1} \text{ d.w.}$ in variant V_5 and by $0.42 \text{ mg}\cdot\text{g}^{-1} \text{ d.w.}$ in variant V_6 . Generally, an increase in the content of chlorophyll *a* is observed in the fertilized variants, the values obtained having varied between $0.50 \text{ mg}\cdot\text{g}^{-1} \text{ d.w.}$ in the plants cultivated from variant V_3 and $0.42 \text{ mg}\cdot\text{g}^{-1} \text{ d.w.}$ in the plants from variants V_4 and V_5 . The content of chlorophyll *a* in the control variant was much more reduced compared to the fertilized variants, by comparing results having obtained an increase by $0.19 \text{ mg}\cdot\text{g}^{-1} \text{ d.w.}$ in variant V_1 , by $0.38 \text{ mg}\cdot\text{g}^{-1} \text{ d.w.}$ in variant V_2 , by $0.45 \text{ mg}\cdot\text{g}^{-1} \text{ d.w.}$ in variant V_3 , by $0.02 \text{ mg}\cdot\text{g}^{-1} \text{ d.w.}$ in variant V_4 , by $0.05 \text{ mg}\cdot\text{g}^{-1} \text{ d.w.}$ in variant V_5 and by $0.38 \text{ mg}\cdot\text{g}^{-1} \text{ d.w.}$ in variant V_6 .

Table 1

Content of assimilatory pigments in *Gazania splendens* species
'BIG KISS' ($\text{mg g}^{-1} \text{ d.w.}$)

Variant	Cl. a mg/g D.W	Cl. b mg/g D.W	x+c mg/g D.W	Σ	Chl./Car. ratio	Chl.b/car. ratio
C	1.09 ± 0.08	0.41 ± 0.03	0.48 ± 0.06	1.98	3.13	0.85
V ₁	1.28 ± 0.09	0.43 ± 0.04	0.45 ± 0.04	2.16	3.80	0.96
V ₂	1.47 ± 0.10	0.45 ± 0.05	0.46 ± 0.05	2.38	4.17	0.98
V ₃	1.54 ± 0.12	0.50 ± 0.05	0.45 ± 0.06	2.49	4.53	1.11
V ₄	1.11 ± 0.12	0.42 ± 0.12	0.45 ± 0.12	1.98	3.40	0.93
V ₅	1.14 ± 0.12	0.42 ± 0.12	0.44 ± 0.12	2.00	3.55	0.95
V ₆	1.47 ± 0.12	0.46 ± 0.12	0.47 ± 0.12	2.40	4.11	0.98

$\pm d$ = standard deviation

The results regarding the content of chlorophyll *b* in the control variant have presented a slight decrease compared to the fertilized variants, by comparing results having obtained an increase by 0.02 mg·g⁻¹ d.w. in variant V₂, by 0.04 mg·g⁻¹ d.w. in variant V₃, by 0.09 mg·g⁻¹ d.w. in variant V₄, by 0.01 mg·g⁻¹ d.w. in variants V₄ and V₅ and by 0.05 mg·g⁻¹ d.w. in variant V₆. The results of the analyses show that in the fertilized variants the ratio between chlorophyll (a + b) and carotenoid pigments is higher, within the six experimental variants the increase being by 0,68 mg·g⁻¹ d.w. in variant V₁, by 1.05 mg·g⁻¹ d.w. in variant V₂, by 1.41 mg·g⁻¹ d.w. in variant V₃, by 0,28 mg·g⁻¹ d.w. in variant V₄, by 0,42 mg·g⁻¹ d.w. in variant V₅ and by 0.98 mg·g⁻¹ d.w. in variant V₆.

Regarding the ratio between chlorophyll *b* / carotenoids, the results present a slight decrease of values under the theoretical limit. The decrease of the values obtained was by 0.10 mg·g⁻¹ d.w. in variant V₁, by 0.12 mg·g⁻¹ d.w. in variant V₂, by 0.26 mg·g⁻¹ d.w. in variant V₃, by 0.08 mg·g⁻¹ d.w. in variant V₄, by 0.10 mg·g⁻¹ d.w. in variant V₅ and by 0.12 mg·g⁻¹ d.w. in variant V₆. Regarding the content of carotenoid pigments the values have varied from 0.48 mg·g⁻¹ d.w. in the plants cultivated from variant V₁ to 0.44 mg·g⁻¹ d.w. in the plants from variant V₅.

The study investigated the influence of the two fertilizers on the anatomical structure of the foliar apparatus (figures 1 - 7).

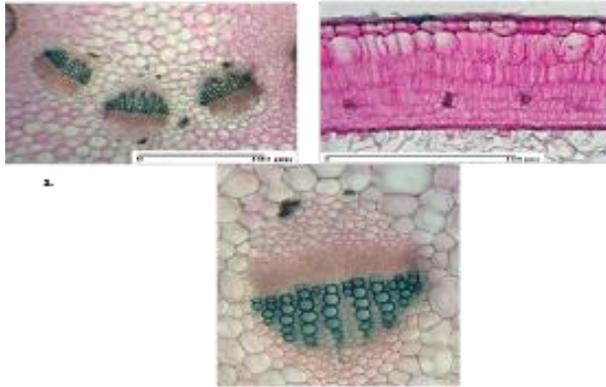


Fig. 1 Cross-section through the foliar fronds in the control variant: a. conducting bundles from the primary vein; b. mesophyll structure; c. detail of conducting bundle from the primary vein

In the cross-section through the foliar fronds, the median vein is strongly prominent in the upper side of the fronds and comprises in its fundamental parenchyma 3 conducting free-ligneous bundles, running in an open arch; the ligneous vessels run in parallel radial rows, separated by cellulose parenchyma; the mesophyll is clearly differentiated in the palisade tissue in the upper side and lacunar tissue in the underside.

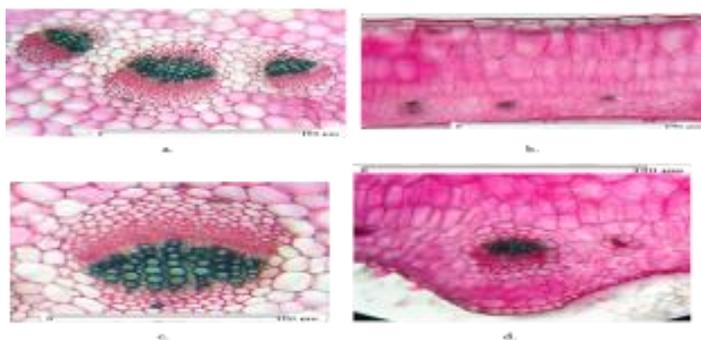


Fig. 2 Cross-section through the foliar fronds in variant V1 : a. conducting bundles from the primary vein; b. mesophyll structure; c. detail of conducting bundle from the primary vein; d. 1st order lateral vein

The median vein comprises 3 free-ligneous bundles; the 1st order lateral veins are visibly prominent in the underside; the perifloemic parenchyma of each bundle forms an arch with cells that have slightly thickened walls.

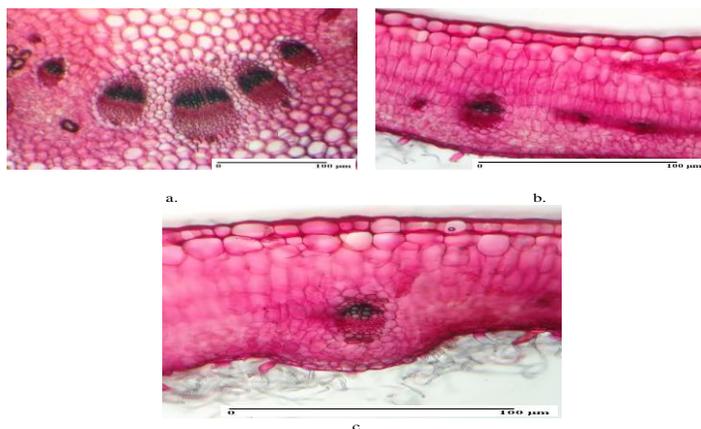


Fig. 3 Cross-section through the foliar fronds in variant V2: a. conducting bundles from the primary vein; b. mesophyll structure; c. 1st order vein structure

The primary vein comprises 5 free-ligneous bundles; the cells of the upper epidermis are very large, compared to the ones on the lower epidermis, at the level of the lateral veins; the 1st order lateral veins are slightly prominent on the underside and each have a conducting bundle of medium size; on the upper side of the fronds, the cells of the hypodermal layer are isodiametric, rounded or pear-shaped, after which there are 3-4 layers of typical palisade cells, the ones that are in the vicinity of the lacunar tissue being visibly shorter.

