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CONTENT

CUPRINS

OBSERVATIONS ON NITRITE CONTENT OF SOME FRUITS AND VEGETABLES DURING DIFFERENT STORAGE CONDITIONS

OBSERVAȚII ASUPRA CONȚINUTULUI ÎN AZOTIȚI LA UNELE FRUCTE ŞI LEGUME LA PĂSTRAREA ÎN DIFERITE CONDIȚII

EPERJESSY Diana Beatrice[2], TROFIN Alina[1]*, UNGUREANU Elena[1], TRINCĂ Lucia Carmen[1], SANDU Tatiana[1]
*Corresponding author e-mail: atrofin@uaiasi.ro

Abstract. *Due to the low caloric intake, correlated with the high content of vitamins, fiber and mineral salts, plant foods are essential for a healthy diet. On the other hand, plant products can also be an important source of potentially harmful compounds, such as nitrogen, residues from fertilizer treatments and soil conditioners. The problem has become particularly relevant since frequent acute and chronic intoxications have been reported in young children who have consumed these substances in water or food, becoming even more complex after highlighting the cumulative effect of nitrates and the possibility of carcinogenic nitrosamines. This study was performed using 5 samples of fruits: red apple, golden apple, grapefruit, pears, lemons and 5 samples of vegetables: green peppers, cucumbers, squash, onions, cabbage. The nitrate content was analyzed and compared during storage for 7 days at different temperatures.*
Key words: vegetables, fruits, nitrites, storage

Rezumat. *Datorită aportului caloric redus, corelat cu conținutul ridicat de vitamine, fibre şi săruri minerale, alimentele de origine vegetală sunt esenşiale pentru o dietă sănătoasă. Pe de altă parte, produsele vegetale pot fi, de asemenea, o sursă importantă de compuşi potențial dăunători, aşa cum este cazul azotiților, reziduurilor de tratamente efectuate cu îngrăşăminte şi agenți de condiționare a solului. Problema a devenit deosebit de actuală de când s-au semnalat frecvente intoxicații acute şi cronice la copii mici care au consumat aceste substanțe din apă sau hrană, devenind şi mai complexă în urma evidențierii efectului cumulativ al azotaților şi al posibilității formării nitrozaminelor cancerigene. Prezentul studiu s-a efectuat folosind 5 probe de fructe: măr roşu, măr golden, grapefruit, pere, lămâi şi 5 probe de legume: ardei verde, castravete, dovlecei, ceapă, varză. A fost analizat şi comparat conținutul în azotiți pe durata păstrării timp de 7 zile la diferite temperaturi.*
Cuvinte cheie: legume, fructe, azotiți, păstrare

INTRODUCTION

The contribution of vegetables and fruits to the accumulation of daily intake of nitrates is considerable, however, nitrates have a low toxicity, but the

[1]University of Agricultural Sciences and Veterinary Medicine Iasi, Romania
[2] Saint Mary Emergency Children Hospital Iasi, Romania

reaction products resulting from their reduction (nitrites and N-nitroso compounds) are considered among the factors responsible for methemoglobinemia in children and of gastric cancer in adults (EFSA, 2008).

Numerous genetic, environmental and cultural factors influence the absorption and accumulation of nitrates in vegetables, including: species, fertilizer treatment and climatic conditions such as temperature, intensity and duration of light exposure, amount of water and the physical - chemical nature of soil.

Inorganic nitrates/nitrites are naturally occurring compounds in foods, especially plant foods and vegetables, and are also used as additives in industrially processed foods. Major sources of exogenous nitrate exposure are vegetables and drinking water, whereas processed meat and animal food products are major nitrite-containing foods; more than 80-95 percent of dietary intake of nitrate is attributed to vegetables especially green leafy vegetables including lettuce and spinach, cabbage, rocket, red beetroot, and radish (Hord *et. al*, 2009; Reinik *et. al*, 2009). A wide range of nitrate in vegetables from <1 to >1000 mg 100 g^{-1} has been reported (Hord *et. al*, 2009; Reinik *et. al*, 2009), whereas most levels of nitrate determined in fresh meats have been low (~10–50 mg kg^{-1}) (Iammarino *et. al*, 2012; Walters, 1996).

Due to many biological and environmental factors, nitrate/nitrite concentrations of foods and especially vegetables, reported in several studies, were extremely variable and also varied from country to country and region to region (Santamaria, 2006; Correia *et al,* 2010).

The main concern regarding nitrate is its potential endogenous conversion to nitrites and nitrosamines, and some acute/chronic toxicities such as methemoglobinemia, thyroid disorders or carcinogenesis. On the other hand, several potential therapeutic properties of nitrate/nitrite have been reported, sparking a growing interest in its clinical applications in several pathological conditions such as cardiovascular disease, hypertension, diabetes, metabolic syndrome and insulin resistance (Ghasemi *et. al*, 2013; Kevil *et. al*, 2011).

This paper aims to compare the nitrite content of different vegetable and fruit samples during storage for seven days at room, refrigeration and freezing temperature.

MATERIAL AND METHOD

The following samples were analyzed, at an interval of 7 days of storage at different temperatures, in what regarded their nitrite content:

P 1 – “Golden Delicious” green apples;
P 2 –“Starkrimson” red apples;
P 3 – Grapefruit;
P 4 – Cureé pears;
P 5 – Lemons;
P 6 – Green peppers;
P 7 – Squash;
P 8 – Cornichon cucumbers;

P 9 – Yellow onions;

P 10 - White cabbage.

The fruits and vegetables under analysis were purchased fresh on the day of the analysis. Each sample was sectioned into 4 equal parts. The first part was analyzed the same day to determine the dry matter and the humidity of fresh vegetables and fruits, respectively. One of the remaining 3 parts of each sample was stored at room temperature in a place away from sunlight and moisture, for a period of 7 days in order to monitor the evolution of changes that may occur, the second was stored in the refrigerator at a temperature of 4^0C and the last part was stored at freezing temperature between -18 and -20^0C. The nitrites content was determined using the Griess reagent colorimetric method and a Spekol 1100 spectrophotometer.

RESULTS AND DISCUSSIONS

As regards the moisture and dry matter of the analyzed samples, the values are shown in table 1. They were determined in order to properly express the nitrite content in samples.

Table 1

Humidity and dry matter values for the analyzed fruit and vegetable samples

Sample	Humidity (%)	Dry matter (%)
P 1	84.038	15.962
P 2	83.072	16.928
P 3	82.144	17.856
P 4	85.78	14.22
P 5	89.572	10.428
P 6	93.86	6.14
P 7	94.65	5.35
P 8	96.133	3.867
P 9	91.22	8.78
P 10	93.972	6.028

According to Griess method, we prepared a series of known concentration solution and draw a calibration curve (fig. 1):

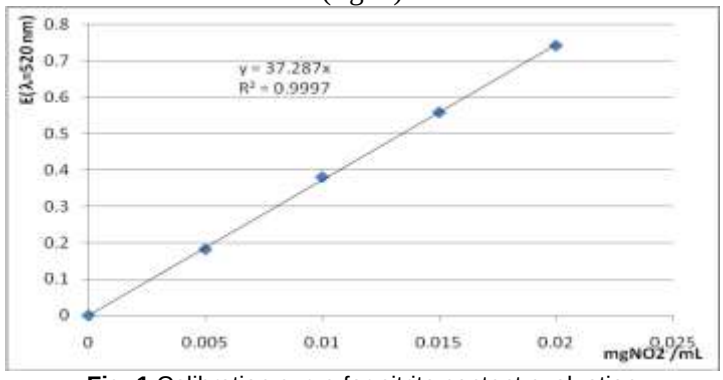
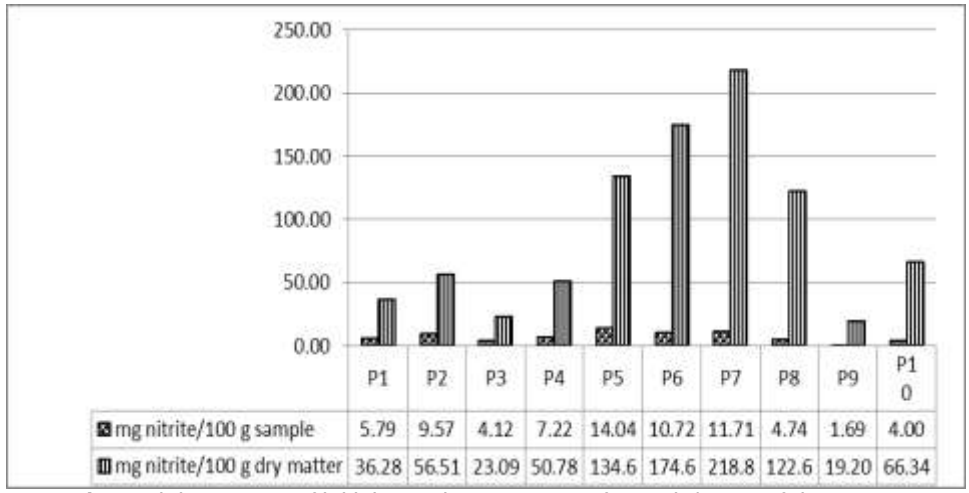


Fig. 1 Calibration curve for nitrite content evaluation

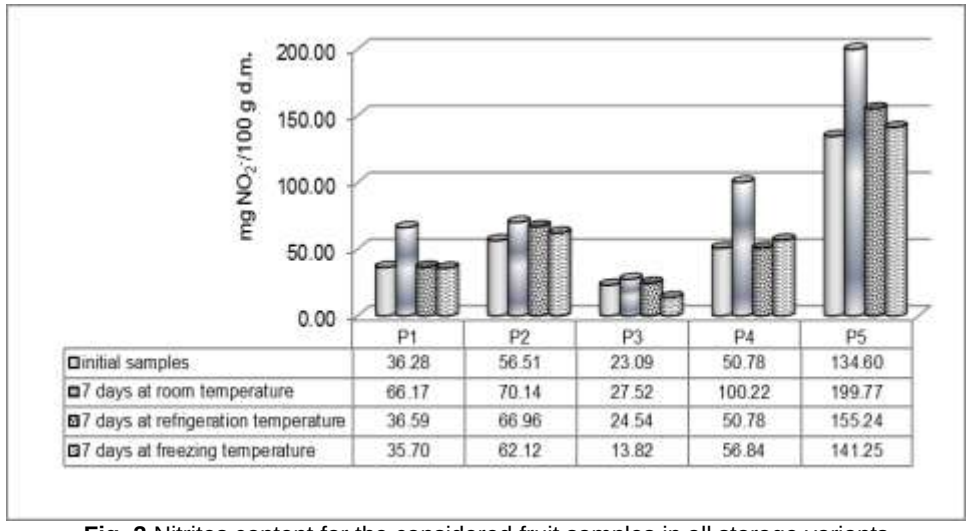


	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
mg nitrite/100 g sample	5.79	9.57	4.12	7.22	14.04	10.72	11.71	4.74	1.69	4.00
mg nitrite/100 g dry matter	36.28	56.51	23.09	50.78	134.6	174.6	218.8	122.6	19.20	66.34

Fig. 2 Nitrite content of initial samples per 100 g of sample/100 g of dry matter

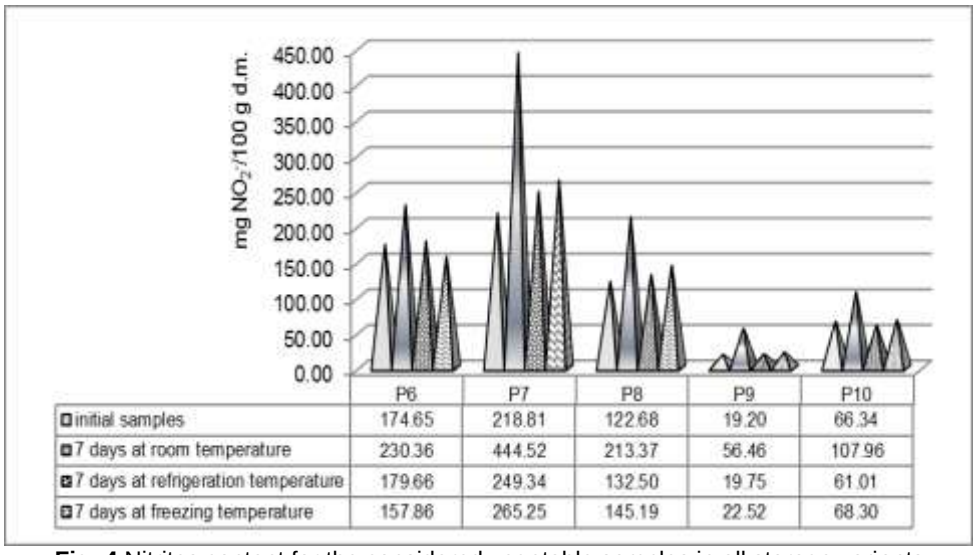
As shown in figure 2, in what regards the fruit samples, the highest value for nitrite content was registered for lemons (P_5) in 100 g dry matter and in normal sample and for the vegetables, the highest value appeared for squash sample (P_7).

We analyzed by comparison the nitrite content of initial samples to those of the samples maintained for 7 days at different storage temperatures (fig. 3 and 4). For all samples, the variant maintained at room temperature showed an increased content of nitrites, while the refrigerated and especially the frozen variants showed very small variations from the initial values.



	P1	P2	P3	P4	P5
initial samples	36.28	56.51	23.09	50.78	134.60
7 days at room temperature	66.17	70.14	27.52	100.22	199.77
7 days at refrigeration temperature	36.59	66.96	24.54	50.78	155.24
7 days at freezing temperature	35.70	62.12	13.82	56.84	141.25

Fig. 3 Nitrites content for the considered fruit samples in all storage variants



	P6	P7	P8	P9	P10
initial samples	174.65	218.81	122.68	19.20	66.34
7 days at room temperature	230.36	444.52	213.37	56.46	107.96
7 days at refrigeration temperature	179.66	249.34	132.50	19.75	61.01
7 days at freezing temperature	157.86	265.25	145.19	22.52	68.30

Fig. 4 Nitrites content for the considered vegetable samples in all storage variants

CONCLUSIONS

1. Dry matter content of the considered fruit samples varied between 10.43 – 17.86% and between 3.87 – 6.14% for the vegetable samples;

2. Observing the samples of fruits initially analyzed, the highest content in nitrites per 100 g dry matter was registered for lemons and the lowest for grapefruits;

3. In what regards the samples of vegetables initially analyzed, the highest content in nitrites per 100 g dry matter was registered for squash and the lowest for yellow onions

4. In the case of both fruit and vegetables, the highest concentrations of nitrites were observed in the case of samples kept at room temperature for 7 days.

5. Both fruits and vegetables are best consumed fresh, of course, but if storage is required, it is preferred to do that in the freezer, at least from the nitrites accumulation point of view.

REFERENCES

1. **Correia M., Â. Barroso, M.F. Barroso, D. Soares, M.B.P.P. Oliveira, C. Delerue-Matos, 2010** - *Contribution of different vegetable types to exogenous nitrate and nitrite exposure*, Food Chem., 120, pp. 960-966;
2. **European Food Safety Authority, 2008** - *Nitrate in vegetables - Scientific Opinion of the Panel on Contaminants in the Food chain,* EFSA Journal, vol. 689, pp.1-7;
3. **Ghasemi A., S. Zahedias, 2013** - *Potential therapeutic effects of nitrate/nitrite and type 2 diabetes mellitus*, Int. J. Endocrinol. Metab., 11, pp. 63-64;
4. **Hord N.G., Y. Tang, N.S. Bryan, 2009** - *Food sources of nitrates and nitrites: the physiologic context for potential health benefits*, Am. J. Clin. Nutr., 90, pp. 1-10;

5. Iammarino M., A. Di Taranto, 2012 - *Nitrite and nitrate in fresh meats: a contribution to the estimation of admissible maximum limits to introduce in directive 95/2/EC*, Int. J. Food Sci. Technol., 47, pp. 1852-1858;

6. Kevil C.G., G.K. Kolluru, C.B. Pattillo, T. Giordano, 2011 - *Inorganic nitrite therapy: historical perspective and future directions*, Free Rad. Biol .Med., 51, pp. 576-593.

7. Reinik M., T. Tamme, M. Roasto, 2009 - *Naturally Occurring Nitrates and Nitrites in Foods*, G. Gilbert, H.Z. Şenyuva (Eds.), Bioactive compounds in foods, Blackwell Publishing Ltd., Oxford, United Kingdom, pp. 225-253;

8. Santamaria P., 2006 - *Nitrate in vegetables: toxicity, content: intake and EC regulation*, J. Sci. Food Agric., 86, pp. 10-17);

9. Walters C.L., M.J. Hill (Ed.), 1996 - *Nitrates and Nitrites in Food and Water* (2nd Edition), Woodhead Publishing Ltd., Cambridge, England, pp. 93-112);

ANTIOXIDANT AND CHROMATIC CHARACTERIZATION OF PHENOLIC CONTENT IN RED CABBAGE

CARACTERIZAREA ANTIOXIDANTĂ ŞI CROMATICĂ A CONŢINUTULUI FENOLIC DIN VARZA ROŞIE

PATRAŞ Antoanela*[1]
*Corresponding author e-mail: apatras@uaiasi.ro

Abstract. *Red cabbage is a widely consumed vegetable, with a high content of health-promoting compounds: minerals, vitamins, phenols and glucosinolates. The phenols group is very well represented and includes, among others, the anthocyanin pigments, which are responsible for the specific colour of red cabbage. The present research analyses the total and individual phenolic content (measured spectrophotometrically and, respective, by HPLC), the total and monomeric anthocyanins content, the chromatic parameters (colour density, polymeric colour, percent of polymeric colour, browning index, the CIELab colour parameters: lightness, green/red colour component, blue/yellow colour component, colour intensity, tone), the antioxidant activity, as well as the pH of an ethanolic red cabbage extract. The results revealed a high content of phenolic compounds and an important antioxidant activity. The main phenols identified are: gallic acid, ellagic acid, procyanidin B1, m-hydroxybenzoic acid, ferulic acid and protocatechuic acid. The results proved an important quantity of anthocyanins, of which 82.59% are monomeric. The values of polymeric colour, percent of polymeric colour and browning index confirm the preponderance of monomeric phenols in the studied red cabbage extract.*
Key words: colour, antioxidant activity, anthocyanins

Rezumat. *Varza roşie este o legumă consumată pe scară largă, cu un conţinut ridicat de compuşi benefici sănătăţii: minerale, vitamine, fenoli şi glucozinolaţi. Grupa fenolilor este foarte bine reprezentată şi include, printre altele, pigmenţii antocianici, care sunt responsabili pentru culoarea specifică a varzei roşii. Prezenta cercetare analizează conţinutul fenolic total şi individual (măsurat spectrofotometric şi, respectiv, prin HPLC), conţinutul de antociani totali şi monomerici, parametrii cromatici (densitatea culorii, culoarea polimerică, procentul culorii polimerice, indicele de brunificare, parametrii de culoare CIELab: luminozitate, componentă de culoare verde/roşu, componentă de culoare albastru/galben, intensitatea culorii, tonul), activitatea antioxidantă, precum şi pH-ul unui extract etanolic de varză roşie. Rezultatele au relevat un conţinut ridicat de compuşi fenolici şi o activitate antioxidantă importantă. Principalii fenoli identificaţi sunt: acidul galic, acidul elagic, procianidina B1, acidul m-hidroxibenzoic, acidul ferulic şi acidul protocatehic. Rezultatele au dovedit o cantitate importantă de antociani, din care 82,59% sunt monomeri. Valorile culorii polimerice, procentul culorii polimerice şi indicele de brunificare confirmă preponderenţa fenolilor monomerici în extractul de varză roşie studiat.*
Cuvinte cheie: culoare, activitate antioxidantă, antociani

[1]University of Agricultural Sciences and Veterinary Medicine Iasi, Romania

INTRODUCTION

Red cabbage (*Brassica oleracea* L., convar. *capitata* (L.) Alef, var. *rubra* DC) is a widespread variety of cruciferous vegetable. It is rich in bioactive compounds with antioxidant and health-promoting properties, which reduce the risk of cancer, cardiovascular and degenerative diseases (Cruz *et al.,* 2016; Jahangir *et al.,* 2009; Kristal and Lampe, 2002). The main bioactive compounds are phenolics and glucosinolates. Within phenol group can be mentioned flavonoids and non-flavonoids as phenolic acids, cinnamic acids, stilbenes. The profile of red cabbage's flavonoids is complex and a special importance have the anthocyanin pigments. Anthocyanins are responsible for the colour of fruits, vegetables and flowers, exhibiting different colours from nuances of red, to magenta, violet, or blue, depending on the physiological pH (Mazza and Miniati, 1993). The colours are due to the structure adopted by this heterocyclic compounds at various pHs, e.g. the flavylium cation (pH 1-3) is red, the quinonoidal base (pH 6-7) is violet, the anionic quinonoidal base (pH 7-8) is blue (Castaneda-Ovando *et al*., 2009; Patras *et al.,* 1995).

The present research is analysing the red cabbage from the point of view of phenolic content, antioxidant activity and chromatic parameters.

MATERIAL AND METHOD

The studied red cabbage material is represented by the variety Red Dynasty F1, from a private producer. The extraction of phenolic compounds, with 60% ethanol, was performed for 30 min on water bath at 40 °C and was followed by filtration. The ratio mass of plant material/volume of solvent = 1 g/10 mL.

The dry weight was determined gravimetrically and the pH was measured with the WTW portable pH-meter 330i.

Total phenolic content, TPC, was analysed spectrophotometrically using Folin-Ciocalteu method, according to Ribereau-Gayon *et al.* (2006), and the result was expressed as mg gallic acid equivalents/100 g fresh weight (FW).

Total (TAC) and monomeric anthocyanins contents (MAC) were determined by pH-differential method, following the procedure presented by Giusti and Wrolstad (Giusti and Wrolstad, 2001) and expressed as mg cyanidin-3-glucoside/100 g FW.

The contents of individual phenols were measured by HPLC, following the procedure described by Cristea *et al*., (2019), and expressed as mg/100 g FW.

CIELab colour parameters (lightness, clarity or luminosity, L*; green/red colour component, a*; blue/yellow colour component, b*; chroma or colour intensity, C*; tone or hue angle, H*) were determined according to the method OIV-MA-AS2-11 (2006).

Other measured chromatic parameters are: colour density (CD), polymeric colour (PC), percent of polymeric colour (PPC) and browning index (BI), which were analysed using the metabisulfite-bleaching method (Giusti and Wrolstad, 2001).

The antioxidant activity, AA, was measured by ABTS radical scavenging method (Re *et al*., 1999) and expressed as µmol trolox equivalents/100 g FW.

All spectrophotometric analyses were performed using the Specord 200 Plus spectrophotometer.

The obtained results are means of 3 measurements of samples resulting from 3 different extractions.

RESULTS AND DISCUSSIONS

The dry weight of red cabbage was 8.19 ± 0.51 % and the pH of fresh extracts had an average value of 6.29 ± 0.03.

Table 1 presents the total phenolics, total and monomeric anthocyanins contents, antioxidant activity and the main individual phenolics identified by HPLC analysis.

Table 1

Phenolic compounds (groups and individuals) and antioxidant activity of 100 g fresh red cabbage

phenolic compounds/ antioxidant activity	value
total phenolic content	194.30 ± 1.89
total anthocyanins	123.15 ± 3.70
monomeric anthocyanins	101.71 ± 2.55
gallic acid	36.21 ± 1.79
ellagic acid	28.7 ± 1.03
procyanidin B1	12.02 ± 0.93
m-hydroxybenzoic acid	2.09 ± 0.09
ferulic acid	1.99 ± 0.14
protocatechuic acid	1.58 ± 0.07
antioxidant activity	1092.78 ± 48.08

The results proved a high antioxidant activity (more than 1000 µmol trolox equivalents/100 g) of Red Dynasty F1 cabbage, comparable to the value obtained by Podsędek *et al.* in red cabbage cv. Koda, cultivated in the central region of Poland (1418 µmol trolox equivalents/100 g) (Podsędek *et al.*, 2014). The differences, apart from the cultivar and pedo-climatic conditions, may result from the fact that the methods of extraction and the used solvents are not identical.

The obtained content of total phenolics (194.3 mg GAE/100 g FW) is higher than the result of Marinova *et al.*, who obtained 139.3 mg GAE/100 g FW by analysing red cabbage from Bulgarian market (Marinova *et al.*, 2005).

The HPLC analysis showed important quantities of gallic acid, ellagic acid, procyanidin B1, m-hydroxybenzoic acid, ferulic and protocatechuic acids. The procyanidin B2, p-hydroxybenzoic, syringic, p-coumaric, salycilic, caffeic or sinapic acids, as well as cis- and trans-resveratrol, quercetin, morin and rutin were not identified in our samples (data not shown).

An important part of TPC is represented by the anthocyanin pigments, which are responsible for the specific colour of red cabbage. The obtained total anthocyanins content is 123.15 mg cyanidin-3-glucoside/100 g FW, of which 82.59% are monomeric anthocyanins (101.71 mg cyanidin-3-glucoside/100 g FW).

Table 2 presents the main chromatic parameters, including the CIELab colour parameters of the hydroethanolic extract of red cabbage with a pH of 6.29.

Table 2

Chromatic parameters of red cabbage extracts at pH 6.29

chromatic parameter	value
colour density	3.02±0.08
polymeric colour	0.19±0.005
percent of polymeric colour	6.31±0.21
browning index	0.0143±0.0004
lightness (luminosity, L*)	78.66±0.57
green/red colour component (a*)	18.69±0.53
blue/yellow colour component (b*)	-11.85±0.49
tone (hue angle, H*)	-1.36±0.03
chroma (colour intensity, C*)	22.13±0.70

The colour density (CD) is due especially to the concentration of pigments in solution. The obtained value (CD=3.02) is similar to the CD=2.86, obtained in other study (Patras, 2019) dealing with red cabbage waste extracts of same concentration (1 g plant material/10 mL hydroethanolic solvent), even if the concentration of the extraction solution was not 60% ethanol, as in the present study, and the plant material and all extraction procedure were different.

The small value obtained for the polymeric colour (PC=0.19) and the low percent of polymeric colour (PPC=6.31%) confirm that monomeric phenols are predominant in the studied extract, and not the polymerized ones (tannins) or brown compounds. The browning index (BI) is reflecting the content in brown compounds, and the very small value (BI=0.0143) prove the absence of products issued from enzymatic browning.

The analysed CIELab parameters of the red cabbage's hydroethanolic extract at pH 6.29 explain which, exactly, are the chromatic components of the observed magenta colour of the extract. It is known that at pH 6-7, the predominant form of the anthocyanins is the quinonoidal base, which has a violet colour. The lightness, clarity or luminosity of the extract (L*=78.66) is not far from white (which has L*=100, while L*=0 has the meaning of black). The green/red colour component, a*, prove the red nuances of the extract at pH 6.29, as it has a positive value (a*=18.69) and it is known, according to the International Commission on Illumination (Commission Internationale de l'Eclairage), that positive numbers indicate red shades, while negative indicate green shades (OIV-MA-AS2-11: R2006). The blue/yellow colour component, b* has a negative value (b*= -11.85), which indicates blue shades, while positive values of b* indicate yellow shades. The chroma or colour intensity, C*=22.13, shows a rather unsaturated colour, as it is closer to 0 (which reflects completely unsaturated colour) and not to 100 (which reflects pure colour). The hue angle, H*= -1.36, is expressed in radians in present study, and indicates the tone of the colour.

CONCLUSIONS

1. The present research revealed that the red cabbage has a high content of phenolic compounds and an important antioxidant activity.
2. The main phenols identified by the HPLC analysis are: gallic acid, ellagic acid, procyanidin B1, m-hydroxybenzoic acid, ferulic acid and protocatechuic acid.
3. An important quantity of anthocyanins, of which 82.59% are monomeric, was revealed.
4. The values of polymeric colour, percent of polymeric colour and browning index confirm the preponderance of monomeric phenols in the studied red cabbage extract and an insignificant quantity of brown compounds.
5. The CIELab colour parameters are a very useful instrument for the chromatic characterization of the anthocyanin containing extracts, as it is known that the colour of these pigments is highly influenced by the pH.

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REFERENCES

1. Castaneda-Ovando A., de Lourdes Pacheco-Hernandez M., Paez-Hernandez M. E., Rodriguez J. A., Galan-Vidal C. A., 2009 - *Chemical studies of anthocyanins: A review.* Food Chemistry, 113(4), p. 859–871.

2. Cristea E., Sturza R., Jauragi P., Niculaua M., Ghendov-Moşanu A., Patras A., 2019 - *Influence of pH and ionic strength on the colour parameters and antioxidant properties of an ethanolic red grape marc extract*. Journal of Food Biochemistry, 43 (4):e12788.

3. Cruz A. B., Pitz H. D. S., Veber B., Bini L. A., Maraschin M., Zeni A. L. B., 2016 - *Assessment of bioactive metabolites and hypolipidemic effect of polyphenolic-rich red cabbage extract.* Pharmaceutical Biology, 54(12), p. 3033-3039.

4. Giusti M. M., Wrolstad R. E., 2001 - *Characterization and measurement of anthocyanins by UV-visible spectroscopy.* Current Protocols in Food Analytical Chemistry, F1.2.1–F1.2.13

5. Jahangir M., Kim H. K., Choi Y. H., Verpoorte R., 2009 - *Health-affecting compounds in Brassicaceae.* Comprehensive Reviews in Food Science and Food Safety, 8(2), p. 31-43.

6. Kristal A. R., Lampe J. W., 2002 - *Brassica vegetables and prostate cancer risk: a review of the epidemiological evidence*. Nutrition and cancer, 42(1), p. 1-9.

7. Marinova D., Ribarova F., Atanassova M., 2005 - *Total phenolics and total flavonoids in Bulgarian fruits and vegetables*. Journal of the University of Chemical Technology and Metallurgy, 40(3), p. 255-260.

8. Mazza G., Miniati E., 1993 - *Anthocyanins in fruits, vegetables, and grains.* CRC press, Chapters 10, 11

9. Patras A., 2019 - *Stability and colour evaluation of red cabbage waste hydroethanolic extract in presence of different food additives or ingredients.* Food Chemistry, 275, p. 539-548.

10. Patras A., Tibirna C., Cotea V., Odageriu Gh., 1995 - *Aspects concerning equilibrium kinetics of anthocyanins tautomer forms influenced by pH.* Scientific Papers

University of Agricultural Sciences and Veterinary Medicine of Iasi, Series Horticulture, 38, 254–259

11. **Podsędek A., Redzynia M., Klewicka E., Koziołkiewicz M., 2014** - *Matrix effects on the stability and antioxidant activity of red cabbage anthocyanins under simulated gastrointestinal digestion*. BioMed Research International, available on-line at: https://www.hindawi.com/journals/bmri/2014/365738/.
12. **Re R., Pellegrini N., Proteggente A., Pannala A., Yang M., Rice-Evans C., 1999** - *Antioxidant activity applying an improved ABTS radical cation decolourization assay.* Free Radical Biology and Medicine, 26(9), p. 1231–1237.
13. **Ribereau-Gayon P., Glories Y., Maujean A., Dubourdieu D., 2006** - *Handbook of enology: The chemistry of wine stabilization and treatments*, 2nd ed.; John Wiley and Sons Ltd.: Chichester, UK, Vol. 2, p. 171–174.
14. *****, 2013** - *Method OIV-MA-AS2-11: R2006, Determination of chromatic characteristics according to CIELab*. Compendium of International Methods of Wine and Must Analysis, International Organisation of Vine and Wine, Paris, Vol. 1

DYNAMICS OF VITAMIN C CONTENT DURING THE TECHNOLOGICAL PROCESSES OF "ROMANIAN PEPPERS IN VINEGAR" FABRICATION

DINAMICA VARIAȚIEI CONȚINUTULUI DE VITAMINA C PE PARCURSUL PROCESELOR TEHNOLOGICE DE FABRICARE A PRODUSULUI „GOGOŞARI ÎN OȚET"

PATRAŞ Antoanela[1]*, BĂETU Alina Loredana, BĂETU M. M.[1]
*Corresponding author e-mail: apatras@uaiasi.ro

Abstract. *The content of vitamin C in processed horticultural products is influenced by multiple factors. Besides the factors concerning the raw material (cultivar, climatic conditions, agricultural practices, harvesting and storage techniques), the processing and preservation technologies are essential. The objective of the present study is to analyse the variation of vitamin C content during the technological processes of obtaining the product "Romanian peppers in vinegar". The samples from 5 different steps of the technological flow were supplied by a company for processing vegetables and fruits (S.C. Contec Foods S.R.L. Tecuci), during two consecutive years. The finished product was also analysed after storage at two temperatures (10 °C and 25 °C), by using two different methods for vitamin C assessment. The results proved that vitamin C content decreased by 76% during the technological flow. All technological phases decreased the content of ascorbic acid, but the most important reduction was registered after the thermal processing (blanching and pasteurization). The storage of the finished product for 3 months determined the diminution of vitamin C content: at 10 ºC by 5% and at 25 ºC by 14%.*
Key words: ascorbic acid, technological flow, storage, temperature, *Capsicum annuum Gogoscharii*

Rezumat. *Conținutul de vitamină C al produselor horticole procesate este influențat de numeroşi factori. În afara factorilor privind materia primă (soiul, condițiile climatice, practicile agricole, tehnicile de recoltare şi păstrare), tehnologiile de procesare şi conservare sunt esențiale. Obiectivul prezentului studiu este analiza variației conținutului de vitamină C pe parcursul proceselor tehnologice de obținere a produsului „Gogoşari în oțet". Probele din 5 stadii diferite ale procesului tehnologic au fost furnizate de o companie de procesare a legumelor şi fructelor (S.C. Contec Foods S.R.L. Tecuci), pe parcursul a doi ani consecutivi. Produsul finit a fost, de asemenea, analizat după păstrarea la două temperaturi (10 °C şi 25 °C), folosind două metode diferite pentru determinarea vitaminei C. Rezultatele au dovedit scăderea conținutului de vitamină C cu 76% pe parcursul fluxului tehnologic. Toate etapele tehnologice au scăzut conținutul de acid ascorbic, dar cea mai importantă reducere a fost înregistrată după procesarea termică (blanşare şi pasteurizare). Păstrarea*

[1]University of Agricultural Sciences and Veterinary Medicine Iasi, Romania

produsului finit timp de 3 luni a determinat diminuarea conținutui de vitamină C: la 10 °C cu 5% şi la 25 °C cu 14%.