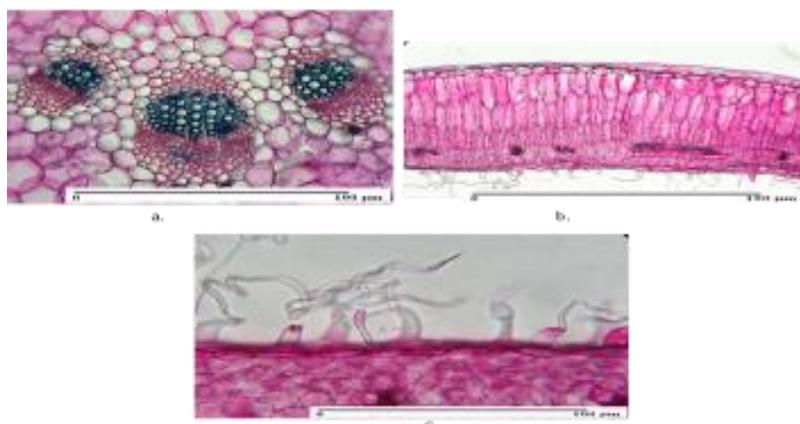


Fig. 4 Cross-section through the foliar fronds in variant V3 : a. conducting bundles from the primary vein; b. mesophyll structure; c. tector hairs

The cross-section through the primary vein highlights 3 free-ligneous conducting bundles; the number of conducting bundles from between the veins is lower; the palisadic tissue is three-layered (70-85%); the cells of the hypodermal layer are larger; the cells of the upper epidermis are visibly larger, with the outer wall much thicker than that on the opposite side of the fronds; the tector hairs are fewer.

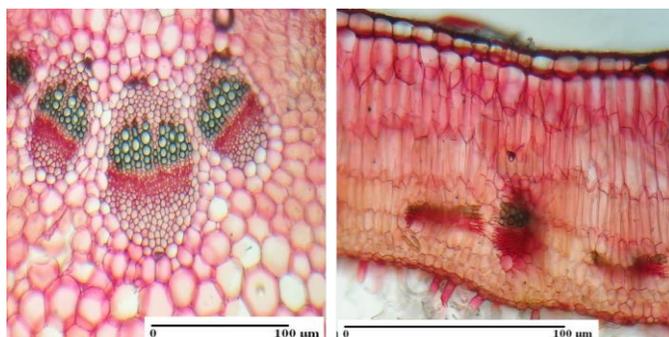


Fig. 5 Cross-section through the foliar fronds in variant V4 : a. conducting bundles from the primary vein; b. mesophyll structure

The median vein has 4 free-ligneous bundles; the palisadic tissue is single-layered, the length of the cells decreasing towards the upper side of the fronds; the lacunar tissue is reduced to 2 layers; the bundles from between the lateral veins are bigger and fewer; the upper epidermis has bigger cells.

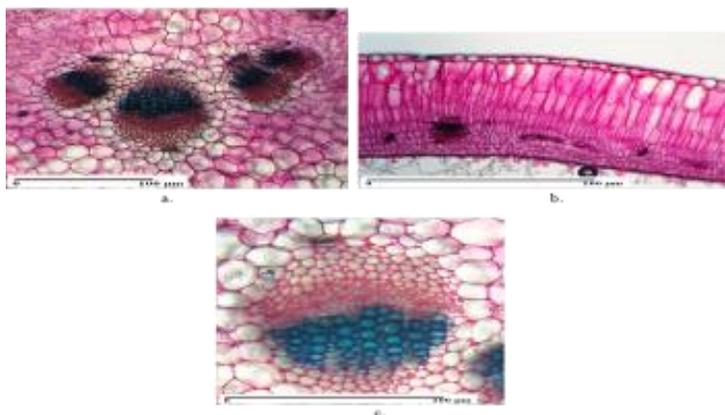


Fig. 6 Cross-section through the foliar fronds in variant V5: a. conducting bundles from the primary vein; b. mesophyll structure; c. conducting bundle from the primary vein

The median vein comprises 4 conducting bundle; the palisadic tissue is four-layered, the cells of the upper layer being much longer and larger, and the layer that is adjacent to the lacunar tissue has more narrow and much shorter cells; the tector hairs are fewer.

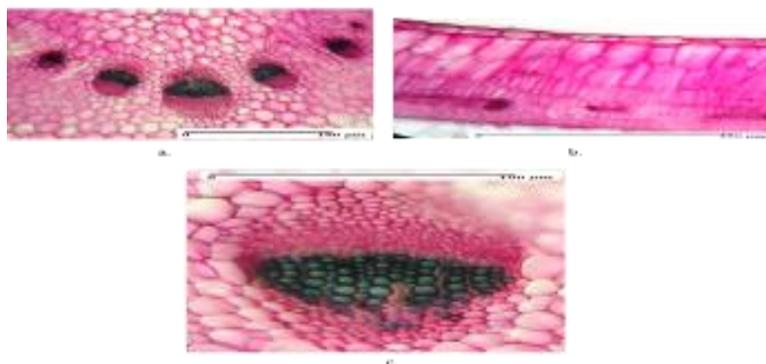


Fig. 7 Cross-section through the foliar fronds in variant V6 : a. conducting bundles from the primary vein; b. mesophyll structure; c. conducting bundle from the primary vein

The median vein comprises 5 conducting bundles and they are less prominent in the underside of the fronds; the ligneous vessels don't run strictly radially.

CONCLUSIONS

1. The variants fertilized with Osmocote® Pro have presented a higher content of photosynthetic pigments than the ones recorded in the variants fertilized with Blütenzauber.

2. The treatment with the Osmocote® Pro fertilizer has determined the highest value of total content of assimilatory pigments, as well as an increase in the content of chlorophyll a, b.

3. The structure of the primary vein, the number of conducting bundles, the cells of the hypodermal layer, the cells of the upper epidermis and the tector hairs are influenced by the type of fertilizer used, the best results being obtained in variants that were fertilized with Osmocote®Pro.

REFERENCES

1. **Beatović D., Jelačić S., Vujošević A., 2007a** - *Uticaj različitih doza spororazlagajućeg đubriva na kvalitet rasada lekovitog, aromatičnog i začinskog bilja*, XVII Simpozijum Društva za fiziologiju biljaka SCG, Zbornik izvoda 23.
2. **Beatović D., Jelačić S., 2007b** - *Primena spororazlagajućih đubriva u proizvodnji rasada lekovitog, aromatičnog i začinskog bilja*, XII Naučno-stručno savjetovanje agronoma Republike Srpske. »Naučna podrška razvojnoj strategiji poljoprivrede Republike Srpske«. Teslić 7-9. mart 2007. Zbornik sažetaka, str. 90.
3. **Beatović D., Jelačić S., Lakić N., Vujošević A., 2007c** – *Uticaj spororazlagajućeg đubriva na kvalitet rasada bosiljka, matičnjaka i ehinaceje*, III Simpozijum sa međunarodnim učešćem »Inovacije u ratarskoj i povrtarskoj proizvodnji« 19-20. oktobar Beograd, Zbornik izvoda 96-97.
4. **Belger U., Drach M., 1989** - *Triabon-a complete slow-release fertilizer containing crotonol for pot and container plants*. Special Issue of BASF No.2. 1-34.
5. **Ferrante A., Mensuali-Sodi A., Serra G., Tognoni T., 2006** - *Evaluation of postproduction performance of Salvia splendens potted plants for interiors use*. Acta Horti (ISHS) 723:415-420.
6. **Hanić E., 2000** - *Značaj supstrata, kontejnera i hormona u rasadničarskoj proizvodnji*, Univerzitet »Džemal Bijedić« Mostar, Studij za mediteranske kulture.
7. **Hartmut K. Lichtenthaler, Claus Buschmann, 2001** - *Current Protocols in Food Analytical Chemistry*. F4.3.1-F4.3.8 Copyright © 2001 by John Wiley & Sons, Inc.
8. **Nelson P.V., 2003** - *Greenhouse Operation&Managment. Sixth Edition; Slow-Release Fertilizers, Growth-Regulating Compounds*. Library of Congress Cataloging. Prentice Hall, p. 335, 434.
9. **Vujošević A., Lakić N., Lazarević S., Beatović D., Jelačić S., 2007a** - *Effect of application of natural biostimulators and slow disintergrating fertilizer in commercial production on Begonia (Begonia semperflorens L.) seedlings*, Journal of Agricultural Sciences. Belgrade, Vol.52 , No 1.
10. **Vujošević A., Adamović M., Beatović D., 2007b** - *Uticaj supstrata na kvalitet rasada jednogodišnjeg cveća*, XII Naučno-stručno savjetovanje agronoma Republike Srpske, »Naučna podrška razvojnoj strategiji poljoprivrede Republike Srpske«, Teslić 7-9. mart 2007. Zbornik sažetaka, str. 95.
11. **Vujošević A., Lakić N., Beatović D., Jelačić S., Lazarević S., 2007** – *Uticaj različitih doza spororazlagajućih đubriva na kvalitet rasada kadifje (Tagetes patula L.) i ukrasne žalfije (Salvia splendens L.)*. III Simpozijum Inovacije u ratarskoj proizvodnji, Beograd 2007, str.225.