Cuvinte cheie: acid ascorbic, flux tehnologic, păstrare, temperature, *Capsicum annuum Gogoscharii*

INTRODUCTION

The Romanian pepper (*Capsicum annuum Gogoscharii*) is a sweet pepper and a bell pepper representative only for a group of countries: Romania, Republic of Moldova, Republic of Bulgaria, Hungary and Republic of Serbia. It is rich in antioxidants as vitamin C, polyphenols, but also in vitamins A, B (including B_9 or folic acid) and iron, potassium, magnesium, zinc, selenium (https://www.horticultorul.ro/legume/gogosarul/).

The vitamin C or ascorbic acid is necessary for the good function of human body, and at under-normal level, metabolic disorders are registered, e.g. in the biosynthesis of collagen, carnitine and some neurotransmitters or in the iron absorption during digestion. Also, the immunity response is affected and the body is more susceptible to influenza virus and to coronavirus COVID-19. This vitamin is an important antioxidant, able to decrease the lipid peroxidation, to reduce the inflammatory response and to manifest anticarcinogenic properties. Being a water-soluble vitamin, it cannot accumulate as deposits in the body, so it needs to be introduced every day from food.

We can find ascorbic acid in fresh vegetables and fruits. In peppers, there is an important quantity of vitamin C which accumulates at early stages of maturation and increases as the pepper reaches maturity (Marin *et al.*, 2004). At maturity, after harvest it registers a constant decrease during storage, which can be delayed at lower temperature. For example, at 20–22 °C, the daily loss of vitamin C is about 1.5%, while at 10 °C the daily diminution is around 0.8% (Cuciureanu, 2010). It is very unstable during any technological process of food preparation and especially at thermal processing (blanching, pasteurisation, etc.).

The present study analyses the changes in total vitamin C content during five different phases of the technological flow of the product "Romanian peppers in vinegar" fabrication. It also compares the ascorbic acid content in the finished product after storage during 3 months at 10 and 25 °C.

MATERIAL AND METHOD

The studied material is represented by 5 phases of the technological flow of "Romanian peppers in vinegar" fabrication: raw material (RM), washed peppers (W), after cutting and removing inedible parts (C), after blanching with hot water at 70 °C for 3 min (B) and the finished product, "Romanian peppers in vinegar", after pasteurisation by maintaining at 95 °C the inside temperature of filled and closed jar for 15 min. From the finished product, two different samples were analysed: the peppers (PFP) and the coating liquid (CL) represented by the vinegar solution enveloping the peppers. In order to assess the stability of ascorbic acid in the finished product, it was analysed after 3 months of storage at 10 and 25 °C. The samples were

supplied during two consecutive years, by the company S.C. Contec Foods S.R.L. Tecuci.

The total vitamin C content (TVCC) was analysed by two methods: the titrimetric assay using 2, 6 dichlorophenol indophenol (2,6 DCFIF) (standards: ISO 6557-2: 1984 and ISO 6557-1: 1986) and the reflectometric assay (RQ) using the Reflectoquant RQFlex from Merck (Eberhardt et al., 2000). Results were expressed as mg/100 g fresh weight and are means of 3 determinations ± standard deviation.

RESULTS AND DISCUSSIONS

Figure 1 presents the total ascorbic acid content (TVCC) during the five phases of the technological flow of "Romanian peppers in vinegar" fabrication (analysed by two methods and during two consecutive years).

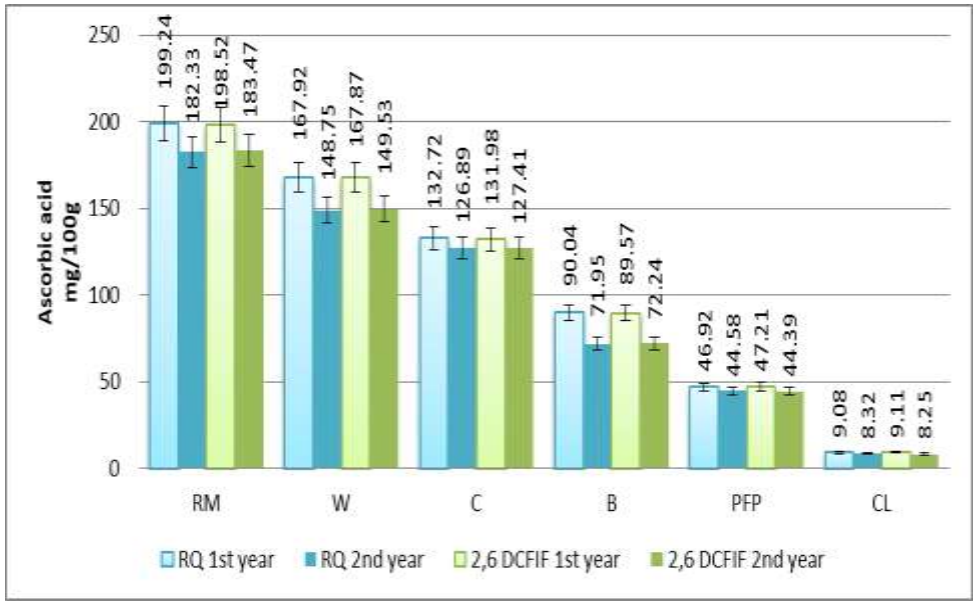

Fig. 1 Dynamics of ascorbic acid content during the technological flow of "Romanian peppers in vinegar" fabrication: raw material (RM), washed peppers (W), after cutting and removing inedible parts (C), after blanching (B), the peppers of finished product (PFP) and the coating liquid (CL) during two different years by 2,6 dichlorophenol indophenol (2,6 DCFIF) and Reflectoquant (RQ) methods. Results are means of 3 determinations ± standard deviation

The two analytical methods (2,6 DCFIF and RQ) gave similar results with insignificant differences. TVCC is smaller in the second year during all steps of processing, due to the quality of the raw material, which contains 8% less vitamin C (around 183 mg/100 g compared to 199 mg/100 g in the first year). This variation may be the consequence of differences concerning pepper cultivar, pedo-climatic conditions, fertilizers and used technologies, harvest procedure and especially, the duration and conditions of storage before processing. Every

procedure decreased the vitamin C content (fig.1): washing (W), by 15.6 – 1st year and 18.6% - 2nd year, cutting (C), by 21.1% - 1st year and 14.8% – 2nd year, blanching (B), by 31.8% - 1st year and 43.3% - 2nd year, pasteurization to obtain the finished product, by 47.8% - 1st year and 38.2% - 2nd year. As expected, the thermal procedures (blanching and pasteurization) decreased mostly TVCC, between 31 - 48%. The vitamin C content in the peppers of finished product had a mean value of 46 mg/100 g (which represent about 24% of the initial TVCC) and in the coating liquid, of 9 mg/100 g (less than 5% of initial TVCC). So, more than 71% of the initial quantity of ascorbic acid (of RM) is lost during the technological flow.

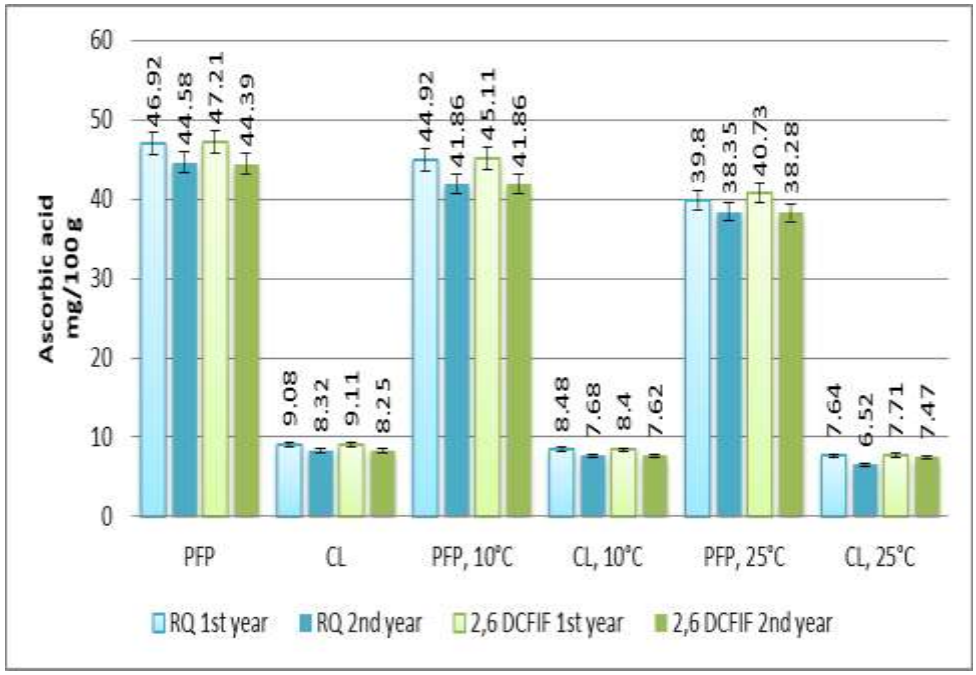

Fig. 2 The ascorbic acid content after 3 months of storage of the finished product at 10 and 25 °C, in the peppers of finished product (PFP) and in the coating liquid (CL) - samples from two different years, assessed by 2,6 dichlorophenol indophenol (2,6 DCFIF) and Reflectoquant (RQ) methods - Results are means of 3 determinations ± standard deviation

The 3 months storage of the finished product diminished the TVCC of peppers by 5.1% at 10 °C (final mean content of 43.44 mg/100 g) and by 14.2% at 25 °C (final mean content of 39.29 mg/100 g). The TVCC of coating liquid was decreased by 7.4% at 10 °C (final mean content of 8.05 mg/100 g) and by 15.6% at 25 °C (final mean content of 7.34 mg/100 g) (fig. 2).

Very similar results were obtained in previous study (Patraş *et al.*, 2018) concerning the technological flow of "Cauliflower in vinegar" fabrication. It was stated that the finished product had 22 - 25% of the initial cauliflower's ascorbic

acid and the most important losses were due also to blanching and pasteurization. It is to be mentioned that the initial TVCC of cauliflower was only 70 – 74 mg/100 g, while Romanian peppers in present research have 182 – 199 mg/100 g. The finished product "Cauliflower in vinegar" had TVCC of 16 – 18 mg/100 g (and the coating liquid around 6 mg/100 g), while in the present study, the "Romanian peppers in vinegar" have 44 – 47 mg/100 g (and the coating liquid 8 – 9 mg/100 g). Also, during the storage of finished product was noticed similar behaviour (Patraş *et al.,* 2018).

Thoroughgoing studies are necessary in order to establish the detailed evolution of vitamin C during the technological processes (including the interconversion of different forms of ascorbic acid) and all compounds issued by its degradation.

CONCLUSIONS

1. The vitamin C content of the raw material decreased by 76% during the technological flow of "Romanian peppers in vinegar" fabrication (almost 5% of the initial vitamin C was found in the coating liquid, while 71% was lost).

2. All technological phases decreased the content of ascorbic acid, but the most important reduction was registered after the thermal processing: blanching (31.8% - 1st year and 43.3% - 2nd year), and pasteurization for the obtaining of finished product (47.8% - 1st year and 38.2% - 2nd year).

3. The storage of the finished product for 3 months determined the diminution of vitamin C content at both temperatures. The storage at 10 ºC decreased the ascorbic acid content in Romanian peppers by 5% and the storage at 25 ºC, by 14%.

***Acknowledgments**: The author would like to thank the Francophone University Agency (AUF) and the S.C. Contec Foods S.R.L. Tecuci for the analysed samples.*

REFERENCES

1. Cuciureanu R., 2010 - *Igiena alimentului*, Editura Performantica, Iaşi, p.63.

2. Eberhardt M.V., Lee C.Y., Liu R.H., 2000 - *Nutrition: antioxidant activity of fresh apples.* Nature, 2000, 405 (6789), p. 903-904.

3. Marín A., Ferreres F., Tomás-Barberán F. A., Gil M. I., 2004 - *Characterization and quantitation of antioxidant constituents of sweet pepper (Capsicum annuum L.).* Journal of Agricultural and Food Chemistry, 52(12), p. 3861-3869.

4. Patraş A., Băetu M., Băetu A. L., 2018 - *Stability of the ascorbic acid content during the technological flow of the product "Cauliflower in vinegar".* Lucrări Ştiinţifice, Universitatea de Ştiinţe Agricole şi Medicină Veterinară "Ion Ionescu de la Brad" Iaşi, Seria Horticultură, 61(2), p. 467-470.

5. *, 1984,** *ISO 6557-2:1984, Fruits, vegetables and derived products - Determination of ascorbic acid content - Part 2: Routine methods,* Standard de stat România. https://www.iso.org/standard/12957.html.

6. *, 1986,** *ISO 6557-1:1986, Fruits, vegetables and derived products - Determination of ascorbic acid - Part 1: Reference methods,* Standard de stat România. https://www.iso.org/standard/12956.html

7. *,** https://www.horticultorul.ro/legume/gogosarul/

GRAVITATIONAL ANALYSES APPLIED TO PROTOBIND 1000 LIGNIN

ANALIZE GRAVITAȚIONALE APLICATE LA LIGNINA PROTOBIND 1000

UNGUREANU Elena[1*], UNGUREANU O.C.[2], TROFIN Alina[1]
ARITON Adina-Mirela[3], JITĂREANU Carmenica Doina[1], POPA V.I.[4]
*Corresponding author e-mail: eungureanu@uaiasi.ro

Abstract. *Lignin derivative (the commercial product - Protobind 1000) offered by the Granit Recherche Developement S.A. company, Lausanne-Schwitzerland was synthesized from annual plants. The lignin stands out by a very large range of applications in extremely various domains: agriculture, the pulp and paper industry, constructions or metallurgy. The adsorption-desorption capacity, ion exchange capacity and its catalytic properties are just a few specific characteristics which are emphasizing the importance of harnessing the lignins. Using the gravitational sedimentation, it can be determined in a shorter period of time the particle dimensions comparing with the sieving method, which is a much more complex one.*
Key words: sedomentometrical analyses, Protobind 1000 lignin, density, pycnometer, sedomentometrical curves.

Rezumat. *Lignina derivativă (produsul comercial Protobind 1000) oferită de firma Granit Recherche Developement S.A. Lausanne-Elveția a fost sintetizată din plante anuale. Lignina se remarcă printr-o gamă largă de aplicații în domenii extrem de diverse: agricultură, industria celulozei şi hârtiei, construcții, sau metalurgie. Capacitatea de absorbție-desorbție, capacitatea de schimb ionic, proprietățile catalitice sunt doar câteva repere specifice care recomandă şi evidențiază importanța valorificării ligninelor. Utilizând sedimentarea în câmp gravitațional, se pot evalua într-un timp mult mai scurt dimensiunile granulelor comparativ cu evaluarea prin sitare, operație ce este mult mai laborioasă.*
Cuvinte cheie: analize sedimentometrice, lignină Protobind 1000, densitate, picnometru, curbe sedimentometrice.

INTRODUCTION

In the last decades, research within the field of lignin has not sought only perfection of extraction processes, but also elucidation of structures of products separated from various vegetal sources, chemical characterization, reactivity, functional properties and developing new applications. (Ungureanu *et al,* 2009).

[1]University of Agricultural Sciences and Veterinary Medicine of Iasi, Romania
[2] "V.Goldiş" West University of Arad, Romania
[3] Station for Cattle Breedind, Dancu, Iasi, Romania
[4] "Gh. Asachi" Technical University of Iasi, Romania.

At a global level, lignin resulted from cellulose fabrication or technologies of hydrolysis of vegetal mass can be considered as raw material with high capitalization potential, because of its provenience from regenerating sources and due to reduced price. Lignin is a macromolecular compound, much more active than cellulose or other natural polymers, due to functional groups contained in its macromolecule, constituting the main aromatic component of vegetal tissues, standing for 20%-30% of the mass at superior plants, where it is present within the cellular membrane and in intercellular spaces (Popa, 2015, 2016).

Due to its regeneration, capacity through photosynthesis, vegetal biomass and its components (including lignin) will become in the future sources of raw material with a high degree of capitalization.

Nowadays, it is important to replace synthetic wood preservatives by more environmentally friendly natural products. Furthermore, there is an enormous problem about the elimination of the vegetal waste from the agricultural, forest, pulp and food industries. Thus to obtain new natural wood preservatives from these residues is increasing (Mansouri et al, 2006).

At the same time the application of copper compounds in wood protection, due to their fungicidal activity is known for a long time. Although such protection is very commonly used, the mode of copper action and its way of binding to wood are still to be established accurately. Possible binding site for copper is lignin, due to several different functional groups present in its structure and its abundance in wood (Ungureanu, 2011).

MATERIAL AND METHOD

The following materials have been used:

- Protobind 1000 (Pb1000), commercial lignin offered by Granit Recherché Dévelopement Switzerland, with the following chemical characteristics presented in table 1;

Table 1

The characteristics Protobind 1000

Characteristics	(Pb1000)
Solide, %	97.5-98.6
Ash, %	1.4-1.8
pH (10 % dispersion)	~ 3.5
Densitatea, g/mL	~ 0.3
Aromatic OH, mmole/g	1.8-1.9
COOH, mmole/g	2.1-2.3
T softening, °C	~ 200
Solubility in furfuryl alcohol, %	40.1

- RS-71 Tensio-tixometer gravimetric sedimentation balance;
- Steel ball crusher;
- Toluene;
- Distilled water.

Methods

- picnometer method;
- gravitational sedimentometrical method.

Work procedure*:* 45 g of Protobind 1000 were weighed, crushed for 30 min. and dissolved in 1L of distilled water.

The electrostatic forces of attraction between the hydroxylic groups of the lignin and the dipoles of the dissociated water are so powerful that a colloidal-hydric aggregate is formed and its volume is smaller that the sum of volumes that interact (water-lignin). Experimental data were statistically processed with the aid of the *Unscrambler* application.

RESULTS AND DISCUSSIONS

Based on the standard curve (fig.1) 10 sedimentation curves were plotted according to the dependence q(g) = f(t, s), and the experimental data are also listed in tables.

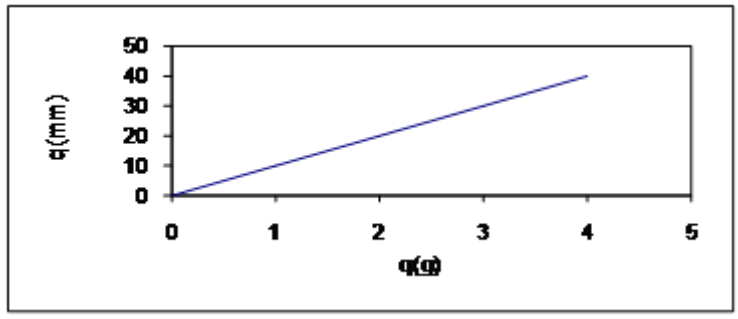

Fig. 1 The standard curve

10 sedimentation curves in q(mm) = f(t, s) coordinates were obtained using RS-71 Tensio-tixometer under constant conditions (mass lignin = 45 g/L water).

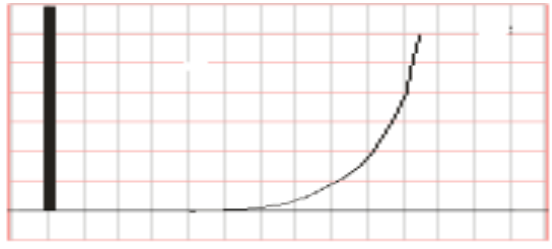

Fig. 2 Exemple of sedimentation curve

These sedimentation curves were also listed in table 2.

Table 2

Parameter values of the sedimentation curves

No det.	t (mm)	t (sec)	q (mm)	q (g)
1	3	7.85	3,5	0,25
2	6	15.7	5.2	0.42
3	9	23.49	7.0	0.58
4	12	31.40	8.1	0.61
5	15	39.25	9.0	0.73
6	18	47.10	10.7	0.83
7	21	54.95	11.1	0.85
8	24	62.80	11.3	0.84
9	27	70.65	12.1	0.91
10	30	78.50	12.6	0,98
11	33	86.35	12.7	0,98
12	36	94.20	13.0	1.02
13	39	102.05	13.6	1.025
14	42	109.90	13.6	1.04
15	45	117.75	14.1	1.10
16	48	125.60	14.1	1.10
17	51	133.45	14.5	1.16
18	54	141.30	14.5	1.16
19	57	149.15	15.0	1.17
20	60	157.00	15.0	1.17

Further on it was obtained the most expected sedimentation curve plotting the values of sediment quantity, q(g) and time t(s), for the reproductible measurements (2, 3, 4, 5, 9) (fig. 3).

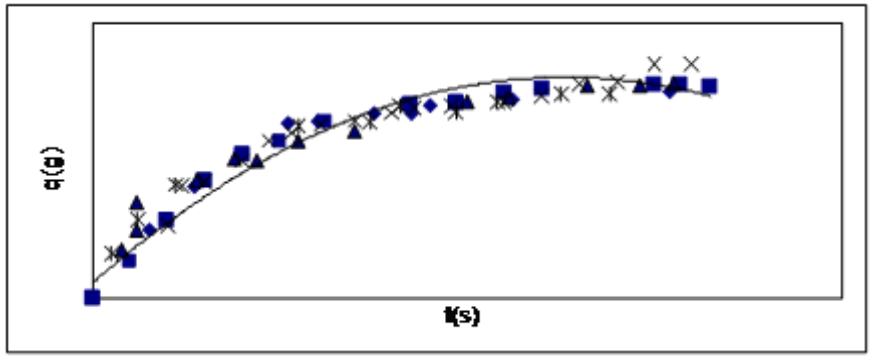

Fig. 3 General sedimentation curve

Measurements 1, 6, 7 and 10 are not reproductible due to a non-uniform distribution of the scattered particles obtained before the recordings (fig. 4a. and b.).

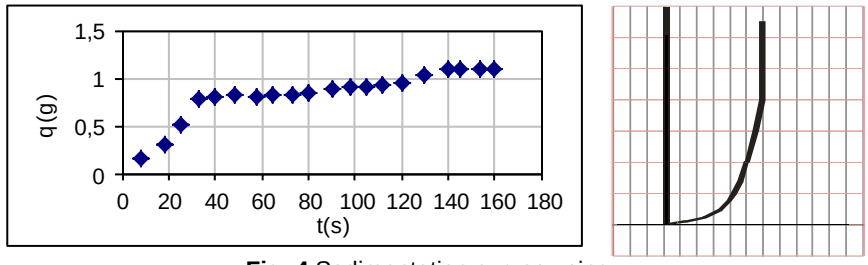

Fig. 4 Sedimentation curves using:
a. q(g) = f(t, s) dependence b. tensio-tixometer q(mm) = f(t, min.) dependence

Based on the general theory of sedimentation in gravimetric field of micro-heterogeneous systems, the radius boundaries of the scattered particles in ground lignin were evaluated. According to the determinations performed the amount of deposited lignin was Q = 1.18 g. In order to determine the density of lignin, the picnometer method was employed. In table 3 are presented the values obtained experimentally by weighing or theoretically determined.

Table 3

Density of lignin measured by picnometer method

m_1 (g)	m_2 (g)	m_3 (g)	m_4 (g)
13.6512	14.6512	23.0627	22.0627
13.6512	14.6514	23.0603	22.0600
13.6512	14.6502	23.0631	22.0632

m_1 – empty pycnometer mass; m_2 – pycnometer mass + solid; m_3 – pycnometer mass + solid + liquid; m_4 – pycnometer mass + liquid (toluene); ρ_s - solid density

By graphical derivation of the sedimentation curve (fig.2), the sedimentation rates were obtained at certain periods of time, t = 0, 14, 30, 70, 80, 90, 100, 105 s. These rates were used to determine various fractions radii of the disperse system (tab. 4).

Table 4

Sedimentation rates corresponding to the most expected sedimentation curve for the reproductible results

Time (s)	Sediment quantity (g)	Sedimentation rates (mm/s)
0	0	0.0360
14	0.22	0.0164
30	0.65	0.0141
70	0.91	0.0033
80	0.96	0.0029
90	1.02	0.0017
100	1.03	0.0012
105	1.04	0.0141

Based on the resulted sedimentation rates, the particle radii of lignin were obtained (tab. 5).

Table 5

Values of disperse particle radii of lignin obtained by sedimentation in gravitational field

Fractions number	Dimension of superior and inferior sieve mesh (mm)	Diameter a_i (mm)	Beam r_i (mm)	
			By rieving	By sedimentation gravitational feils
1	1.23 – 1.11	1.124	0.561	-
2	1.0 – 0.04	0.813	0.403	0.3200 (0)
3	0.64 – 0.22	0.440	0.211	0.1571 (14)
4	0.25 – 0.20	0.221	0.112	0.1400 (30)
5	0.21 – 0.126	0.162	0.0810	0.0742 (70)
6	0.17 – 0.11	0.131	0.0648	0.0629 (80)
7	0.10 – 0.08	0.098	0.0479	0.0522 (90)
8	0,08 – 0.07	0.084	0.0426	0.0441 (100)
9	0.07 – 0.06	0.072	0.0362	0.0381 (105

CONCLUSIONS

1. The sedimentometrical method applied in gravitational field confirms that the reproducibility of the experimental data depends on the uniform distribution degree of the analyzed disperse particle.

2. In order to determine the lignin density, the picnometer method was success fully employed.

3. The variation range of the disperse particle radius in ground lignin can be determined either by sieving or by sedimentation in gravitational field.

4. The analysis of the values obtained for particle dimensions of Protobind 1000 lignin using both methods leads to a general conclusion that the obtained data are reproductible.

REFERENCES

1. **Mansouri N.E., El Salvad´o J., 2006 -** *Structural characterization of technical lignins for the production ofadhesives: Application to lignosulfonate, kraft, soda-anthraquinone, organosolv and ethanol process lignins,* Industrial Crops and Products, 24 (8-16), pp.213.

2. Popa V.I., 2015 - *Wood bark as valuable raw material for compounds with biological activity*, Celuloză şi hârtie, 64 (1), pp. 5-17.

3. **Popa V.I., 2016 -** *An example of biomass valorization as source of energy and chemical products*, Celuloză şi hârtie, 65 (1), pp. 14-21.

4.Ungureanu Elena, Ungureanu O.C., Căpraru Adina-Mirela Popa V.I., 2009 - *Chemical modification and characterization of straw lignin*, Cellul. Chem. Technol., 43 (7-8), pp.261-267.

5.**Ungureanu Elena, 2011** - *Lignina, polimer natural aromatic cu ridicat potențial de valorificare*, Ed. PIM, Iaşi, pp. 112.

HEAVY METALS: A SOURCE OF CONTAMINATION FOR MEDICINAL PLANTS AND POSSIBLE IMPLICATIONS TO HUMAN HEALTH

METALE GRELE: O SURSĂ DE CONTAMINARE PENTRU PLANTELE MEDICINALE ŞI POSIBILE IMPLICAŢII ASUPRA SĂNĂTĂŢII UMANE

ASIMINICESEI Dana Mihaela[1,2*], HLIHOR Raluca Maria[1,2*], GAVRILESCU Maria[1,3*]

*Corresponding author e-mail: dana.asiminicesei@ch.tuiasi.com, raluca.hlihor@uaiasi.ro, mgav@tuiasi.ro

Abstract. *Due to the antioxidant properties of medicinal plants and their beneficial effects on human health, they are used and consumed as natural medical sources. Despite this, due to the current pollution of environmental compartments (soil, water, air), they can be contaminated with various pollutants. Heavy metals are a category of toxic compounds of great interest, due to the negative action on the environment and human health. Although some heavy metals are important in maintaining the proper functioning of plants, in high concentrations, they can become toxic. In the context of heavy metal pollution of the environment and possible contamination of medicinal plants with these pollutants, the need for chemical analysis of toxic plant compounds is necessary. This paper approaches results from literature which show that medicinal plants can be subjected to contamination with heavy metals, and this has the consequence of altering the normal functions of medicinal plants. Moreover, following consumption through the food chain (soil - plant - human or soil - plant - animal - human), human health may be endangered. This paper also investigates the toxic action of heavy metals in plants, represented, in principle, by the production of reactive oxygen species (ROS), enzyme inhibition and damage to antioxidants.*

Key words: abiotic stress, heavy metals, human health risks, pollution, reactive oxygen species

Rezumat. *Datorită proprietăţilor antioxidante ale plantelor medicinale şi efectelor benefice asupra sănătăţii umane, ele sunt utilizate şi consumate ca surse medicale naturale. În ciuda acestui fapt, datorită poluării actuale a compartimentelor de mediu (sol, apă, aer), acestea pot fi contaminate cu diverşi poluanţi. Metalele grele sunt o categorie de compuşi toxici de mare interes, datorită acţiunii negative asupra mediului şi a sănătăţii umane. Deşi unele metale grele sunt importante în menţinerea bunei funcţionări a plantelor, în concentraţii mari, ele pot deveni toxice. În contextul poluării cu metale grele a mediului şi a eventualei contaminări a plantelor medicinale cu aceşti poluanţi,*

[1]"Gheorghe Asachi" Technical University of Iasi, Romania
[2] University of Agricultural Sciences and Veterinary Medicine of Iasi, Romania
[3] Academy of Romanian Scientists, Bucharest, Romania

este necesară analiza chimică a compuşilor toxici ai plantelor. Această lucrare abordează rezultatele din literatura de specialitate care arată că plantele medicinale pot fi supuse contaminării cu metale grele şi acest lucru are drept consecinţă modificarea funcţiilor normale ale plantelor medicinale. Mai mult, în urma consumului prin lanţul alimentar (sol - plantă - om sau sol - plantă - animal - om), sănătatea umană poate fi pusă în pericol. Această lucrare investighează, de asemenea, acţiunea toxică a metalelor grele din plante, reprezentată, în principiu, de producerea de specii reactive de oxigen (ROS), inhibarea enzimelor şi deteriorarea antioxidanţilor.

Cuvinte cheie: stres abiotic, metale grele, riscuri pentru sănătatea umană, poluare, specii reactive de oxigen

INTRODUCTION

As a result of pollution, environmental compartments (soil, water and air) are subjected to contamination with various pollutants. Heavy metals are an important category of pollutants with negative effects for the environment and also for the human health. Medicinal plants received a special interest in research due to the complexity of the fields of use in medicine, aromatherapy, perfumes and cosmetics. Phytochemicals contained in medicinal plants, such as polyphenols, tannin, flavonoid and ascorbic acid are functional elements for many human diseases (diabetes and its complications). They have a low cost and, due to their antioxidant and antimicrobial properties, are of great interest for their use as synthetic compounds in pharmaceuticals, perfumery or cosmetics (Neagu *et al.*, 2018; Zhi *et al.*, 2020).

Although medicinal plants contain natural compounds that have effects on the healing process and have the potential to reduce and inhibit inflammatory processes (Ghuman *et al.*, 2019), their development in environments contaminated with heavy metals may reduce the beneficial effect of their use. Heavy metals produce negative changes in the structure of the plant, and by entering into the food chain, human health can be endangered (Asiminicesei *et al.,* 2020; Lajayer *et al.*, 2017).

Considering the above information, the objectives of this paper are: (i) to identify the response of medicinal plants to heavy metal stress, (ii) to show the antioxidant properties of medicinal plants and (iii) make an overview on the implications to human health due to contaminated medicinal plants.

HEAVY METALS STRESS AND THE RESPONSES OF MEDICINAL PLANTS

Although some metals, in low concentrations, are essential for plant growth (Zn, Cr, Mn, Cu), others even in insignificant amounts can be toxic for plant growth and development (Pb, Cd, As, Ni). Negative effects of heavy metals on plants include damage to antioxidants, accumulation of reactive oxygen species (ROS) and enzymatic inhibition (fig. 1). As a result of the contact between the plant and the heavy metal, the metabolic activity of the plant intensifies and

physiological changes occur to combat the toxic action of metals (Anyanwu *et al.*, 2018) (tab. 1).