ASPECTS REGARDING THE MORPHOLOGICAL AND DECORATIVE CHARACTERISTICS OF *ECHINOPS RITRO* PLANTS OBTAINED FROM SEEDS EXPOSED TO GAMMA RADIATION

ASPECTE PRIVIND CARACTERELE MORFOLOGICE ȘI DECORATIVE ALE PLANTELOR DE *ECHINOPS RITRO* OBTINUTE DIN SEMINȚE TRATATE CU RADIAȚII GAMMA

MORARU Mihaela¹, CHELARIU Elena Liliana¹,
BRÎNZĂ Maria¹, DRAGHIA Lucia¹
e-mail: julia@uaiasi.ro

Abstract. *The experiments were carried out during 2016-2017, aimed to determine the influence on morphological characters of Echinops ritro, obtained from seeds, subjected to gamma radiations treatments. The gamma radiation used in experiments was 50, 100 and 250 Gy. In 2017, determinations and observation were made regarding the starting of vegetation and appearance of floral stems, the height of the plants, the number of leaves/plants, and the number of inflorescences/plants. In most of the analyzed characters the positive influence were notice at seeds kept at room temperature and irradiated at 50 Gy.*

Key words: *Echinops ritro*, seeds, gamma radiations, morphological characters

Rezumat. *Experiențele desfășurate în perioada 2016-2017 au avut ca scop determinarea influenței tratamentelor cu radiații gamma a semințelor de Echinops ritro asupra caracterelor morfologice ale plantelor obținute. Dozele de radiații gamma la care semințele au fost supuse au fost de 50, 100 și 250 Gy. În anul 2017 s-au efectuat determinări și observații privind pornirea în vegetație a plantelor și apariția tijelor florale, înălțimea plantelor, numărul de frunze/plantă, numărul de inflorescențe/plantă. La majoritatea caracterelor analizate s-a constatat influența pozitivă a iradierii semințelor cu doze de 50 Gy.*

Cuvinte cheie: *Echinops ritro*, semințe, radiații gamma, caractere morfologice

INTRODUCTION

In order to improve the floral assortment, it is important to introduce new and interesting plants. *Echinops* species draw attention through the globular form of inflorescences and their colours, ranging from gray, blue to purple (Ondra, 2009).

Most of these plants have modest requirements than growing conditions, being adapted to temperate climate, the perennial being resistant to low temperatures.

¹University of Agricultural Sciences and Veterinary Medicine from Iași, Romania

To obtain plants with high ornamental value is very important to apply appropriate technologies. Studies show that low temperatures treatments applied to seeds help the plants to blossom uniformly. Appropriate plant development occurs when seeds are exposed for some weeks at a temperature of 4-5°C (Iversen *et al.*, 1989). According to the results obtained in other species of plants, other treatments can be interesting (irradiation).

Gamma rays have immense potential for various agricultural applications as evidenced from their interaction at crop, plant, tissue and cellular level. Gamma radiation does interact with the bio-molecules in the plant, thus may cause a reduction or an increase in the level of respective molecules and lead to apparent morphological and physiological changes to impact growth, vigour and yield of plants. There are still gaps in our knowledge, uncertainty and lack of information on the radiation dose-effect relationship for different crops and agro-applications (Ilyas and Naz, 2014).

Ionized radiations penetrated into living organisms may give rise to mutations or may cause lethal lesions. Into cells, radiation can influence plant growth and development, through cytological, genetic and biochemical changes (Gunckel, 1961). Studies show that gamma rays on plants can cause changes in growth, development, metabolism and DNA (Esnault, 2010; Kovalchuk *et al.*, 2007, Vandenhove *et al.*, 2010).

The study of the effects of gamma radiation on plants is a broad and complex field. Work is being done in many areas on a large number of plant species. The morphological, structural and the functional changes depend on the strength and duration of the gamma irradiation stress. The results from one species or varieties should not be applied to others because different types of responses are to be expected in different plants (Ayneband and Afsharinafar, 2012).

The objective of the present study was to investigate the influence of the pre-treatment of seeds different doses of gamma radiations on morphological characteristics of *Echinops ritro* (globe thistle).

MATERIAL AND METHOD

The experiment was conducted in two consecutive seasons of 2016 and 2017 in field of Floriculture discipline, at the University of Agricultural Sciences and Veterinary Medicine from Iași, Romania.

The material used in the experiment was represented by *Echinops ritro* plants (fig. 1). *E. ritro* is an herbaceous perennial thistle, which reaches heights between 40-60 cm, with prickly leaves and steel-blue flowers in spherical inflorescences (2.5 cm – 4.5 cm in diameter).



Fig. 1 *Echinops ritro* (original)

The seeds used in the experiment were exposed to gamma radiations and have resulted four variants (tab. 1). Radiation was applied with the sources of Cobalt-60, Cesium-137 and Europium-151. As a control is the variant V_1 (non-irradiated). For the experiments, a randomized design with three replicates was used.

Table 1

Experimental scheme		
Experimental factors	Specification	Variants
Irradiation seeds	Gamma radiations 50, 100, 250 GY	V_1 – non-irradiated
		V_2 - 50 Gy
		V_3 - 100 Gy
		V_4 - 250 Gy

Biometric determinations were made on the main morphological characters (average leaf number, plant height, number of inflorescences) and were analyzed from ornamental perspective value of the plants. The data obtained were statistically analysed using the variance analysis and the interpretation of the results was made using the limit differences.

RESULTS AND DISCUSSIONS

From the synthesis of the results, the applied treatment with gamma radiations influenced differently the morphological characters of *Echinops ritro*.

For the studied species, the treatment applied to the seeds gave different

results on the number of leaves, height and number of inflorescences, compared to the control variant of the experience.

The influence of gamma radiations on the leaf counts was higher, compared to the control, very significant in the positive sense, for all the studied variants (tab. 2).

Differences between the irradiated variants and control recorded values such as 10.4 for V_2 , 4.2 for V_3 and 4.4 for V_4 .

Table 2

The influence of gamma radiations on the number of leaves

Variants	Number of leaves		d (\pm)	Significance of differences
	Absolute value	Relative value (%)		
V_1 -control	25.3	100.00	0.0	-
V_2	35.7	141.11	10.4	***
V_3	29.5	116.60	4.2	***
V_4	29.7	117.39	4.4	***
LSD 5% = 1.1 LSD 1% = 1.6 LSD 0.1% = 2.6				

The treatment with 50 Gy showed very significant positive differences, resulted in a higher height of the flowering stem with 18.1 cm more than the control variant of the experience (tab. 3).

Compared to the control variant, the plants whose height resulted in distinctly significant in the positive sense, belonged to the experimental variant V_4 (250 Gy), having the value of 96.5 with a difference from the control variant of 2.2 cm. The influence of gamma radiation on the plant height for variants V_3 (100 Gy), recorded statistically insignificant values.

The number of inflorescences was mainly influenced by the variant V_2 (50 Gy), where the results showed very significant differences in the positive sense, showing values of 25.4 and a difference from the control variant of 4.4 inflorescence (tab. 4).

In case of variant V_4 (250 Gy), there were distinctly significant differences in negative sense, were observed with 8.1% fewer inflorescences than the control variant.

Statistically insignificant values were also recorded for experimental variant V_3 (100 Gy), with values of 94.8 inflorescences.

The influence of gamma radiations on plant height

Variants	Plant height		d (±)	Significance of differences
	Absolute value (cm)	Relative value (%)		
V ₁ -control	94.3	100.00	0.0	-
V ₂	112.4	119.19	18.1	***
V ₃	94.8	100.53	0.5	ns.
V ₄	96.5	102.33	2.2	**
LSD 5% = 1.3 LSD 1% = 1.9 LSD 0.1% = 3.0				

Table 4

The influence of the gamma radiations on the number of inflorescences

Variants	Number of inflorescences		d (±)	Significance of differences
	Absolute value	Relative value (%)		
V ₁ -control	21.0	100.00	0.0	-
V ₂	25.4	120.95	4.4	***
V ₃	20.9	99.52	-0.1	ns
V ₄	19.3	91.90	-1.7	oo
LSD 5% = 1.0 LSD 1% = 1.5 LSD 0.1% = 2.5				

CONCLUSIONS

1. Gamma radiation can influence differently the growth and developments of plants.

2. Plants whose seeds were irradiated with gamma rays at doses of 50 Gy exhibited more leaves, higher heights of floral stems and more inflorescences.

3. The influence of gamma radiations on the leaf counts and plants height was higher, compared to the control, for all the studied variants.

4. In case of number of inflorescences, gamma rays at doses of 250 Gy (variant V₄) caused the decrease in the number of inflorescences (with 8.1% fewer inflorescences than the control variant).

REFERENCES

1. **Aynehband A., Afsharinafar K., 2012** - *Effect of gamma irradiation on germination characters of amaranth seeds*. European Journal of Experimental Biology, 2 (4):995-999.
2. **Esnault M.A., Legue F., Chenal C., 2010** - *Ionizing radiation: advances in plant response*. Environ. Exp. Bot. 68(3):231–237.
3. **Gunckel J.E., Sparrow A.H., 1961** - *Ionizing radiation: Biochemical, Physiological and Morphological aspects of their effects on plants*. In: Encycl. Plant Physiol. (ed.) W. Ruhland. XVI: pp. 555-611, Springer-verlag, Berlin.
4. **Ilyas S., Naz S., 2014** - *Effect of gamma irradiation on morphological characteristics and isolation of curcuminoids and oleoresins of Curcuma longa L.* The Journal of Animal & Plant Sciences, 24(5):1396-1404.
5. **Iversen R., Weiler T., 1989** - *Forcing the issue: a guide to forcing garden perennials into bloom for flower show exhibitions*. American Nurseryman 169(8):95-103.
6. **Kovalchuk I., Molinier J., Yao Y., Arkhipov A., Kovalchuk O., 2007** - *Transcriptome analysis reveals fundamental differences in plant response to acute and chronic exposure to ionizing radiation*. Mutat. Res. 624(1):101–113.
7. **Ondra J. Nancy, 2009** - *The perennial care manual. A plant-by-plant guide: What to do & when to do it*. Storey Publishing, Massachusetts.
8. **Vandenhove H., Vanhoudt N., Cuypers A., Van Hees M., Wannijn J., Horemans N., 2010** - *Life-cycle chronic gamma exposure of Arabidopsis thaliana induces growth effects but no discernible effects on oxidative stress pathways*. Plant Physiol. Biochem. 48:778–786.