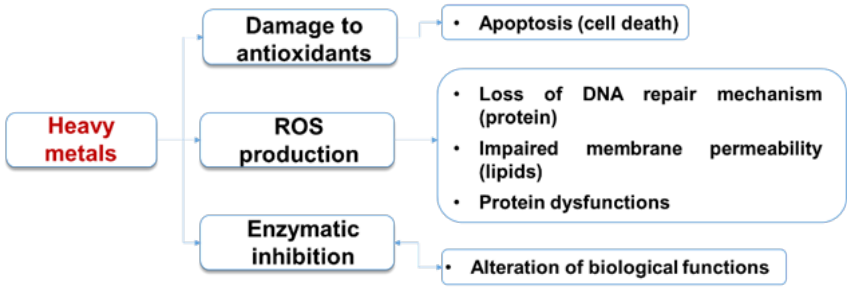

Fig. 1 Heavy metal damage to plant cell

Table 1

The physiological and chemical response of medicinal plants subjected to heavy metals stress (Adapted upon Maleki et al., 2017)

Medicinal plant species	Heavy metal	Concentration	Effects
Allium sativum L. (garlic)	Cd	10^{-2}–10^{-3}M	Reduction of plant growth
Portulaca oleracea (fat grass)	Se, Hg	0.1–5ppm	Shoot and root inhibition
Ocimum tenuiflorum (holy basil)	Cr	10–100µM	Reductions in protein, photosynthetic pigments, cistein
Ocimum basilicum L. (basil)	Pb	500, 600, 750,900 mgkg^{-1}	Raising of essential oils
	Cu	270, 300, 500,700 mgkg^{-1}	
	Cd	6, 10, 20, 30mgkg^{-1}	
Mentha crispa (spearmint)	Pb	900, 1800, 3600, 7200, and 9000 mgkg^{-1}	Raising of essential oils
Mentha spicata L. (spearmint)	Cd	6, 10, 20, 30mgkg^{-1}	Change in the composition of essential oils
Hypericum perforatum(yellow rattle)	Ni	25 and 50mM	Produces a decrease in the concentration of hypericin and pseudohypercine
Matricaria chamomilla (chamomile)	Cd	60 and 120µM	Pronounced decrease in chlorophyll and water in the leaves

Some plants use certain defense strategies against the toxic action of metals, including the accumulation of secondary metabolites, but this depends on the metal concentration with whom the plant interacts, as well as the plant species (Maleki *et al.*, 2017).

ANTIOXIDANT PROPERTIES OF MEDICINAL PLANTS

It is well known that medicinal plants are used worldwide as natural medical sources due to their antioxidant properties and significant amounts of nutrients and are used as a remedy for diseases caused by oxidative stress (aging, Parkinson's disease, certain disorders of cognitive function) (Alzoubi*et al.*, 2020; Mani *et al.*, 2017; Shaban*et al.*, 2016).Antioxidants support human health, and they are nutrients that can delay certain cellular degradation caused mainly by the effect of free radicals, and consist of a complex of nutrients that can reduce the toxic effects of free radicals (Alok *et al.*, 2014; Mauricette *et al.*, 2018) (fig. 2).

The main compounds synthesized by medicinal plants are secondary metabolites (such as alkaloids, terpenoids or phenolic compounds), and they provide to medicinal plants anti-inflammatory, anti-cancer and antioxidant properties (Moreira de Almeida *et al.*, 2020).

Research has shown that herbs have a significant antioxidant activity. Herbal antioxidants have major properties against cellular diseases. For example, silymarin found in *Silybummarianum* is a liver antioxidant that protects the liver from pharmaceutical damage or alcohol. Nature is a good "medicine" for all the diseases that mankind faces, and medicinal plants have an important and vital role in terms of antioxidant properties. Thus, the undesirable effects of modern medicine have turned many people's attention to herbal medicines (Alok *et al.*, 2014).

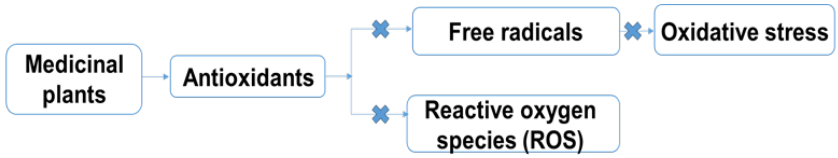

Fig. 2 Antioxidant properties of medicinal plants

IMPLICATIONS OF MEDICINAL PLANTS CONTAMINATION TO HUMAN HEALTH

The interaction between medicinal plants and soils contaminated with heavy metals leads to the assimilation of essential metals by active absorption, while by ion exchange between roots and water or roots-soil, non-essential metals (heavy metals) can penetrate the plant cells (Akinci *et al.*, 2019; Diaconu *et al.*, 2020; Hasan *et al.*, 2019). Once inside plants, heavy metals can reach the human body through consumption. Harvesting medicinal plants from areas subject to heavy metal contamination, for example from areas with heavy road traffic or from long-term irrigated areas with wastewater, or from areas where the chemical

composition of the soil is unknown, favors the entry of toxic compounds into the human body (Wang *et al.*, 2017; Zhang *et al.*, 2019).

Despite the fact that medicinal plants bring many health benefits due to their antioxidant properties, through contamination with heavy metals, they can become a source of risk to human health (Asiminicesei *et al.*, 2020). The penetration of heavy metals into the body triggers a number of health risks, including lung cancer, gastrointestinal cancer, kidney damage and liver disease, epigenetic changes, genetic mutations (Liu *et al.,* 2018). For example, the entry of lead into the body can affect the central nervous system or the respiratory system (Abdul *et al.,* 2015).

CONCLUSIONS

Although medicinal plants are a significant source of compounds beneficial to human health, they can pose health risksthrough their contamination with heavy metals. Some heavy metals are important as micronutrients for the proper functioning of plants, but in high concentrations they become toxic, moreover, some metals are extremely toxic even in low concentrations. Heavy metals produce negative effects on the structure of medicinal plants, and these include damage to antioxidants, ROS production or enzyme inhibition.In this way, by entering into the food chain, human health can be endangered.

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REFERENCES

1. **Abdul K.S.M., Jayasinghe S.S., Chandana E.P.S., Jayasumana C., De Silva P.M.C.S**., **2015** - *Arsenic and human health effects: A review*. Environmental Toxicology and Pharmacology, 40, p. 828-846.
2. **Akinci G., Gok G., Bilgin M., 2019 -** *Heavy metals bioconcentration and translocation in plants: The influence of a thermal power site*. Environmental Engineering and Management Journal, 18(8), p. 1625-1637.
3. **Alok S.,Jain S.K, Verma A., Kumar M., Mahor A., Sabharwal M., 2014**- *Herbal antioxidant in clinical practice: A review*. Asian Pacific Journal of Tropical Biomedicine, doi: 10.1016/S2221-1691(14)60213-6.
4. **Alzoubi K.H., Al-Jamal F.F., Mahasneh A.F., 2020** - *Cerebrolysin prevents sleep deprivation induced memory impairment and oxidative stress*.Physiology & Behavior, 217, https://doi.org/10.1016/j.physbeh.2020.112823.
5. **Anyanwu B.O., Ezejiofor A.N., Igweze Z.N., Orisakwe O.E., 2018**- *Heavy metal mixture exposure and effects in developing nations: an update*. Toxics, 6, p. 65, https://doi.org/10.3390/toxics6040065.
6. **Asiminicesei D.M., Vasilachi I.C., Gavrilescu M., 2020** -*Heavy metal contamination of medicinal plants and potential implications on human health*. Revista de Chimie, 71(7), p. 16-36, doi:https://doi.org/10.37358/RC.20.7.8222.
7. **Diaconu M., Pavel L.V., Hlihor R.M., Rosca M., Fertu D.I**., **Lenz M., Corvini P.X., Gavrilescu M., 2020**- *Characterization of heavy metal toxicity in some plants and*

microorganisms-A preliminary approach for environmental bioremediation. New Biotechnology, 56, p. 130-139, http://doi.org/10.1016/j.nbt.2020.01.003.

8. **Ghuman S., Ncube B., FinnieJ.F., McGaw L.J., Njoya E.M., Coopoosamy R.M., Van Staden J., 2019** - *Antioxidant, anti-inflammatory and wound healing properties of medicinal plant extracts used to treat wounds and dermatological disorders*. South African Journal of Botany, 126, p. 232-240.
9. **Hasan M.M., Udin N.M, Ara-Sharmeen I., Alharby H.F., Alzahrani Y., Hakeem K.R., Zhang L., 2019 -** *Assisting phytoremediation of heavy metals using chemical amendments*. Plants, 8, p. 295. 7https://doi.org/10.3390/plants8090295.
10. **LajayerB.A., Ghorbanpour M., Nikabadi S., 2017 -** *Heavy metals in contaminated environment: Destiny of secondary metabolite biosynthesis, oxidative status and phytoextraction in medicinal plants*. Ecotoxicology and Environmental Safety, 145, p. 377-390.
11. **Liu X., Zhong L., Meng J., Wang F., Zhang J., Zhi Y., Zeng L., Tang X., Xu J., 2018** - *A multi-medium chain modeling approach to estimate the cumulative effects of cadmium pollution on human health*, Environmental Pollution, 239, p. 308-317.
12. **Maleki M., Ghorbanpour M., Kariman K., 2017**- *Physiological and antioxidative responses of medicinal plants exposed to heavy metals stress*. Plant Gene, 11, p. 247-254, https://doi.org/10.1016/j.plgene.2017.04.006.
13. **Mani S., Archana S., Mahmoud A., Mayada R.F., Ashok M., Kuldeep D., 2017**- *Beneficial health applications and medicinal values of Pedicularis plants: A review*. Biomedicine & Pharmacotherapy, 95, p. 1301-1313.
14. **Mauricette T.L., Jeremy P., Claire G., Edmond S.M, André K., Jean M.N., Joël S., Louis M., 2018**- *Ethnobotanical study of medicinal plants used by traditional healers for the treatment of oxidative stress-related diseases in the Congo Basin*. Journal of Herbal Medicine,13, p. 76-90, https://doi.org/10.1016/j.hermed.2018.05.002
15. **Moreira de Almeida E., Ferreira H.J., Alves D.R., Barbosa da Silva M., 2020** - *Therapeutic potential of medicinal plants indicated by the Brazilian public health system in treating the collateral effects induced by chemotherapy, radiotherapy, and chemoradiotherapy: A systematic review*. Complementary Therapies in Medicine, 49, https://doi.org/10.1016/j.ctim.2019.102293.
16. **Neagu E., Paun G., Ungureanu O., Radu G.L., 2019 -** *Antioxidant activity and phenolics content of Capsella Bursa-Pastoris and MarrubiumVulgare depending on environmental factors***.** Environmental Engineering and Management Journal, 18(7), p. 1553-1560.
17. **Shaban S.N., Abdou A.K., Hassan N.E., 2016**- *Impact of toxic heavy metals and pesticide residues in herbal products*. Beni-Suef University Journal of Basic and Applied Sciences, http://doi.org/10.1016/j.bjas.2015.10.001.
18. **Wang Z., Wang H., Wang H., Li Q., Li Y., 2017**- *Heavy metal pollution and potential health risks of commercially available Chinese herbal medicines*. Science of the Total Environment, **653**, p.748-757, http://doi.org/10.1016/j.scitotenv.2018.10.388.
19. **Zhang J., Wang W.K., Geng Y.N., Wang Z.F., Cao S.M., 2019**- *Effect of Cd^{2+} stress on seed germination characteristics of ryegrass, Indian mustard and grain amaranth*. Environmental Engineering and Management Journal, 18, p. 1875-1884.
20. **Zhi X.N.,Phaik H.Y., Sin Y.L., 2020**- *Customized drying treatments increased the extraction of phytochemicals and antioxidant activity from economically viable medicinal plants*. Industrial Crops and Products, 155, p. 112815.

PALYNOLOGICAL FEATURES AND POLLEN GERMINATION POTENTIAL IN *HYACINTHUS ORIENTALIS* L.

PARTICULARITĂŢILE PALINOLOGICE ŞI POTENŢIALUL GERMINATIV AL POLENULUI DE *HYACINTHUS ORIENTALIS* L.

PĂDUREANU Silvica[1]*
*Corresponding author e-mail: silvyp27@yahoo.com

Abstract. *Palynology is a field of research on pollen and plant spores. Pollen research provides phylogenetic evidence in plant systematics. In this study are reported the main palynological features of a genotype known in the culture of ornamental plants, namely Hyacinthus orientalis. Respective palynological determinations concerned: shape, color of pollen grains, ornamentation of exine, size of pollen grains, number of germination pores/pollen grain. In connection with these determinations, the germination potential was tested on nutrient mediums with different carbohydrate compositions. In this regard, the effects of sucrose and glucose in different concentrations on pollen germination rates were investigated. Hyacinthus orientalis pollen has been shown to prefer 15% sucrose, when percentage of germinated grains was 95%, a percentage that is maintained for the next 96 hours. Glucose were suboptimal for pollen of this genotype. The results of this experiment provide useful information in taxonomy of genus Hyacinthus and in ornamental plant breeding.*
Key words: *Hyacinthus orientalis*, pollen grain, nutritive medium, pollen germination

Rezumat. *Palinologia este domeniul de cercetare al polenului şi sporilor plantelor. Cercetările asupra polenului furnizează dovezi filogenetice în sistematica plantelor. În prezentul studiu sunt relatate principalele particularităţi palinologice ale unui genotip cunoscut în cultura plantelor ornamentale, şi anume Hyacinthus orientalis. Respectivele determinări palinologice au vizat: forma, culoarea granulelor polinice, ornamentaţia exinei, dimensiunea granulelor de polen, numărul porilor germinativi/granulă de polen. Corelat cu aceste determinări s-a procedat la testarea potenţialului germinativ pe medii nutritive cu compoziţii glucidice diferite. În acest sens au fost investigate efectele zaharozei şi ale glucozei în diferite concentraţii asupra ratelor de germinare a polenului. S-a demonstrat că polenul de Hyacinthus orientalis preferă medii nutritive îmbogăţite cu 15% zaharoză, când procentul granulelor germinate a fost de 95%, procent care se menţine şi în următoarele 96 ore. Glucoza a fost suboptimală pentru polenul acestui genotiop. Rezultatele prezentului experiment oferă informaţii utile în taxonomia genului Hyacinthus şi în ameliorarea plantelor ornamentale.*
Cuvinte cheie: *Hyacinthus orientalis*, granulde polen, mediu nutritiv, germinarea polenului

[1]University of Agricultural Sciences and Veterinary Medicine Iasi, Romania

INTRODUCTION

Palynology is the study of pollen and spores. Pollen grains and spores have certain features, which provide important information for inferring the phylogenetic relationships of plants. Also, the features of pollen grains and spores help identify a particular plant taxon. Furthermore, these features it has been shown to have great benefit to the criminal investigator (Adams-Groom B., 2012; Adams-Groom B., 2015). Pollen grains are unique for each vegetable taxon, having a certain shape, size, ornamentation of the exine (Erdman, 1952).

Hyacinthus is a monocot genus of bulbous plants, native to the eastern Mediterranean. *Hyacinthus orientalis* L. is among the few species of this genus, is rare in the wild but common in the cultured landscape. This species has not only decorative value, but is also an important source of pollen and nectar for supporting valuable pollinators, such as *Apis mellifera* and *Bombus* spp. in early spring (Bożek , 2019).

Researchs about *Hyacinthus orientalis* pollen focused on the synthesis of RNA and proteins in vegetative and generative cells during the maturation of pollen grains, demonstrating that the rhythm of these syntheses is more accentuated in vegetative cell (Bednarska, 1984). Zienkiewicz K. *et al*. (2008a) deepen this researchs and confirms that transcriptional activity is more intense in vegetative cells in young pollen grains of *Hyacinthus orientalis* and decreases in mature pollen grains, reaching a minimum before anthesis. Using labeled antigens it has been shown that organization of splicing machinery elements during *Hyacinthus orientalis* pollen grain development undergoes spatial changes in the two pollen cells (Zienkiewicz *et al*., 2008b).

The present study aims to clarify the main palynological features and the degree of fertility in *Hyacinthus orientalis* pollen.

MATERIAL AND METHOD

The biological material was represented by the fresh pollen of *Hyacinthus orientalis.* For to determine the pollen features palynological, was evaluated: shape of pollen grains, exine sculpturing, size of pollen grains and number of germinative pores/pollen grain. For determining the shape of pollen grains, the apertures, the exine sculpturing, we have used the Oxion light microscope, at which we took microphotographs. For determining the size of pollen we did micromeasurements at 1000 pollen grains. The values obtained were statistically processed, resulting the biostatistics indexes. For establishing the number of germinative pores/pollen grain, we have done determinations on 1000 pollen grains. The method was based on introducing the pollens in a mixture of sulphuric acid and acetic acid.

The germination capacity of pollen was determined used the hanging drop method (Stanley and Linskens,1985). The nutrient mediums were prepared from distilled water in which two types of carbohydrates were dissolved: sucrose and glucose, in different concentrations. The type of carbohydrate and its concentration in distilled water contributed to preparing 12 experimental variants of mediums: sucrose enriched mediums: 5%, 15%, 25%, 50%, 70%, 100%; glucose enriched mediums: 5%, 15%, 25%, 50%, 70%, 100%. Along with the 12 variants of mediums with added

carbohydrates, a variant of medium without carbohydrates was prepared, label 0%. For each experimental variant, we have used 8 "wet rooms". The amount of inoculated pollen per each medium drop was the same in all cases. Readings at the Oxion optic microscope were done at 2, 24, 48, 72, 96 and 120 hours since the pollen inoculation in mediums, thus being established the percent dynamics of the germination capacity. The germination capacity was expressed as percentage, by reporting the number of germinated grains to total pollen grains.

RESULTS AND DISCUSSIONS

The palynological features of *Hyacinthus orientalis* L.

The pollen of is *Hyacinthus orientalis* elliptical, pale yellow color (fig. 1-left). The exine is reticulata (fig. 1- right).

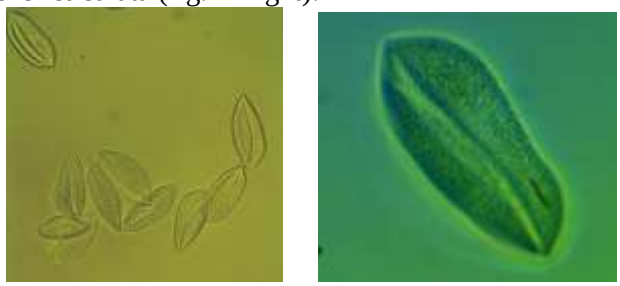

Fig. 1 The shape of pollen grains and the exine sculpturing of *Hyacinthus orientalis*: 400X(left); 1000X (right) (Original)

The pollen of *Hyacinthus orientalis* is monoporate, namely each pollen grain has only one germinative pore sheltered by an a single aperture (fig. 2). The presence of only one germinative pore/pollen grain is characteristic for all liliopsids species.

Fig. 2 Pollen grain to which is indicated the only germinative pore (1000X) (Original)

These palynological data about *Hyacinthus orientalis* pollen are in accord to SEM pollen images selected of British flora (https://www.worldplants.ca/documents/books/Pollen%20Project_web_Part2.pdf).

The size of pollen grains was estimated by measuring the two pollen axes. The polar axis has an average of 71.64 μm and the equatorial axis is 33.19 μm. The ratio between the two polinic axes is 2.16 μm. The coefficient of variation (s%) indicates low variability for both axes (tab. 1).

Table 1

Variability of pollen grain size in *Hyacinthus orientalis*

Type of axis	Mean value (µm)	Minimum value (µm)	Maximum value (µm)	Variation height (µm)	S (µm)	S%	$S_{\bar{x}}$ (µ)	Ratio P/E (µm)
Polar axis (P)	71.64	51.75	82.80	31.05	4.99	6.97	0.69	2.16
Equatorial axis (E)	33.19	24.15	41.40	17.25	3.37	10.2	1.02	

The germination capacity of *Hyacinthus orientalis* pollen

The germination capacity of hyacinth pollen was tested on two categories of nutrients mediums which differs by the type of carbohydrate as mentioned in the section "Material and Method".

After 2 hours from inoculation of pollen on mediums, pollen germinated in high proportions on mediums with 15% carbohydrates, namely: 72% germinated pollen grains on sucrose and 50% on glucose. On mediums with 25% carbohydrates were registered: 20% germinated pollen grains on sucrose and 15% on glucose. On carbohydrate deficient mediums (0%, 5%), germination was very low. Mediums with 50-100% carbohydrates have not yet allowed the germination process to start (figs. 3 and 4).

After 24 hours from inoculation, germination percentages of pollen increased considerably, especially on mediums with 15% carbohydrates (95% on sucrose, respectively 61% on glucose). Among the glucose averages, the one with 25% offered higher chances (85%) for hyacinth pollen germination. The pollen also germinated on mediums with 50% and 70% carbohydrates, but at lower levels compared to the mediums with 15% and 25% carbohydrates. On low-carbohydrate mediums, germination rates remain low (3%), while on the most carbohydrate-rich mediums (100%), germination has not yet begun (figs. 3 and 4).

48 hours after pollen inoculation, we constate that are increases in germination rates on mediums with 15-70% carbohydrates. In all cases, germination on sucrose was higher than on glucose. Even on medium with 100% sucrose, 10% germinated pollen was registered, but not on glucose (figs. 3 and 4).

After 72 hours from inoculation, germination rates increase especially on mediums with 50-70% carbohydrates (figs. 3 and 4).

After 96 and 120 hours from inoculation, germination rates remain approximately constant compared to the previous interval, with specification that on mediums with 70%, germination rates decreases slightly (figs. 3 and 4).

The dynamics of germination during the 120 hours of analysis, show that in the first 24 hours after pollen inoculation occurs a significant increase in germination rate on most mediums variants (figs. 3 and 4).

In case of sucrose mediums, the highest levels of pollen germination were supported by variants of the mediums with 15% and 25%, when the percentage values reached 98% and 90%, respectively. The germination capacity high of

pollen in *Hyacinthus orientalis* is a proof that polinic meiosis at this genotype is normale and the male gametes are genetically well balanced.

In case of glucose mediums, profile of germination dynamics in the same time interval is somewhat irregular, however it indicates that the best of these is the with 15% glucose, which insured about 90% germinated pollen.

Hyacinth'pollen does not germinate optimally on hypotonic mediums (0%, 5% carbohydrates), nor on hypertonic mediums (50% - 100% carbohydrates). It should be noted that on medium with 100% glucose, pollen of this genotype did not germinate at all.

From these determinations, in addition to the information already presented, we extract another one, namely that the hyacinth pollen is viable for at least 120 hours. Research on the vitality of pollen in certain varieties of *Hyacinthus orientalis* shows that this one it is lost after 9 days of storage at room temperature, while storage for 12 days between 4 ^{0}C and -20 ^{0}C ensures a germination of over 20% (Li *et al.*, 2010).

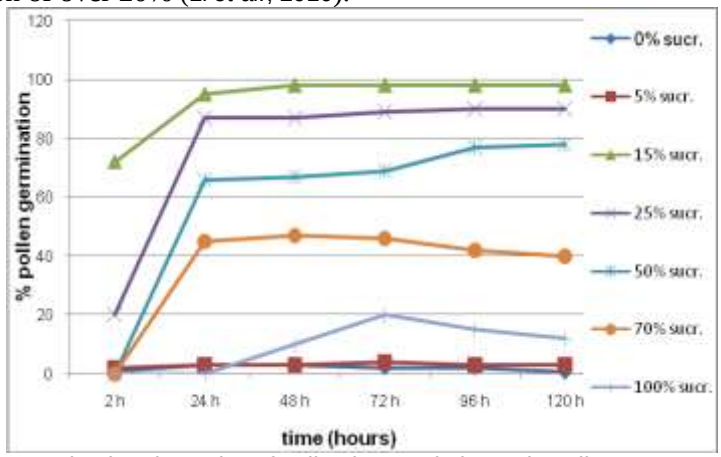

Fig. 3 The germination dynamics of pollen in *Hyacinthus orientalis* on sucrose mediums

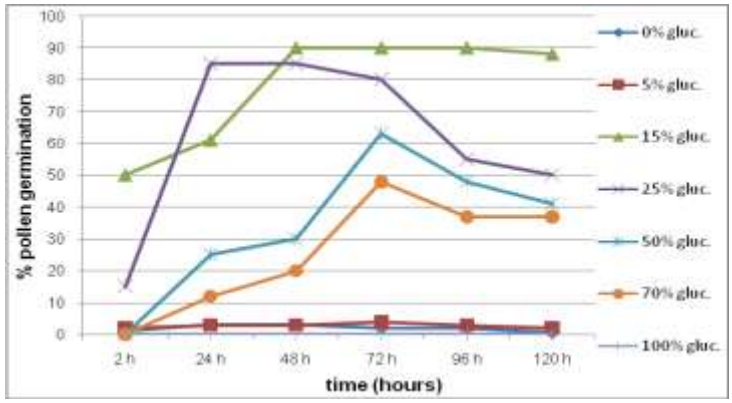

Fig. 4 The germination dynamics of pollen in *Hyacinthus orientalis* on glucose mediums

CONCLUSIONS

1. Palinological features for *Hyacinthus orientalis* comply with those reported in the literature.

2. Size of *Hyacinthus orientalis* pollen grains have one smalle variability, which means that it is homogeneous. This characteristic is closely correlated in positive sense, with the germination capacity of pollen.

3. *Hyacinthus orientalis* pollen germinates at maximum level (98%) if the germination medium is enriched with sucrose in a concentration of 15%, at most 25%.

4. Sucrose is preferred to glucose for the optimal development of the male hyacinth gametophyte. This aspect proves that sucrose is more energy efficient than glucose, ensuring the optimal energy for hyacinth pollen in the germination process.

5. Our investigations have demonstrate that *Hyacinthus orientalis* pollen has a viability of at least 5 days (120 hours) at room temperature. This aspect can be taken into account for hybridization works in order to create new varieties within this species.

REFERENCES

1. **Adams-Groom B. 2012** - *Forensic palynology*. Forensic ecology handbook, London: Wiley-Blackwell, p. 153–167.
2. **Adams-Groom B., 2015** - *Frequency and abundance of pollen taxa in crime case samples from the United Kingdom.* Grana, 54(2), p. 146-155.
3. **Bednarska E., 1984** - *Ultrastructural and metabolic transformations of differentiating Hyacinthus orientalis L., pollen grain cells. I. RNA and protein synthesis*. Acta Societatis Botanicorum Poloniae, 53(2), p. 145-158.
4. **Bożek M., 2019** - Nectar secretion and pollen production in *Hyacinthus orientalis* 'Sky Jacket' (Asparagaceae). Acta Agrobotanica, 72 (4), ref. 67.
5. **Erdman G., 1952 –** *Pollen morphology and Plant taxonomy*. Angiosmerms (An introduction to Palynology I). Almqvist and Wiksele, Stockholm, p. 53-71.
6. **Li Y., Luo F., Wang C., Tang G., 2010** - *Characteristics of pollen germination and storage in Hyacinthus orientalis.* Acta Botanica Boreali-Occidentalia Sinica, 30(12), p. 2484-2489.
7. **Stanley R.G., Linskens H.F., 1985** - *Pollen biologye, biochemie, gewinnung und verwendung urs freund verlag.* Greifenberg Ammersee, p. 349.
8. **Zienkiewicz K., Zienkiewicz A., Smoliński D.J., Rafińska K., Świdziński M., Bednarska E., 2008a** - *Transcriptional state and distribution of poly(A) RNA and RNA polymerase II in differentiating Hyacinthus orientalis L. pollen grains.* Sex Plant Reprod, 21, p. 233–245.
9. **Zienkiewicz K., Zienkiewcz A., Smoliński D.J., Świdziński M., Bednarska E., 2008b** - *Intracellular organization of the pre-mRNA splicing machinery during Hyacinthus orientalis L. pollen development*. Sex Plant Reprod, 21, p. 217–231.
10. ***https://www.worldplants.ca/documents/books/Pollen%20Project_web_Part2.pdf

DYNAMICS OF POLLEN TUBE GROWTH IN *HYACINTHUS ORIENTALIS* L.

DINMICA CREŞTERII TUBULUI POLINIC DE *HYACINTHUS ORIENTALIS* L.

PĂDUREANU Silvica*[1]
*Corresponding author e-mail: silvyp27@yahoo.com

Abstract. *The pollen tube is essential for sexual reproduction of plants, as it ensures the delivery of male gametes cells into ovule. Edification of pollen tube by elongation of vegetative cell from pollen grain, growth rate of pollen tube, its response to orientation signals to ovule micropyle and to other extracellular factors are fascinating aspects of pollen biology, which recommend pollen tube as a model for studying the behavior of plant cells. This study focuses on dynamics of in vitro growth of pollen tube of Hyacinthus orientalis on nutrient mediums with different carbohydrate compositions. 15% sucrose medium ensured growth of the longest pollen tubes exceeding 5000 µm just 24 hours after inoculation. Those pollen tubes increased at least another 96 hours, but at low rates, remaining viable. Pollen tubes grown on glucose mediums were significantly shorter, not exceeding 1080 µm. The length of pollen tube indicates its efficiency in fertilizing ovule.*

Key words: *Hyacinthus orientalis*, nutritive medium, pollen tube, dynamics growth

Rezumat. *Tubul polinic este esenţial pentru reproducerea sexuală a plantelor, acesta asigurând livrarea gameţilor masculini în ovul. Edificarea tubului polinic prin alungirea celulei vegetative din granulul de polen, rata de creştere a tubului polinic, răspunsul acestuia la semnalele de orientare către micropilul ovulului şi la alţi factori extracelulari sunt aspecte fascinante ale biologiei polenului, care recomandă tubul polinic ca model pentru studiul comportamentului celulelor vegetale. În prezentul studiu se focalizează dinamica creşterii in vitro a tubului polinic de Hyacinthus orientalis pe medii nutritive diferite prin glucidul din compoziţie. Mediul cu 15% zaharoză a asigurat creşterea celor mai lungi tuburi polinice care depăşesc 5000 µm la doar 24 ore de la inoculare. Respectivele tuburi polinice au crescut încă cel puţin 96 ore, însă cu rate scăzute, rămânând viabile. Tuburile polinice crescute pe mediile cu glucoză au fost semnificativ mai scurte, nedepăşind 1080 µm. Lungimea tubului polinic indică eficienţa acestuia în fertilizarea ovulului.*

Cuvinte cheie: *Hyacinthus orientalis*, mediu nutritiv, tub polinic, dinamica creşterii

[1]University of Agricultural Sciences and Veterinary Medicine Iasi, Romania

INTRODUCTION

The pollen tube of flowering plants grows in length at its tip to reach an ovule where it delivers two nonmotile male gametes during double fertilization and initiate seed development. The mechanism of guiding the pollen tube in stylar tissue can be explained by the fact that pollen tubes respond to chemoattractants secreted by unfertilized ovules (Yetisen *et al*., 2011). Pollen is considered an excellent model for the study of gene expression and the growth process of the pollen tube, given that its genome is haploid (Johnson *et al.,* 2019).

Molecular studies using immunofluorescence techniques have shown that transcriptional resumption and pre-mRNA maturation occur during the growth of the pollen tube of *Hyacinthus orientalis*, compared to the anthesis stage of pollen (Zienkiewicz *et al.,* 2006, 2008). In the pollen tube, the sperm nuclei of *Hyacinthus orientalis* have an intense transcriptional activity that ends before fertilization (Zienkiewicz *et al.,* 2011).

The aim of this paper is to highlight the peculiarities of dynamics' growth of the pollen tube in *Hyacinthus orientalis*, as well as the influence of the nutritive medium on it. These investigations also contribute to the completion of the knowledge about sexual reproduction of this genotype known as a valuable ornamental plant, with a short flowering period.

MATERIAL AND METHOD

The biological material is represented by the fresh pollen of *Hyacinthus orientalis* L. For to determine the dynamics of pollen tube growth, we have used the hanging drop method (Stanley and Linskens, 1985). The nutrient mediums were prepared from distilled water in which two types of carbohydrates were dissolved: sucrose and glucose, in different concentrations. The type of carbohydrate and its concentration in distilled water contributed to preparing 12 experimental variants of mediums: sucrose enriched mediums: 5%, 15%, 25%, 50%, 70%, 100%; glucose enriched mediums: 5%, 15%, 25%, 50%, 70%, 100%. Along with the 12 variants of mediums with added carbohydrates, a variant of medium without carbohydrates was prepared, label 0%. For each experimental variant, we have used 8 “wet rooms”. The amount of inoculated pollen per each medium drop was the same in all cases. Were made micromeasurements for determining the dynamics for the extension of pollen tubes. In this respect, the readings at microscope were done at 2, 24, 48, 72, 96 and 120 hours since the pollen inoculation on nutritive mediums. The data shown represent arithmetic averages obtained from 8 readings/nutritive medium variant/time interval.

Micromeasurements of pollen tube length were recorded directly by an ocular micrometer fitted to the eyepiece on microscope based on micrometer scale (µm). The length of the pollen tube was expressed by micrometers (µm). For pointing out the characteristics of pollen tubes from this genotype, photographs were taken at Oxion optical microscope.

To determine the length of floral style, it was calculated an average by measuring of 100 style from 100 flowers of *Hyacinthus orientalis*, using the binocular magnifying glass Bel photonics.