ASPECTS REGARDING THE ORNAMENTAL VALUE OF PLANTS FROM *ERYNGIUM* GENUS

ASPECTE PRIVIND VALOAREA DECORATIVĂ A PLANTELOR DIN GENUL *ERYNGIUM*

MORARU Mihaela¹, CHELARIU Elena Liliana¹,
BRÎNZĂ Maria¹, GOANȚĂ Mirela², DRAGHIA Lucia¹

e-mail: julia@uaiasi.ro

Abstract. *The Eryngium genus, of the Apiaceae family, includes plants characterized by morphological attributes that give them, in many situations, the status of decorative plants. Relatively modest ecological requirements and fairly good resistance to less favourable crop conditions (sunstroke, water deficit, poor soils and salinity etc.) contribute to the interest in these plants. This paper aims to highlight the possibilities of using for five Eryngium taxa (E. alpinum 'Superbum', E. planum 'Blue Sea Holly', E. planum 'Blue Hobbit', E. leavenworthii) with ornamental qualities, cultivated in the conditions of Iași, with a view to their promotion and superior exploitation in floral art and landscaping.*

Key words: *Eryngium*, morphology, ecology, ornamental value

Rezumat. *Genul Eryngium, din familia Apiaceae, cuprinde plante caracterizate prin însușiri morfologice care le conferă, în multe situații, și statutul de plante decorative. Cerințele ecologice relativ modeste și rezistența destul de bună la condiții de cultură mai puțin favorabile altor specii (insolație, deficit de apă, soluri sărace și cu salinitate crescută etc.) contribuie la creșterea interesului pentru aceste plante. Lucrarea de față își propune să evidențieze posibilitățile de utilizare a cinci taxoni de Eryngium (E. alpinum 'Superbum', E. planum 'Blue Sea Holly', E. planum 'Blue Hobbit', E. leavenworthii) cu calități ornamentale, cultivați în condițiile de la Iași, în vederea promovării și valorificării superioare a acestora în arta florală și în amenajări peisagistice.*

Cuvinte cheie: *Eryngium*, morfologie, ecologie, valoare ornamentală

INTRODUCTION

The genus *Eryngium* include about 250 species and is the most complex genus in the *Apiaceae* family, three quarters of the diversity of species belongs to the *Saniculoides* subfamily. The complexity of the *Eryngium* genus is remarkable by the large number of species discovered over time, which have diverse morphological and ecological characters, so researchers continue to find new species, important by food, medicinal or decorative qualities. Information on the

¹University of Agricultural Sciences and Veterinary Medicine from Iași, Romania

²“Alexandru Ioan Cuza” University of Iași, Romania

morphology, diversity, distribution, karyology and ecological preferences of *Eryngium* species is due to studies by numerous researchers who have devoted some of their professional activity to the knowledge of these plants (Calvino *et al.*, 2010).

Representatives of the genus *Eryngium* are perennial or annual plants with fascicular roots (in some cases, a few meters long), erect (sometimes prostrate) stems, rigid leaves, whole or divided, small sessile flowers, grouped in umbels (elongated, spheres or cylindrical). As specific formations, there are the brackets at the base of each flower and the bracts surrounding the base of the inflorescence (first, the smallest and the simplest, and the other better developed the whole or split pens). The fruits are achene, generally oval, slightly flattened, with a rough, scaly covered surface with spines (Wörz and Diekmann, 2010).

Species and cultivars of the *Eryngium* genus can adapt to different environmental conditions. Some of them can grow in poor, dry, saline soils, others thrive in typical garden soil, and one species, *Eryngium aquaticum*, is appreciated for the water gardens (Armitage, 2008). Plants of this genus prefer wet and well-drained soils. Perennial species do not support cold soils that retain water in winter, because it can have a negative effect on the roots.

Eryngium species were grown for the first time in the 18th century, after being brought from the journeys by botanists and plants collectors. Due to the growing demand for new ornamental plants, the ornamental interest in these plants has increased since 1970, being appreciated for their less common appearance, but also for the interesting colour or shape of the inflorescences (tab. 1).

Table 1

The decorative characters of the main ornamental species of *Eryngium*
(after Taylor, 1983)

Species/Cultivars	Height (m)	Blooming period	Flower color
<i>Eryngium alpinum</i>	0.60	July-September	blue purple
<i>Eryngium amethystinum</i>	0.60	July-August	blue purple
<i>Eryngium aquaticum</i>	1.20-1.80	July-August	light blue
<i>Eryngium agavifolium</i>	0.45	July-September	green
<i>Eryngium bourgati</i>	0.45	July-August	blue purple
<i>Eryngium creticum</i>	0.25-1.0	June-August	light blue, white
<i>Eryngium giganteum</i>	1.50-2.10	June-August	blue, light green
<i>Eryngium leavenworthii</i>	0.8-0.9	July-September	blue purple
<i>Eryngium oliverianum</i>	0.60-0.90	July-September	blue purple
<i>Eryngium pandanifolium</i>	2.5	July-September	silver purple
<i>Eryngium planum</i>	0.90	July-August	blue purple
<i>Eryngium yuccifolium</i>	0.5-1.0	June-September	whiteish green
<i>Eryngium variifolium</i>	0.40	July-August	silver blue

They are also known for phytochemical properties (diuretics, aromatics, expectorants) and are frequently used in phytopharmacy (Moerman, 1988).

MATERIAL AND METHOD

This paper brings to the front some *Eryngium* taxa (*E. alpinum* 'Superbum', *E. planum* 'Blue Sea Holly', *E. planum* 'Blue Hobbit', *E. leavenworthii*) with ornamental value, cultivated in the collection of Floriculture discipline at the University of Agricultural Sciences and Veterinary Medicine from Iași. The main goal is to promote them in culture, taking into account the advantages of a relatively simple technology and the possibility of much diversified exploitation.

***Eryngium alpinum* L.** is a perennial hemicyptophyte species from Austria, Liechtenstein, Croatia, France, Switzerland, Italy and Slovenia. It develops in alpine, rocky and wetland pastures, at an altitude of 1500-2000 m, on soils with a pH between 8 and 10 (Gygax *et al.*, 2013). Cv. 'Superbum' (fig. 1 a) is noticeable by the blue metallic inflorescences,

***Eryngium planum* L.** originates from Central Europe, Yugoslavia, Caucasus, Western Siberia, Central Asia. The plants have heights ranging from 70 to 100 cm, glaucous leaves, blue flowers grouped in umbels, achene fruit. Plants prefer a sunny position and sandy soil, with a pH between 8 and 10 (Taylor, 1983). Cv. 'Blue Sea Holly' has stems in size at 70-100 cm and light blue flowers (fig. 1 b), and cv. 'Blue Hobbit' shows through the dwarf port and intense blue inflorescences (fig. 1 c).

***Eryngium leavenworthii* Torr & A. Gray** is an annual native species from North America's prerogatives. The plants grow properly in places with sunny exposure, reaching heights of up to 90 cm. The foliage is glaucous, which is coloured in autumn, in purple (Mathew and Hall, 2003).

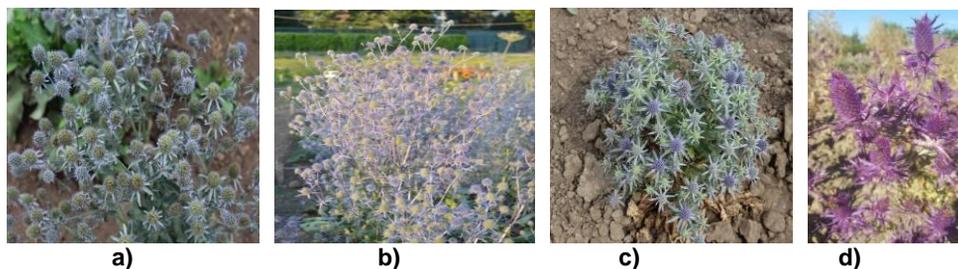


Fig. 1 The appearance of the plants *Eryngium alpinum* 'Superbum' (a), *Eryngium planum* cv. 'Blue Sea Holly' (b), *Eryngium planum* 'Blue Hobbit' (c) and *Eryngium leavenworthii* (d) (original)

Establishing experimental crops for both annual and perennial plants was done with greenhouse seedlings. For a uniform flowering quality, it is important that the cold season is identified in perennial plants naturally with the winter season or can be achieved with thermal treatments. It should also be noted that in the perennial species the plants obtained from the seeds bloom in the second year.

RESULTS AND DISCUSSIONS

Eryngium species with ornamental characters have been described by recognized botanists and scientists such as: Carl Linnaeus, 1753 (*E. alpinum*, *E.*

maritimum, *E. planum*, *E. aquaticum*); André Michaux, 1803 (*E. yuccifolium*); Friedrich August Marschall Von Bieberstein, 1808 (*E. giganteum*); Ernest Saint-Charles Cosson, 1875 (*E. variifolium*); François Delaroché, (*Eryngium x oliverianum*); John Merl (*E. yuccifolium* var. *synchaetum*); Edward Lee Greene, 1895 (*E. alismifolium*); Jean-Baptiste Pierre Antoine de Monet de Lamarck (*E. creticum*); Asa Gray, Mildred Esther Mathias, (*E. aquaticum* var. *ravenelii*); Melines Conklin Leavenworthii (*E. leavenworthii*) (Wörz, 2004).