RESULTS AND DISCUSSIONS

Two hours after pollen inoculation, the first pollen tubes appeared, only on mediums with 0% - 25% carbohydrates. The longest are the pollen tubes formed on mediums with 15% sucrose (428 μm), and the shortest ones on mediums without carbohydrates (12 μm) (fig. 1, fig. 2).

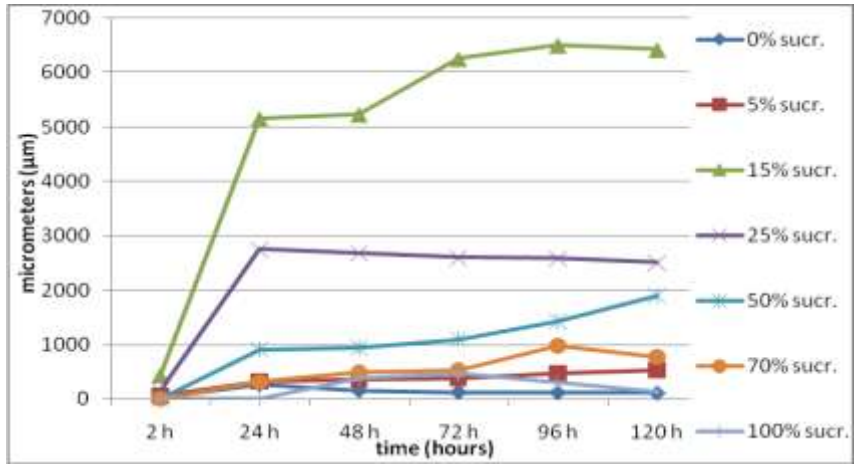

Fig. 1 Dynamics of average length of the pollen tube in *Hyacinthus orientalis* on sucrose mediums

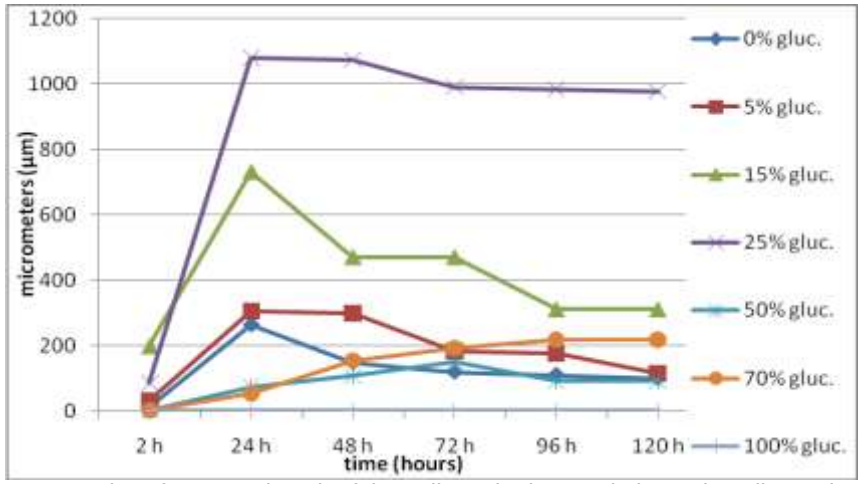

Fig. 2 Dynamics of average length of the pollen tube in *Hyacinthus orientalis* on glucose mediums

At 24 hours after inoculation, the pollen tubes increase significantly in length, especially by on 15% sucrose, when the average length exceeds 5000 μm. There are large differences between the length of pollen tubes grown on sucrose

mediums and those grown on glucose mediums, in favor of those on sucrose mediums (fig. 1, fig. 2).

48 hours after pollen inoculation, pollen tubes grown on sucrose mediums are found to increase in length, but not significantly. The longest tubes are supported by the medium with 15% sucrose. In case of pollen tubes grown on glucose mediums, the situation is different, in sense that they are much shorter than those grown on sucrose mediums. Moreover, some pollen tubes underwent resorption on mediums with 5%, 15% and 25% glucose. Of the glucose mediums, only the 25% glucose variant supports the longest pollen tubes, but they are much shorter than those developed on the 25% sucrose medium (fig. 1, fig. 2).

After 72 hours from inoculation, the evolution of increase in length of the pollen tubes does not differ much from previous time interval. Tubes grown on sucrose mediums grow insignificantly, the longest being those increased on sucrose 15% (6000 μm), and the shortest being those increased on sucrose 5% (375 μm). Glucose mediums continue to be suboptimal for the increase in length of hyacinth pollen tubes. Even 72 hours after inoculation, pollen tubes grown on glucose mediums have no lengths comparable to those on sucrose. On the contrary, there are regressions of their length due to degeneration by breaking them at the tip. There is a slight increase in the tubules on the media with 50% and 70% glucose. Medium with 100% glucose does not allow the growth of any pollen tubes (fig. 1, fig. 2).

96 hours after inoculation, pollen tubes of *Hyacinthus orientalis* are still viable in both categories of nutritive mediums.The tubes grown on sucrose mediums are still elongating, but at insignificant speeds compared to the previous interval. The pollen tubes grown on glucose remain significantly shorter than those grown on sucrose (fig. 1, fig. 2).

120 hours after inoculation, hyacinth pollen tubes, especially those grown on sucrose mediums, are still viable, whole. The nutritive medium with 100% glucose did not allow the growth of pollen tubes even after five days from pollen inoculation (fig. 1, fig. 2).

The dynamic analysis of the growth of pollen tube of *H. orientalis* during the 120 hours of observation highlights the following aspects (fig. 1, fig. 2).

In the first 24 hours after pollen inoculation on nutrient mediums, was the most significant increase in pollen tubes, on most mediums variants, but with different rates.

Mediums with 0%, 5% and 100% carbohydrates (sucrose and glucose) were inhibitory mediums for the growth of hyacinth pollen tubes.

Mediums enriched with 50% and 70% carbohydrates proved to be suboptimal mediums because they do not allow the normal elongation of pollen tubes of *H. orientalis*.

The 15% sucrose medium has been shown to be optimal for expressing the maximum growth potential of *H. orientalis* pollen tubes. On this medium, the pollen tubes reached over 6000 μm in length.

Of the nutrient mediums with glucose, only that with 25% concentration supported the longest pollen tubes (about 1000 μm in length).

Analysis of the growth dynamics of hyacinth pollen tubes shows that hypotonic (0-5% carbohydrates) and hypertonic (50-100% carbohydrates) mediums are suboptimal for egg fertilization.

The optimal mediums for growing hyacinth pollen tubes are those with 15% and 25% carbohydrates, but the type of carbohydrate matters a lot. So 15% sucrose is much better for hyacinth pollen than 15% and 25% glucose.

Pollen quality is ensured by two parameters: germination capacity and pollen tube length. The pollen tube must be long enough to reach the ovule, to which it will deliver the two sperm cells. In this sense, the normal length of pollen tube is in direct correlation with length of the flower style and ovary which it penetrates to reach the ovule (Harder *et al.,* 2016). In *H. orientalis*, the average length of style is 1.62 mm, and that of ovary 3.54 mm (original dates) (fig. 3). Considering the length of style and ovary of pistil, it follows that the pollen tubes in *H. orientalis*, in order to reach ovules, must be at least 5000 μm long.

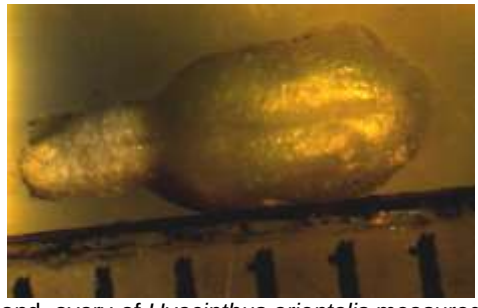

Fig. 3 The floral style and ovary of *Hyacinthus orientalis* measured by binocular loupe. A division = 1 millimeter (Original)

In figure 4 are presented aspects of pollen tubes of *H. orientalis* grown on mediums with 15% sucrose.

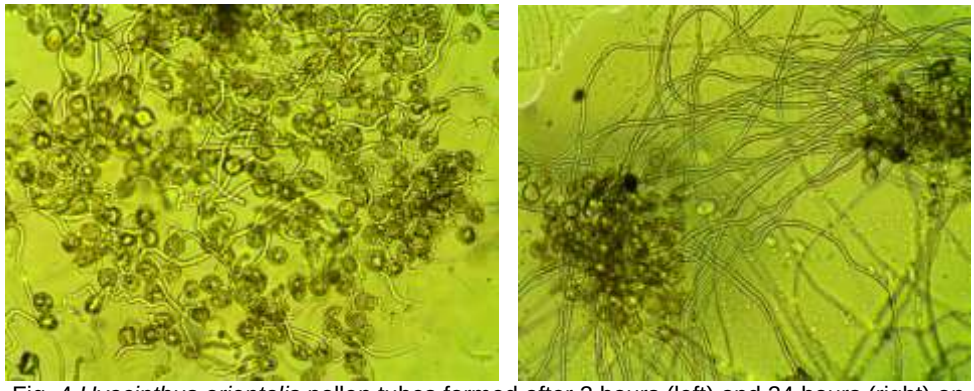

Fig. 4 *Hyacinthus orientalis* pollen tubes formed after 2 hours (left) and 24 hours (right) on medium with 15% sucrose from inoculation on nutritive medium (100x) (Original)

CONCLUSIONS

1. The present experiment showed that the length of pollen tubes varies depending on three factors: the type of carbohydrate in nutritive medium, the concentration of carbohydrate in nutritive medium and the time elapsed since the inoculation of the pollen on nutritive medium.

2. Sucrose has been shown to be preferred to glucose for the optimal development of the male gametophyte in *Hiacynthus orientalis*. This fact suggests that the energy required for pollen tube growth of hyacinth can be provided by successfully supplied by sucrose which is much more efficient than glucose.

3. The optimal concentration of sucrose required to express the maximum length of the pollen tube of *Hyacinthus orientalis* is 15%.

4. The time required for *Hyacinthus orientalis* pollen tube to reach the optimal length that allows it to reach the ovule is 24 hours.

5. *Hyacinthus orientalis* pollen tubes are viable for at least 120 hours from the time of their construction.

REFERENCES

1. **Harder L.D., Aizen M.A., Richards S.A., Joseph M.A., Busch J.W., 2016 -** *Diverse ecological relations of male gametophyte populations in stylar environments*. Am. J. Bot., 103(3), p. 484-497.
2. **Johnson M.A., Harper J.F., Palanivelu R., 2019** - *A Fruitful Journey: Pollen Tube Navigation from Germination to Fertilization.* Annu. Rev. Plant Biol, 70, p. 809-837.
3. **Stanley R.G., Linskens H.F., 1985** - *Pollen biologye, biochemie, gewinnung und verwendung urs freund verlag.* Greifenberg Ammersee, p. 349.
4. **Yetisen A.K., Jiang L., Cooper J.R., Qin Y., Palanivelu R., Zohar Y., 2011** - *A microsystem-based assay for studying pollen tube guidance in plant reproduction*. J. Micromech. Microeng. 21(5) 054018.
5. **Zienkiewicz K., Smolinski D.J., Bednarska E., 2006** - *Distribution of poly(A) RNA and splicing machinery elements in mature Hyacinthus orientalis L. pollen grains and pollen tubes growing in vitro.* Protoplasma, 227, p. 95–103.
6. **Zienkiewicz K., Zienkiewicz A., Rodriguez-Garcia M.I., Smolinski D.J., Swidzinski M., E. Bednarska E., 2008** - *Transcriptional activity and distribution of splicing machinery elements during Hyacinthus orientalis pollen tube growth*. Protoplasma 233, p. 129–139.
7. **Zienkiewicz K., Suwińska A., Niedojadło K., Zienkiewicz A., Elżbieta Bednarska E., 2011** - *Nuclear activity of sperm cells during Hyacinthus orientalis L.* in vitro *pollen tube growth.* Journal of Experimental Botany, 62(3), p.1255–1269.

THE INFLUENCE OF CHEMICAL TREATMENTS APPLICATION ON THE *OSTRINIA NUBILALIS* HBN. ATTACK TO MAIZE SOWED IN DIFFERENT EPOCHS IN THE CONDITIONS OF CENTRAL MOLDOVA

INFLUENȚA APLICĂRII UNOR TRATAMENTE CHIMICE ASUPRA ATACULUI PRODUS DE LARVELE SPECIEI *OSTRINIA NUBILALIS* HBN. LA PORUMBUL SEMĂNAT ÎN DIFERITE EPOCI ÎN CONDIȚIILE DIN CENTRUL MOLDOVEI

URSACHE Paula – Lucelia[1]*, TĂLMACIU M.[1], TROTUŞ Elena[2], AMARGHIOALEI Roxana – Georgiana[2], ISTICIOAIA Simona – Florina[2], LEONTE Alexandra[2]

*Corresponding author e-mail: p.ursache03@gmail.com

Abstract. *The Ostrinia nubilalis Hbn. species it is one of the pests specific to the maize crop that produces production losses in terms of quality and quantity. At A.R.D.S. Secuieni, in 2019, researches were conducted regarding the application of chemical treatments to reduce the attack produced by the Ostrinia nubilalis Hbn. larvae to maize sown in different epochs. The results obtained regarding the influence of the interaction between the sowing epoch and the treatments applied on the vegetation on the attack produced by the european corn borer larvae indicated that regardless of the sowing epochs, the variant where it was applied cyantranyliprole had the lowest percentage of attacked plants. The influence of the interaction of the two factors (epoch and treatment) also materialized by reducing the average number of holes and larvae/plant, highlighting with the best results, the variants sown in the third epoch, where chemical treatments ensured a good protection of maize plants.*

Key words: european corn borer, chemical treatments, swoing epoch, maize, attack

Rezumat. *Specia Ostrinia nubilalis Hbn. este unul dintre dăunătorii specifici culturii de porumb care produce pierderi de producție din punct de vedere calitativ şi cantitativ. În condițiile anului 2019 la S.C.D.A. Secuieni, s-au efectuat cercetări privind aplicarea unor tratamente chimice pentru reducerea atacului produs de larvele speciei Ostrinia nubilalis Hbn. la porumbul semănat în diferite epoci. Rezultatele obținute privind influența interacțiunii dintre epoca de semănat şi tratamentele aplicate pe vegetație asupra atacului produs de larvele de sfredelitorul porumbului au indicat faptul că, indiferent de epoca de semănat, varianta unde s-a aplicat substanța activă cyantranyliprole a înregistrat cel mai redus procent al plantelor atacate. Influența interacțiunii celor doi factori (epocă şi tratament) s-a materializat şi prin reducerea numărului mediu de orificii şi larve/planta, evidențiindu- se cu cele mai bune*

[1] University of Agricultural Sciences and Veterinary Medicine Iasi, Romania
[2] Agricultural Research and Development Station Secuieni, Neamț, Romania

rezultate, variantele semănate în epoca a treia, unde tratamentele chimice au asigurat o protecție bună plantelor de porumb.

Cuvinte cheie: sfredelitorul porumbului, tratamente chimice pe vegetație, epoca de semănat, porumb, atac

INTRODUCTION

The species *Ostrinia nubilalis* Hbn is a polyphagous pest, adults show sexual dimorphism. Females lay clustered eggs covered with wax on the underside leaves to protect them from climatic variations and predators. The larva goes through five larval stages. The first two stages are the most sensitive to climatic factors because they are found outside the plant, on the leaves. The larva of the third stage enters the stem where it creates its galleries. This is where the mature larvae of the fifth stage enter in diapause and transform into pupae in spring and then into adults (Roşca *et al*., 2011).

The production losses due to the attack of the larvae on the stem vary depending on the climatic conditions, but also on the reserve of hibernating larvae. Among the methods to prevent and combat the attack caused by the insect we mention: compliance with agrotechnical measures by chopping plant residues, avoiding monoculture, cultivating hybrids tolerant to attack, biological control through the species *Tricogramma*, etc. One aspect of chemical control is the timing of treatment. Data from the literature underline the particular importance of correlating treatments with the biology of the species in order to maximize the efficacy of active substances. Thus the application of treatments is necessary to be carried out before the larvae enter the stem where they are protected.

In Poland, Mazurek et al. (2005) studied the effectiveness of chemical and biological control of corn borer larvae at sweet corn. Among the insecticides studied, the commercial product Karate Zeon 100 CS was noted, which recorded efficacy values between 77% (1998) and 90% (2000), and maize plants showed a lower percentage of attack.

From the research conducted by Obopile *et al.* (2008), for maize sown in different epochs, it was found that maize sown later has larger galleries.

Chemical control of larvae of *Ostrinia nubilalis* Hbn. has also been studied by romanian researchers. The results obtained by Georgescu et al. (2016) showed that active substance indoxacarb (500 ml/ha) and cyantraniliprol (150 and 200 mL/ha) provided good protection of corn plants and reduced the attack of larvae.