The morphological characters of the *Eryngium* taxa studied and cultivated under the conditions of Iasi determine their use in different ways. It is noticeable that it generally falls within the category of medium-sized plants (approximately 70-100 cm), which are blooming in summer (tab. 2).

Table 2

Morphological characters and possibilities of using of *Eryngium* taxa cultivated under the Iași conditions

Species/Cultivars	Height (m)	Blooming period	Flower colour	Ornamental use
<i>E. alpinum</i> 'Superbum'	0.70-1.00	June-July	metallic blue	cut flower: fresh and dry landscaping: groups, rocks garden, colour spots
<i>E. planum</i> 'Blue Sea Holly'	0.70-1.00	July-August	light blue	cut flower: fresh and dry landscaping: groups, rocks garden, colour spots
<i>E. planum</i> 'Blue Hobbit'	0.20-0.30	June-July	dark blue	landscaping design: groups, mixed borders, rocks garden
<i>E. leavenworthii</i>	0.90	July-September	purple	cut flower: fresh and dry landscaping: groups, rocks garden, colour spots

In landscaping, *Eryngium* plants are useful because they are light-loving and can be positioned in full sun, decorating areas where other flower plants do not resist. It is recommended to use these species in mixed bordering arrangements along with other resistant species. The silver or blue bracts, typical of the *Eryngium* species, can be perfectly combined with almost any type of decorative plant (tab. 2).

In addition to the design that plants offer in gardens (fig. 1), *Eryngium* flowers can be used in floral arrangements (fig. 2) both fresh and dry (as immortal). In 1991, *Eryngium* was ranked by Armitage as the top 30 plants suitable for dry use.

The blooming period is summer. For *Eryngium* taxa, harvesting occurs when the inflorescences and bracts are coloured in characteristic shades (Scoggins, 2002).

Storage in refrigerated warehouses at temperatures of 4-5°C, without water, can be done for 7-10 days (Armitage, 1993, 1991); in water-filled pots the flowers resist even 30 days, but the foliage is around 7-10 days (Cantor and Buta, 2010). Also, low positive temperatures intensify flowers' colours (Whyman, 1993).



Fig. 2 Floral design with inflorescences of *E. alpinum* 'Superbum' (a) and *E. planum* cv. 'Blue Sea Holly' (b, c) (original)

CONCLUSIONS

1. The genus *Eryngium* is one of the largest and most complex genus of the *Apiaceae* family and includes species of medicinal and ornamental importance.

2. Research has shown that *Eryngium* species have moderate environmental requirements, being adapted to a temperate climate, perennials being resistant to low temperatures.

3. From an economic point of view, generative multiplication is recommended, with the specification that perennial plants bloom from the second year. Splitting of bushes, although recommended, requires attention because plants have a sensitive root system and do not easily support transplantation.

4. Species / cultivars of *Eryngium* have decorative importance in the summer months, through habitus, colour and inflorescences.

5. Because of their rusticity, they can be used in group arrangements,

colour spots, mixed borders, rock gardens, etc.

6. In floral design, they are attractive due to the unique appearance of the inflorescences and the effect they give to the arrangements. Although used as a secondary role in floral creation, they often become the centre of attraction of compositions.

REFERENCES

1. **Armitage A., 1991** - *Stage of flower development at harvest*. The Cut Flower Quarterly. Timber Press. Portland, Oregon.
2. **Armitage A., 1993** - *Specialty cut flowers*. Varsity Press. Timber Press. Portland, Oregon.
3. **Armitage A., 2008** - *Herbaceous perennial plants. A Treatise on their identification, culture, and garden attributes*. Third Edition. University of Georgia. Stipes Publishing.
4. **Calvino C.I., Martinez S.G., Downie S.R., 2010** - *Unraveling the taxonomic complexity of *Eryngium* L. (Apiaceae, Saniculoideae): Phylogenetic analysis of 11 non-coding cpDNA loci corroborates rapid radiations*. Stuttgart, Plant Div. Evol. Vol.128/1-2.
5. **Cantor Maria, Buta Erzsebet, 2010** - *Artă florală*. Editura Toderco, Cluj Napoca.
6. **Gygax A., Bernhardt K.G., Jogan N., Montagnani C., Gigot G. 2013** - *Eryngium alpinum*. The IUCN Red List of Threatened Species 2013: e.T162328A5574460.
7. **Mathew B., Hall T., 2003** - *Eryngium leavenworthii*. *Umbelliferae*. Curtis's Botanical Magazine. Blackwell Publishers. Oxford.
8. **Moerman D., 1988** - *Nature America Ethnobotany*. Timber Press, Oregon.
9. **Scoggins H.L. 2002** - *Field production of cut flowers: Potential crops*. Virginia Tech. Ext. Publ. 426–619.
10. **Taylor N. 1983** - *The garden dictionary. An Encyclopaedia of Practical Horticulture. Garden Management and Landscape Design*. Boston and New York. Houton Mifflin Company. The Riverside Press Cambridge.
11. **Whyman A., 1993** - *Pricing profile*. The Cut Flower Quarterly. 5(3):6.
12. **Wörz A., 2004** - *On the distribution and relationships of the South-West Asian species of *Eryngium* L. (Apiaceae – Saniculoideae)*. Turk. J. Bot., 28 (2004), pp. 85–92.
13. **Wörz A., Diekmann H., 2010** - *Classification and evolution of the genus *Eryngium* L. (Apiaceae – Saniculoideae): results of fruit anatomical and petal morphologies studies*. Plant Divers. Evol., 128 (2010), pp. 387–408.

CHARACTERIZATION OF *EREMURUS* PLANTS FOR ORNAMENTAL PURPOSES

CARACTERIZAREA PLANTELOR GENULUI *EREMURUS* PENTRU UTILIZARE ÎN SCOP ORNAMENTAL

**BAHRIM C.¹, BRÎNZĂ Maria¹,
CHELARIU Elena Liliana¹, DRAGHIA Lucia¹**

e-mail: mariabrinza2007@yahoo.com

Abstract. *Eremurus* genus (Liliaceae family), originating in Western and Central Asia, is known as foxtail lilies or desert candles. These spectacular plants resemble giant candles, due to their height and the hundreds of small flowers in cylindrical racemes. *Eremurus* is admired for its beautiful stems that are clothed for half their length in flowers. Except the ornamental importance, plants of this genus also have uses in other fields (especially in pharmacology and nutrition, but also in the production of glues, bio-oils or other products). The foxtail lilies are among the most spectacular specimen perennials, but, despite its high ornamental potential, they are still little known in the cut flower market and so seldom seen in our gardens. This paper presents several taxa of *Eremurus* genus, respectively three species (*E. himalaicus* Baker, *E. robustus* Regel, *E. stenophyllus* (Boiss. & Buhse) Bak.) and three cultivars of *Eremurus x isabellinus* hybrid ('Romance', 'Cleopatra', 'Pinokkio'), which are growing in floral collection from UASVM Iași.

Key words: *Eremurus*, morphology, ornamental potential

Rezumat. Genul *Eremurus* (familia Liliaceae), originar din Asia de vest și centrală, este cunoscut sub numele de crin coada vulpii sau lumânări deșert. Aceste plante spectaculoase se aseamănă cu niște lumânări uriașe, datorită înălțimii lor și sutelor de flori mici care alcătuiesc inflorescențele cilindrice, tip racem. *Eremurus* este admirat pentru tulpinile sale frumoase, care sunt îmbrăcate, pe jumătate din lungimea lor, în flori. Cu excepția importanței ornamentale, plantele din acest gen se folosesc și în alte domenii (în special în farmacologie și alimentație, dar și în obținerea cleiurilor, bio-uleiurilor sau altor produse). *Eremurus*ii sunt printre cele mai spectaculoase exemplare perene, dar, în ciuda potențialului lor ornamental ridicat, sunt încă puțin cunoscuți pe piața florilor tăiate și foarte rar întâlniți în grădinile de la noi. Lucrarea de față prezintă câțiva taxoni de *Eremurus* cultivați în condițiile de la Iași, respectiv trei specii (*E. himalaicus* Baker, *E. robustus* Regel, *E. stenophyllus* (Boiss. & Buhse) Bak.) și trei cultivare ale hibridului *Eremurus x isabellinus* ('Romance', 'Cleopatra', 'Pinokkio'), cultivați în colecția floricolă de la USAMV Iași.

Cuvinte cheie: *Eremurus*, morfologie, potențial ornamental

¹University of Agricultural Sciences and Veterinary Medicine from Iași, Romania

INTRODUCTION

Eremurus genus (Liliaceae family) comprises approx. 50 plant species, originating in Western and Central Asia and spread in natural areas of Caucasus, Afghanistan, Iran, Pakistan, Iraq, Lebanon, Turkey, Turkmenistan, India, China (Mabberley, 1990, cited by Naderi Safar *et al.*, 2009; Wendelbo and Furse, 1963, cited by Naderi Safar *et al.*, 2009).

The genus *Eremurus* is known as foxtail lilies or desert candles. Genus name comes from the Greek words *eremia* - meaning desert and *oura* - meaning a tail for the appearance of the flower spike (Șelaru, 2007).

Plants of the genus *Eremurus* are perennial herbs. The underground organs of the plant consist of tuberous roots and a corm-like crown with renewal buds (Schiappacasse *et al.*, 2013). Roots are shaped like an octopus, are fragile and do not like to be disturbed after planting. Linear leaves forming tufts or rosettes. Leaves die back in mid-summer after flowering as the plant goes into dormancy. The inflorescences are racemes, usually dense, elongated, with many flowers in copper, bright yellow, snow white, pastel pink, orange or any combination of those colours. Pedicellate flowers are placed, each one, per membranous bract axil. The perianth has 6 tepals, with conspicuous stamens. Fruit a dehiscent loculicidal capsule. Seeds are irregularly 3-angled (Pollock and Griffiths, 2005; Brickell and Cathey, 2004).

Not difficult to grow, *Eremurus* needs rich soil with a very good drainage, and sun that reaches the foliage while in growth and bakes the roots when plants go dormant after flowering. These plants require cold in winter to flower well. Protect from winter wet with the mulch (Pollock and Griffiths, 2005).

Propagate *Eremurus* from ripe side in autumn, or by division. Once planted, they like to remain undisturbed for several years. It may be divided after 4 to 5 years in late summer, by lifting the whole root and carefully separating into individual plants (Pollock and Griffiths, 2005).

These spectacular plants resemble giant candles, due to their height and the hundreds of small flowers that open from the bottom upward. *Eremurus* is admired for its beautiful stems that are clothed for half their length in flowers. It is also known for being tall, sometimes rising up to 1.8-2 m over the foliage, depending on the variety.

The foxtail lilies are among the most spectacular specimen perennials, but, despite its high ornamental potential, they are still little known in the cut flower market and so seldom seen in our gardens.

Except the ornamental importance, plants of this genus also have uses in other fields. The studies indicate the presence of various phytochemicals in the plant extracts, which may be responsible for the pharmacological activity: used to treat rheumatism and physical weaknesses in Chinese folk medicine (Jahanbin *et al.*, 2017), for the treatment of allergic rashes, skin irritations, boils, wounds, dermatitis, and pyoderma (Mamedov *et al.*, 2005), as a remedy for ulcers and stomach diseases (Jahanbin *et al.*, 2017); aerial parts possess antibacterial and cytotoxic properties and root extracts show anti-inflammatory properties (Rossi *et*

al., 2017). The roots are traditionally used in making a kind of bread and as natural glue (Zargari, 1994, cited by Jahanbin *et al.*, 2017). In recent research, the effects of catalysts on degradation of *E. spectabilis* to liquid products were investigated. As the bio-oils obtained exhibit high heat values, *E. spectabilis* is presented as a potential feedstock candidate for production of bio-fuels or valuable chemicals (Aysu *et al.*, 2015).

The purpose of this paper is to promote *Eremurus* as ornamental plants and their extension to growing as a garden plants and cut flowers.

MATERIAL AND METHOD

The species and cultivars of *Eremurus* presented in this paper were cultivated in the experimental field of floriculture from University of Agricultural Sciences and Veterinary Medicine from Iași, Romania. The cultures were set up in 2014 and the behaviour of the plants was studied in the climatic conditions of the NE of Romania.

Six taxa were studied, respectively three species (*E. himalaicus* Baker, *E. robustus* Regel, *E. stenophyllus* (Boiss. & Buhse) Bak.) and three cultivars of hybrid *Eremurus x isabellinus* ('Romance', 'Cleopatra', 'Pinokkio').

RESULTS AND DISCUSSIONS

E. himalaicus Baker (fig. 1) is native to the Western Himalayas. In natural habitats is found on rocky slopes of the drier areas, at altitudes of 2100-3300 m. Is a plant that can be easily identified by its inflorescences of hundreds of white flowers with protruding orange anthers. The leaves have a length of 30-60 cm and form rosettes with a diameter of 50-80 cm. From the centre of each rosette rises a thick stalk to 1.2-1.8 m, an erect inflorescence (terminal racemes), with tiny, densely, outward facing, white flowers. Each raceme grows from 1/3 to 1/2 of the flowering stem. The flowers are fragrant and appear in mid to late spring. The roots are consumed as food. The leaves are cooked as a vegetable. The leaves are used in traditional systems of medicines (young leaves are consumed in the treatment of anaemia) (Mushtaq *et al.*, 2016).

E. robustus Regel (fig. 2) is species native to Central Asia (Tien Shan and Pamir Mountains). The leaves can vary from a bright green to a bluish-green in color. The stem grows to 1-1.3 m in length and the inflorescence (75-90 cm long) is covered with many fragrant flowers. Flowers have six pale-pink tepals (with brown marks at the bases) and bright yellow stamens. Flowers bloom in late spring to early summer. Young roots (boiled) have edible uses, and rhizomes and roots have constituents with pharmaceutical potential. Also, a glue is made from the roots of these plants.

E. stenophyllus (Boiss. & Buhse) Bak. (syn. *E. bungei* Bak.) (fig. 3) is one of the species mainly distributed in Western and Central Asia and commonly thrives in the slope of the mountains (Jahanbin *et al.*, 2017). Plant

height is approx. 1 m. Racemes, 30-50 cm long, composed of numerous small flowers, golden yellow, fading to orange-brown (Brickell and Cathey, 2004). Considered to be a delicacy in Siberia, the flavour is similar to spinach. The root contains an arabinic acid derivative and this makes good quality glue.



Fig. 1. *E. himalaicus*



Fig. 2. *E. robustus*
(original)



Fig. 3. *E. stenophyllus*

Eremurus x isabellinus is a horticultural hybrid, derived from the crossing of *E. stenophyllus* with *E. olgae*. The first crossing was made by Sir Michael Foster at Great Shelford, England, at the end of the 19th century. The name of the hybrid is derived from the isabelline colour (pale fawn, pale cream-brown or parchment colour) of the original F1 hybrid flowers (wikipedia.org).

E. 'Romance' has many flower stems with buds pink, which opens in star-shaped flowers, a pale pink-salmon, with contrasting lemon stamens (fig. 4).

E. 'Cleopatra' is a special beauty characterized by mandarin-coloured flowers, arranged on elegant stems, 1.20 – 1.50 m tall. Flowers, with orange anthers and a dark red marks on the backs of the tepals (fig. 5).

E. 'Pinokkio' is an erect, clump-forming perennial, to 1.5m tall, with narrow strap-like leaves. It has yellow-orange flowers with orange anthers (fig. 6).

Considering the aesthetic aspect and the ecological plasticity of the species and cultivars of *Eremurus* genus, we consider that they need to be more promoted and growing, both in garden designs and as cut flowers.

Their orange, yellow, pink or white flowers can be very interesting in beds and borders. *Eremurus* likes to have its own space in the garden, but they can be associated with other plants which bloom at the same time (*Paeonia*, *Iris*, *Papaver*, *Aquilegia* etc.).



Fig. 4. *E. 'Romance'*



Fig. 5. *E. 'Pinokkio'*
(original)



Fig. 6. *E. 'Cleopatra'*

Also, in some countries (Netherlands, Germany, Israel, Japan, Turkey, Iran, Central Asian countries, North America) *Eremurus* is a commercially important specialty cut flower, because of its long spike-type inflorescences available in several colours (Schiappacasse *et al.*, 2013). These flowers can last up to several weeks when cut, so they can be used as cut flower in big bouquets (Cantor and Buta, 2010). Several species of *Eremurus* and their hybrids, in different combinations were introduced to market in order to make variety of flowers colour, long lasting cut flower, etc. (Dashti and Ketabi, 2003).

CONCLUSIONS

1. Foxtail lily species (*Eremurus* spp.) are perennial plants (geophyte), Liliaceae family, decorative by beautiful long racemes and flower with a variety of white, pink, orange, yellow and golden colours. They have high stems, sometimes rising up to 1.8-2 m over the foliage. Blooming is usually late spring or early summer.

2. Plants of *Eremurus* genus are characterized by the great diversity.

3. Foxtail lily foliage is insignificant, and may begin the fade before the flowers even form.

4. *Eremurus* needs rich soil with a very good drainage and sun. These plants require cold in winter to flower well.

5. Flowers of Foxtail lily can last up to several weeks when cut, so they can be used as cut flower in big bouquets.

REFERENCES

1. **Aysu T., Bengü A.S., Demirbaş A., Küçük M.M., 2014** – *Evaluation of Eremurus spectabilis for production of bio-oils with supercritical solvents*. Process Safety and Environmental Protection, vol. 94:339-349.
2. **Brickell C., Cathey H.M. (editor-in-chief), 2004** – *A-Z encyclopaedia of garden plants*. The American Horticultural Society. DK Publishing, Inc.
3. **Cantor Maria, Buta Erzsebet, 2010** – *Artă florală*. Editura Todesco, Cluj Napoca.
4. **Dashti M., Ketabi Z.H., 2003** – *Introduction of ornamental Foxtail species for garden and parks designing*. FAO - Agricultural Scientific Information and Documentation Centre, Agricultural Research and Education Organization.
5. **Jahanbin K., Abbasian A., Ahang M., 2017** – *Isolation, purification and structural characterization of a new water-soluble polysaccharide from Eremurus stenophyllus (Boiss. & Buhse) Baker roots*. Carbohydrate Polymers (Elsevier), vol. 178: 386-393.
6. **Mamedov N., Gardner Zoë, Craker L.E., 2005** – *Medicinal Plants Used in Russia and Central Asia for the Treatment of Selected Skin Conditions*. Journal of Herbs Spices & Medicinal Plants 11(1-2):191-222.
7. **Mushtaq A., Masoodi M.H., Wali A.F., Ganai B.A., 2016** – *Multiple treatment of Eremurus himalaicus extracts ameliorates carbon tetrachloride induced liver injury in rats*. International Journal of Pharmacy and Pharmaceutical Sciences, vol. 8, Issue 9, 24-27.
8. **Naderi Safar K., Kazempour Osaloo S., Zarrei M., 2009** – *Phylogeny of the genus Eremurus (Asphodelaceae) based on morphological characters in the Flora Iranica area*. Iran. J. Bot. 15(1):27-35.
9. **Pollock M., Griffiths M., 2005** – *Illustrated Dictionary of Gardening*. The Royal Horticultural Society.
10. **Rossi Daniela, Ahmed K.M., Gaggeri Raffaella, Della Volpe Serena, Maggi Lauretta, Mazzeo G., Longhi Giovanna, Abbate S., Corana Federica, Martino Emanuela, Machado Marisa, Varandas R., Maria do Céu Sousa, Collina Simona, 2017** – *(R)-(-)-Aloesaponol III 8-Methyl Ether from Eremurus persicus: A Novel Compound against Leishmaniosis*. Molecules, 22, 519; doi:10.3390/molecules22040519 www.mdpi.com/journal/molecules.
11. **Schiappacasse F., Szigeti J.C., Manzano E., Kamenetsky R., 2013** – *Eremurus as a new cut flower crop in Aysen, Chile: introduction from the northern hemisphere*. Acta Hort., 1002, 115-121.
12. **Șelaru Elena, 2007** – *Cultura florilor de grădină*. Editura Ceres, București.

**MORPHOLOGICAL AND ORNAMENTAL STUDIES OF
EREMURUS SPECIES**

**STUDII PRIVIND CARACTERELE MORFOLOGICE ȘI
ORNAMENTALE ALE UNOR SPECII DE EREMURUS**

**BAHRIM Cezar¹, BRÎNZĂ Maria¹,
CHELARIU Elena Liliana¹, DRAGHIA Lucia¹**

e-mail: mariabrinza2007@yahoo.com

Abstract. *The species of Eremurus genus (Liliaceae family), by its distinctive ornamental characters and its ability to adapt to the most diverse ecological conditions, can represent valuable variants in the enrichment of floral assortment, for landscaping design or cut flowers. In this paper are presented the results of observations and determinations carried out for three species of Eremurus (E. himalaicus Baker, E. robustus Regel, E. stenophyllus (Boiss. & Buhse) Bak.) cultivated in Iasi (N-E Romania) during 2015-2016. The main objective of the paper is to highlight the morphological and decorative characters of these plants, so that their cultivation can be valid in unprotected conditions and the efficient way of uses. The results obtained support the promotion of these plants in culture, both in floral art and in landscaping design.*

Key words: *Eremurus*, morphological characters, ornamental value

Rezumat. *Speciile genului Eremurus (familia Liliaceae), prin caracterele ornamentale deosebite și prin capacitatea bună de adaptare la cele mai diverse condiții ecologice, pot reprezenta variante foarte valoroase în îmbogățirea sortimentului de plante floricole pentru amenajarea grădinilor sau pentru flori tăiate. În lucrarea de față sunt prezentate rezultatele observațiilor și determinărilor efectuate în perioada 2015-2016 la trei specii de Eremurus (E. himalaicus Baker, E. robustus Regel, E. stenophyllus (Boiss. & Buhse) Bak.) cultivate la Iași (partea de N-E României). Obiectivul principal al lucrării este de a evidenția caracterele morfo-decorative ale acestor plante, astfel încât să poată fi argumentată cultivarea lor în condiții neprotejate și modul eficient de valorificare. Rezultatele obținute susțin promovarea în cultură a acestor plante, atât în arta florală, cât și în amenajările peisagistice.*

Cuvinte cheie: *Eremurus*, caractere morfologice, valoare decorativă

INTRODUCTION

The species of the *Eremurus* genus (*Liliaceae* family) are spread over large areas in Central Asia, Afghanistan, Iran, Pakistan, Iraq, Turkey, Lebanon, India and China (Wendelbo and Furse, 1963, cited by Naderi Safar et al., 2009) and have been studied by many researchers concerned with taxonomy, cytology, morphology, ecology, decorative traits, etc. of these plants (Naderi Safar et al., 2009, 2014; Kumari et al., 2016; Schiappacasse et al., 2013; Mushtaq et al., 2016). From an ornamental point of view, most

¹University of Agricultural Sciences and Veterinary Medicine Iasi, Romania

of the *Eremurus* species are particularly appreciated for high, elegant, inflorescences with differently colored flowers (Șelaru, 2007).

The purpose of the paper is to evaluate series of morphological and decorative characters of some *Eremurus* species cultivated in the N-E of Romania, so that on the basis of the results obtained recommendations can be made for cultivation of these plants in unprotected conditions and their efficient utilization for ornamental purposes.

MATERIAL AND METHOD

The research has been carried out in 2015-2016, in the floriculture fields of the University of Agricultural Sciences and Veterinary Medicine Iasi, Romania. Establishing experimental crops was done in the autumn of 2014 by planting underground *Eremurus* organs (rhizomes with 1-2 large buds from which, as in a giant star, are detach 5-8 tuberous roots), purchased from specialized firms in the production of the seedlings (fig. 1d).

In this paper are presented the results of the researches conducted on three species of *Eremurus* - *E. himalaicus* Baker, *E. robustus* Regel, *E. stenophyllus* (Boiss. & Buhse) Bak. - differentiated by both flower color and other characters. *E. himalaicus* (fig. 1a) shows white flowers with elongated tepals, inclined and with a brown line on the outside, and the leaves are erect and have lengths of approx. 30-50. *E. robustus* (fig. 1b) has green-bluish leaves and grows up to 50-70 cm long and numerous flowers with pink pale color. *E. stenophyllus* (fig. 1c) has stellate yellow flowers and leaves of 30-40 cm.

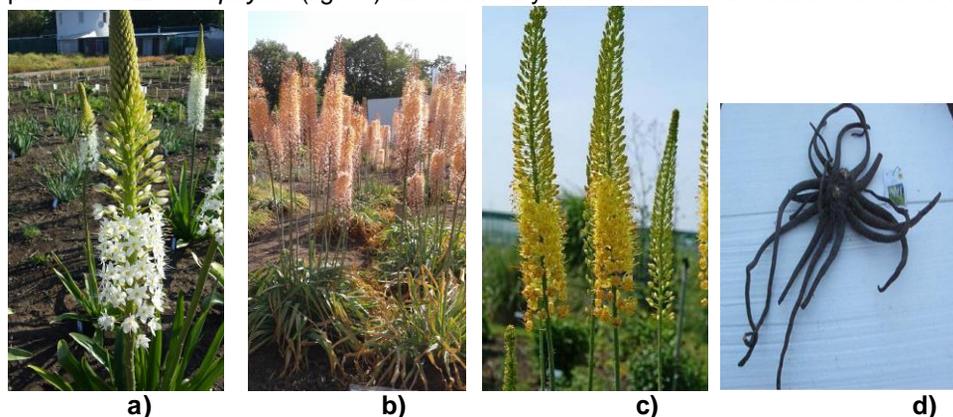


Fig. 1. Aspects with the biological material in the experimental field (original):
a) *E. himalaicus*; **b)** *E. robustus*; **c)** *E. stenophyllus*; **d)** underground organ

Each species analyzed was an experimental variant, the experience being organized in randomized blocks with three repetitions (5 plants/repetition, respectively 15 plants of each species/variant).

In order to determine the adaptation of *Eremurus* plants in ecological conditions in Iasi, determinations and observations were made during the vegetation periods of 2015 and 2016, in different phenophases (those aimed at starter, growth and development the leaves began in April, and those on the growth and development of inflorescences have started since May). The data was processed using analysis of variance, by testing the difference between variants with LSD test (Săulescu and Săulescu, 1967). As a control was considered the average of variants.

RESULTS AND DISCUSSIONS

It is known that the ornamental value of a plant is given not only by flowers or inflorescences, but also by other parts of the plant, including the appearance of the foliage. Although the *Eremurus* leaves begin to wilt before the end of flowering, they can ensure the decoration, even for a short period, in early spring, after starting vegetation and until flowering. Therefore, biometric determinations were carried out: average leaf / plant size, length and leaf width, diameter of the plant.

The number of leaves / plant varies between 24.6 and 29.3, compared to the average control (26.3), the differences being negative for *E. himalaicus* and *E. robustus*, but very significant positive for *E. stenophyllus* (tab.1).

Table 1

Number of leaves / plant at *Eremurus*

Var.	Species	Number of leaves		d (±)	Significance of differences
		Absolute value	Relative value (%)		
V ₁	<i>E. himalaicus</i>	24.60	93,54	-1.7	000
V ₂	<i>E. robustus</i>	25.10	95.44	-1.2	00
V ₃	<i>E. stenophyllus</i>	29.30	111.41	+3.0	xxx
Average (control)		26.30	100.00	-	-

LSD 5% = 0.4; LSD 1% = 0.7; LSD 0,1% = 1.3

Table 2

Length of leaves at *Eremurus*

Var.	Species	Length of leaves		d (±)	Significance of differences
		Absolute value (cm)	Relative value (%)		
V ₁	<i>E. himalaicus</i>	51.90	111.37	+5.3	xx
V ₂	<i>E. robustus</i>	54.20	116.31	+7.6	xxx
V ₃	<i>E. stenophyllus</i>	33.60	72.10	-13.0	000
Average (control)		46.57	100.00	-	-

LSD 5% = 1.9; LSD 1% = 3.2; LSD 0,1% = 6.0

Table 3

Width of leaves at *Eremurus*

Var.	Species	Width of leaves		d (±)	Significance of differences
		Absolute value (cm)	Relative value (%)		
V ₁	<i>E. himalaicus</i>	4.70	180.77	+2.1	xx
V ₂	<i>E. robustus</i>	2.10	80.77	-0.5	00
V ₃	<i>E. stenophyllus</i>	1.10	42.31	-1.5	000
Average (control)		2.63	100.00	-	-

LSD 5% = 0.2; LSD 1% = 0.3; LSD 0,1% = 0.5

The length and width of the leaves also varied according to the species. It can be seen from the data presented in Tables 2 and 3 that longer leaves, more than 50 cm, form *E. himalaicus* and *E. robustus*, with significant differences, respectively distinct significant differences, compared to average control. At *E. stenophyllus* the leaf length is approx. 72% below the control value, the differences being very significantly negative. The data on the leaf width reveals, first of all, the species *E. himalaicus* with the wider leaves (4.7 cm) and the *E. stenophyllus* species with the narrowest leaves (1.1 cm).

To establish the assortment of plants in the landscaping design is also accomplish according to the diameter of the plant, the number of plants at unit surface, being given also by the diameter of the plants, therefore, during the researches, measurements were made regarding this character to the *Eremurus* species. Analyzing the obtained results we can see values of the diameter of the plants ranging from 69 cm to *E. robustus* to 58.10 cm in *E. stenophyllus*, the character being correlated with the length of the rosette leaves (tab. 4).

Table 4

Diameter of plants at *Eremurus*

Var.	Species	Diameter of plants		d (±)	Significance of differences
		Absolute value (cm)	Relative value (%)		
V ₁	<i>E. himalaicus</i>	63.20	99.68	-0.2	-
V ₂	<i>E. robustus</i>	69.00	108.83	+5.6	xxx
V ₃	<i>E. stenophyllus</i>	58.10	91.64	-5.3	000
Average (control)		63.43	100.00	-	-

LSD 5% = 1.1; LSD 1% = 1.8; LSD 0,1% = 3.4

An important indicator for the ornamental value of a plant is the number of floral stems formed. By comparing the results obtained with the analyzed species it was found that the values varied from 2.5 floral stems / plant to *E. himalaicus*, at 1.25 floral stems / plant at *E. robustus*, the differences from the average of the experience (1.9) being distinct significantly positive, respectively significantly negative In *E. stenophyllus*, although the values are slightly above average, the differences are not statistically assured (tab. 5).

Table 5

Number of floral stems/plant at *Eremurus*

Var.	Species	Number of floral stems		d (±)	Significance of differences
		Absolute value	Relative value (%)		
V ₁	<i>E. himalaicus</i>	2.50	131.58	+0.6	xx
V ₂	<i>E. robustus</i>	1.25	68.42	-0.6	00
V ₃	<i>E. stenophyllus</i>	2.00	105.26	+0.1	-
Average (control)		1.90	100.00	-	-

LSD 5% = 0.3; LSD 1% = 0.5; LSD 0,1% = 1.0

In the studied *Eremurus* species, determinations were made regarding the height of the floral stems, the length and the diameter of the inflorescences. Therefore, large differences were recorded at the inflorescence length, respectively the height of the plants (tab. 6). *E. himalaicus* formed the highest rods (135.5 cm), exceeding the average of the experiment by 37 cm (very significant positive differences) and being at double values against *E. stenophyllus* with the shortest flower stems. At *E. robustus* the differences from the average of the experience were insignificant (tab. 6).

Table 6

Length of floral stems at *Eremurus*

Var.	Species	Length of floral stems		d (±)	Significance of differences
		Absolute value (cm)	Relative value (%)		
V ₁	<i>E. himalaicus</i>	135.50	137.98	+37.3	xxx
V ₂	<i>E. robustus</i>	97.90	99.69	-0.3	-
V ₃	<i>E. stenophyllus</i>	61.20	62.32	-37.0	000
Average (control)		98.2	100.00	-	-

LSD 5% = 1.7; LSD 1% = 2.9; LSD 0,1% = 5.4

In the study was determined, in all species, a long inflorescence (raceme), more than 50 cm. The values obtained ranged from 69.30 cm (*E. himalaicus*) to 52.60 cm (*E. stenophyllus*), with very significant differences from the average. The values for this character were closer to the average at *E. robustus* experience, so the differences were insignificant (tab. 7).

Table 7

Length of inflorescences at *Eremurus*

Var.	Species	Length of inflorescences		d (±)	Significance of differences
		Absolute value (cm)	Relative value (%)		
V ₁	<i>E. himalaicus</i>	69.30	113.98	+8.5	xxx
V ₂	<i>E. robustus</i>	60.40	99.34	-0.4	-
V ₃	<i>E. stenophyllus</i>	52.60	86.51	-8.2	000
Average (control)		60.8	100.00	-	-

LSD 5% = 0.7; LSD 1% = 1.2; LSD 0,1% = 2.2

Table 8

Diameter of inflorescences at *Eremurus*

Var.	Species	Diameter of inflorescences		d (±)	Significance of differences
		Absolute value (cm)	Relative value (%)		
V ₁	<i>E. himalaicus</i>	8.10	110.96	+0.8	xx
V ₂	<i>E. robustus</i>	8.20	112.33	+0.9	xx
V ₃	<i>E. stenophyllus</i>	5.60	76.71	-1.7	000
Average (control)		7.30	100.00	-	-

LSD 5% = 0.5; LSD 1% = 0.8; LSD 0,1% = 1.5

Relating to the inflorescence diameter, the values were larger and very close (8.2-8.1 cm) to *E. himalaicus* and *E. robustus*, with distinct positive differences compared to the control (tab. 8). In *E. stenophyllus*, inflorescences are thinner with approx. 2.5 cm from the other two species, determined very significant negative differences from the control.

CONCLUSIONS

1. Under the conditions of Iași, the three *Eremurus* species developed normally and displayed specific ornamental characters.

2. *E. himalaicus* and *E. robustus* form a smaller number of leaves / plant, but their dimensions (length, width) are higher compared to those of *E. stenophyllus*.

3. The highest production of floral stems (2-2.5) was recorded in the plants of *E. himalaicus* and *E. stenophyllus*.

4. *E. himalaicus* and *E. robustus* are distinguished by the most vigorous inflorescences.

5. *Eremurus* species which have been studied can be successfully utilized in landscaping design or cut flowers.

REFERENCES

1. Kumari K., Saggoo M.I.S., 2016 - *Analysis of Meiotic Behavior in Eremurus himalaicus Baker (Liliaceae): A Rare Endemic Perennial from Kinnaur, Himachal Pradesh, India.* Cytologia 81(4): 447-453.
2. Mushtaq A., Masoodi M.H., Wali A.F., Ganai B.A., 2016 - *Multiple treatment of Eremurus himalaicus extracts ameliorates carbon tetrachloride induced liver injury in rats.* International Journal of Pharmacy and Pharmaceutical Sciences, Vol 8, Issue 9, 24-27
3. Naderi Safar K., Kazempour Osaloo S., Zarrei M., 2009 - *Phylogeny of the genus Eremurus (Asphodelaceae) based on morphological characters in the Flora Iranica area.* Iran. J. Bot. 15(1): 27-35. Tehran.
4. Naderi Safar K., Kazempour Osaloo S., Assadi M., Zarrei M, Maryam Khoshokhan Mozaffar, 2014 - *Phylogenetic analysis of Eremurus, Asphodelus, and Asphodeline (Xanthorrhoeaceae-Asphodeloideae) inferred from plastid trnL-F and nrDNA ITS sequences.* Biochemical Systematics and Ecology 56: 32-39
5. Săulescu N.A., Săulescu N.N., 1967 - *Câmpul de experiență.* Editura Agro-Silvică, București.
6. Schiappacasse F., Szigeti J.C., Manzano E., Kamenetsky R., 2013 - *Eremurus as a new cut flower crop in Aysen, Chile: introduction from the northern hemisphere.* Acta Hort. 1002, 115-121
7. Șelaru Elena, 2007 - *Cultura florilor de grădină.* Editura Ceres, București.

Consilier editorial:

Vasile VÎNTU

Tehnoredactori:

Elena Liliana CHELARIU

Corectori:

**Lucia DRAGHIA
Elena Liliana CHELARIU**

Bun de tipar:

15.12.2017

Apărut:

2017

Format:

61x86/16

Editura:

**„Ion Ionescu de la Brad” Iași
Aleea M. Sadoveanu, 3
Tel.: 0232-407471
e-mail: editura@uaiasi.ro**

ISSN–L=1454-7376

(Print)-ISSN 1454-7376

(Online)=ISSN 2069-8275

(CD-ROM) = ISSN 2069 – 847X

PRINTED IN ROMANIA

Editorial Consultant:

Vasile VÎNTU

Technical Editors:

Elena Liliana CHELARIU

Readers:

**Lucia DRAGHIA
Elena Liliana CHELARIU**

Imprimatur:

15.12.2017

Published:

2017

Format:

61x86/16

Publishing House:

**„Ion Ionescu de la Brad” Iași
Aleea M. Sadoveanu, 3
Tel.: 0232-407471
e-mail: editura@uaiasi.ro**

ISSN–L=1454-7376

(Print)-ISSN 1454-7376

(Online)=ISSN 2069-8275

(CD-ROM) = ISSN 2069 – 847X

PRINTED IN ROMANIA