In the Transylvanian Plain, Vălean *et al*. (2017) applied the active substances cyantraniliprol and thiacloprid + deltamethrin, and maize plants had a lower attack rate and were protected from corn borer larvae attack. The research was continued by Tărău et al. (2019), and the results obtained show that among the active substances that provided good protection to maize plants are indoxacarb and deltamethrin, reducing the length of the gallery / plant and had efficacy values of 90% and 85% respectively. Among the least effective in reducing the attack

were the active substances tiacloprid and thiamethoxam, which showed efficacy values of 15% and 27%, respectively.

This paper presents the results obtained at A.R.D.S. Secuieni, where, starting with 2019, researches were conducted on the influence of the application of chemical treatments in reducing the attack produced by the larvae of *Ostrinia nubilalis* Hbn. species to maize sown in different epochs.

MATERIAL AND METHOD

Due to the importance of this pest for corn cultivation, at A.R.D.S. Secuieni, starting with 2019, was initiated research to the influence of chemical treatments application for reducing the *Ostrinia nubilalis* Hbn larval attacks to corn sown in different epochs.

In order to achieve the objective, in the experimental field was located a bifactorial experience, type 3 x 6, according to the method of subdivided plots into three repetitions, were the first factor (A) it is represented of the sowing epoch (a1- Epoch I - 10.04.2019, a2 - Epoch II - 22.04.2019 and a3 - Epoch III - 01.05.2019), and the second factor (B) by the chemical treatment (b1 - untreated control, b2 - cyantranyliprole 200 g/L -Coragen - 175 ml/ha, b3 - deltamethrin 50 g/l - Decis mega 50 EW -75 ml/ha, b4 - tau-fluvalinate 240 g / l - Mavrik 2 F - 0,2 l/ha, b5 - acetamiprid 200g / kg - Mospilan 20 SG - 0,1 kg / ha and b6 - thiacloprid 480 g/l - Calypso 480 SC - 0,1 l/ha. The experimental variant had a length of 10 m and a width of 4.2 m.

The biological material used for sowing was the Turda Star maize hybrid. Maize cultivation was established according with the technology of cultivation of some species in conditions in Central Moldova (Trotuş *et al.*, 2015).

The timing of applying the insecticide treatment on vegetation was correlated with the pest biology. At 10 days after recharging the maximum flight peak for adults were applied the insecticide, so that the treatments effectiveness can be maximum after the larvae have hached and are in the early stages of life.

To determine the frequency of plants attacked by *Ostrinia nubilalis* Hbn. larvae and attack parameters (frequency of attacked plants; average number of holes /plant; number of larvae; length of galleries) the observations were made on 25 plants/variant, which were harvested from the rows in the middle of the variant and sectioned.

The year 2018/2019 was characterized climatically as warm in terms of temperature, with a deviation of 1.1 ^{0}C compared to the average multiannual temperature of 8.9 ^{0}C for the area. The amount of rainfall sum up 430.2 mm during the year, with a deficit of 114.1 mm, characterized the year as dry, the amount recorded and the distribution of the vegetation period being very varied.

RESULTS AND DISCUSSIONS

Following the determinations performed, it was observed that the interaction between the sowing season and the treatments on the vegetation influences the level of the attack produced by the larvae.

For maize sown in epoch I, the untreated variant had a frequency of attacked plants of 25.00%, relative with the variants treated with its cyantranyliprole 200 g/L (Coragen - 175 mL / ha) of 11.67% and was between

15.00% at the variant treated with thiacloprid 480 g/l (Calypso 480 SC - 0.1 L / ha) and 16.67% for the variant where acetamiprid was applied 200g / kg (Mospilan 20 SG - 0.1 kg/ha) (fig. 1).

At the interaction between the second sown epoch x the chemical treatments applied on the vegetation, the obtained results show that the maize plants registered higher percentages of attack at the untreated variant, of 15% compared to the treated variants, where the frequency of the attacked plants reached values between 10% at the variants treated with cyantranyliprole 200 g/L (Coragen - 175 mL/ha) and acetamiprid 200 g/kg (Mospilan 20 SG - 0.1 kg/ha), 13.00% in the variant treated with tiacloprid 480 g/L (Calypso 480 SC - 0.1 L/ha) and 15.00% in the case of variants where deltamethrin 50 g/L was applied (Decis mega 50 EW -75 mL/ha) and tau-fluvalinate 240 g/L (Mavrik 2 F - 0.2 L/ha) (fig. 1).

The frequency of the attacked plants was reduced to the interaction between the maize sown in Epoch III x chemical treatments applied on the vegetation and reached up to 25% to the untreated variant of the experiment.

Regarding the influence of the interaction between the sowing season and the treatments applied on vegetation on the frequency of the attacked plants, the obtained results show that in all three sowing epochs experienced the variant where cyantranyliprole 200 g/L (Coragen - 175 mL/ha), recorded a low percentage of attacked plants (fig. 1).

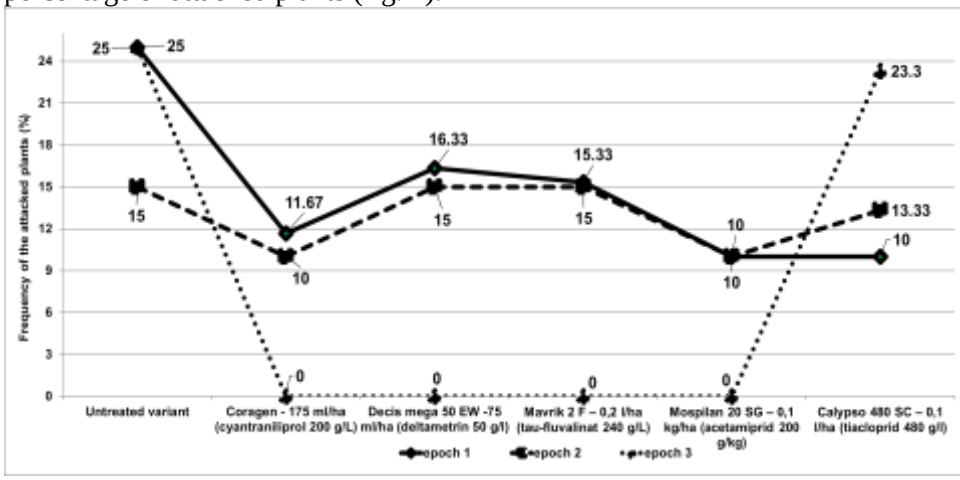

Fig. 1 The influence of the interaction between the sowing season and the treatments applied on the vegetation on the frequency of the attacked plants (%), Secuieni- Neamț - 2019

At the interaction between Epoch I (sown on 10.04.2019) x Treatments applied on vegetation with different active substances, all treated variants recorded low values of the number of holes, these being between 0.23 holes / plant (cyantranyliprole 200 g/L - Coragen - 175 mL/ha) and 0.40 holes (tau-fluvalinate 240 g / L - Mavrik 2 F - 0.2 L/ha) compared to 0.67 holes/plant as

recorded in the control, untreated variant. Regarding the average number of larvae/plant, the variant treated with active substances cyantranyliprole 200 g/L (Coragen - 175 mL/ha) in which 0.18 larvae / plant were registered, and following the application of pyrethroid products, the number of larvae varied from 0.25 (deltamethrin 50 g/L- Decis mega 50 EW -75 mL / ha) at 0.22 (tau-fluvalinate 240 g/L - Mavrik 2 F - 0.2 L/ha). In variants treated with acetamiprid 200 g/kg (Mospilan 20 SG - 0.1 kg/ha) and thiacloprid 480 g/L (Calypso 480 SC - 0.1 L/ha) up to 0.22 were identified on average larvae (fig. 2).

Compared to the untreated control of the second epoch sown in the second decade of April which showed 0.38 holes / plant and 0.37 larvae / plant, the variants where the products based on pyrethroids, neonicotinoids and anthranilamides were applied did not register larvae / plant, and the number of holes / plant varied from 0.15 (acetamiprid 200 g / kg - Mospilan 20 SG - 0.1 kg/ha) and 0.18 (cyantranyliprole 200 g/L - Coragen - 175 mL/ha) at 0.42 larvae / plant (deltamethrin 50 g/L - Decis mega 50 EW -75 mL/ha).

The lowest values of the average number of holes were recorded in the variants treated with cyantranyliprole 200 g/L (Coragen - 175 mL/ha) and acetamiprid 200 g / kg (Mospilan 20 SG - 0.1 kg/ha, while the variants where the products based on pyrethroids were applied obtained values relatively close to the average number of holes/plant to those of the control of the experiment, the untreated variant (fig. 2).

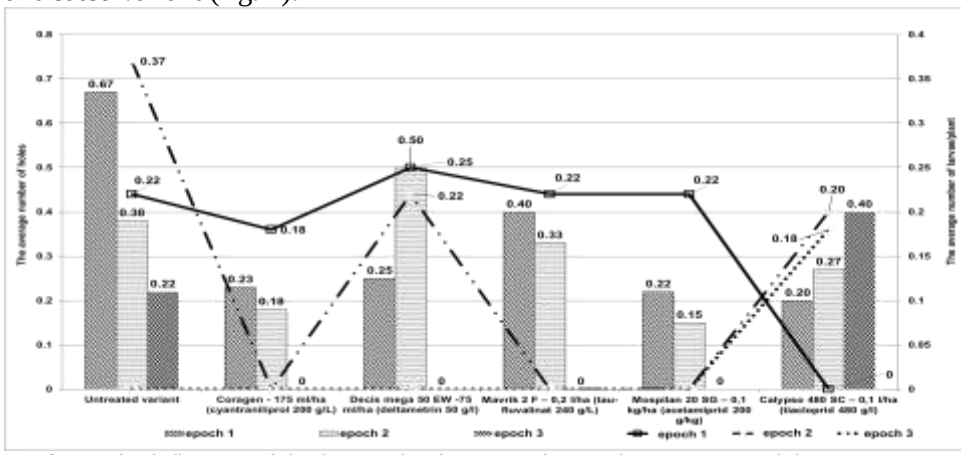

Fig. 2 The influence of the interaction between the sowing season and the treatments applied on vegetation on the average number of holes / plant and the average number of larvae/plant, Secuieni- Neamț - 2019

Similar results were obtained by Pilcher and Rice (2001) who found that maize sown at different times recorded significant differences in eggs density, the first generation of the pest laying between 50 and 100% of eggs on early sown maize plants, and about 40-60% of the eggs laid by the second generation were recorded in late sown maize.

CONCLUSIONS

1. The results obtained showed that vegetation treatments applied with insecticides from the class of pyrethroids, neonicotinoids and anthranilamides prevented the attack of larvae, reducing the number of holes, larvae and the average length of the gallery.

2. Chemical treatment with cyantraniliprole register the lowest values of the attack produced by this pest.

3. Indifferent of the epoch of sowing, the variant treated with the active substance cyantranyliprole recorded the lowest percentage of attacked plants.

4. The influence of the interaction of the two factors (epoch and treatment) led to the reduction of the average number of holes and larvae / plant, the lowest values were recorded at the variants sown in the third epoch.

REFERENCES

1. **Georgescu E., Toader Maria, Balaban Nicoleta, Rasnoveanu Luxita, Cana Lidia, 2016** - *Testing of the new active ingredients for controlling of the Ostrinia nubilalis Hbn at maize crop, in conditions of artificial infestation*, *at NARDI Fundulea*, Annals of the University of Craiova - Agriculture, Montanology, Cadastre Series, XLVI, 121
2. **Mazurek J., Hurej M., Jackowski J., 2005** - *The effectiveness of selected chemical and biological insecticides in control of European corn borer (Ostrinia nubilalis Hbn.) on sweet corn,* Journal of Plant Protection Research, 45(1)
3. **Obopile M., Hammond R.B., Thomison P.R., 2012**, *Maize–planting date interaction and effect of Bt maize on European corn borer (Ostrinia nubilalis (Hubner) (Coleoptera: Crambidae) damage*, South African Journal of Plant and Soil, 29:2, 109-115, DOI:10.1080/02571862.2012.719040
4. **Pilcher C.D., Rice M.E., 2001** - *Effect of planting times and Bacillus thuringiensis corn on the population dynamics of European corn borer* (*Lepidoptera: Crambidae*). Journal of Econ. Entomol. 94(3): 730-742.
5. **Roşca I., Oltean I., Mitrea I., Tălmaciu M., Petanec D. I., Bunescu H. S., Rada I., Tălmaciu Nela, Cătălin S., Micu Lavinia Mădălina, 2011** – *Tratat de entomologie generală şi specială*, Buzău, Ed. Alpha MDN
6. **Tărău Adina, Păcurar Ana-Maria, Mureşanu Felicia, Şopterean Laura, Cheşan Felicia, Varga A., Porumb Ioana, Russu F., Suciu Loredana, 2019** -*The research on the chemical control of the Ostrinia nubilalis Hbn., in natural and artificial infestation conditions, important link in integrated pest management*, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 19,(3),PRINT ISSN 2284-7995, E-ISSN 2285-3952, 585
7. **Trotuş Elena, Druțu Adina Cătalina, Găucă C., Popa Lorena Diana, Lupu Cornelia, Pochişcanu Simona, Naie Margareta, Leonte Alexandra, 2015** – *Tehnologii de cultivare a unor plante de câmp pentru zona Centrală a Moldovei*, Ed. Ion Ionescu de la Brad, Iaşi, ISBN 978 973 147
8. **Vălean Ana-Maria, Muresanu Felicia, Tărău Adina, Suciu Loredana, Sopterean Laura, Oltean I., 2017** – *Research on the Relationship between the degree of European corn borer (Ostrinia nubilalis Hbn.) attack and maize fusariosis (Fusarium spp.) at ARDS Turda*, Bulletin USAMV, series Agriculture 74(1), Print ISSN 1843-5246, Electronic ISSN 1843-5386

RESEARCHES REGARDING THE INFLUENCE OF TECHNOLOGICAL SEQUENCES ON THE YIELDS OF TUBERS AND BIOMASS AT JERUSALEM ARTICHOKE UNDER THE CONDITIONS OF A.R.D.S. SECUIENI

CERCETĂRI PRIVIND INFLUENȚA UNOR SECVENȚE TEHNOLOGICE ASUPRA PRODUCȚIEI DE TUBERCULI ŞI BIOMASĂ LA TOPINAMBUR ÎN CONDIȚIILE DE LA S.C.D.A. SECUIENI

MÎRZAN Oana[1]*, BOSTAN M.D.[1]., POPA D.L.[1]
*Corresponding author e-mail:spanuoana@yahoo.com

Abstract. *The paper aims to highlight the influence of the distance between tubers in a row and the nutrition system of the Jerusalem artichoke plant on the yields of tubers and biomass. The research was conducted between 2018 and 2019, in the experimental field of A.R.D.S. Secuieni. The obtained results showed that the studied factors influenced to a great extent the tuber yield obtained. Thus, the yield of tubers varied within wide limits, being between 23.16 t / ha (40 cm x N0P0K0) and 32.77 t / ha (50 cm x N120P120K80). The interaction of the studied factors influenced the yield of biomass at Jerusalem artichoke, ranging from 25.15 t / ha (40 cm x N0P0K0) to 35.45 t / ha (50 cm x N120P120K80).*
Key words: tubers, biomass, Jerusalem artichokes

Rezumat. *Lucrarea îşi propune să evidenţieze influența distanței între tuberculi pe rând şi a sistemului de nutriție al plantei de topinambur asupra producției de tuberculi şi biomasă. Cercetările au fost efectuate în perioada 2018 - 2019, în câmpul experimental al S.C.D.A. Secuieni. Rezultatele obținute au arătat că factorii studiați au influențat într-o măsură foarte mare producția de tuberculi obținută. Astfel, producția de tuberculi a variat în limite largi, fiind cuprinse între 23,16 t/ha (40 cm x N0P0K0) şi 32,77 t/ha (50 cm x N120P120K80). Interacțiunea factorilor studiați au influențat producția de biomasă la topinambur, variind de la 25,15 t/ha (40 cm x N0P0K0) până la 35,45 t/ha (50 cm x N120P120K80).*
Cuvinte cheie: tuberculi, biomasă, topinambur

INTRODUCTION

In Central and Western European countries, Jerusalem artichoke tubers are widely used as a raw material for the extraction of inulin and fructose (Fuchs, 1987; Grube *et. al*., 2002; Niness, 1999). Large tubers are preferred because they have a higher inulin content (Baert, 1996). Tubers can be used successfully to obtain biomass for biofuel or in the alcohol industry. They can also be used as animal feed or in the food and medicine industry. A substance contained in tubers,

[1] Agricultural Research and Development Station Secuieni, Neamț, Romania

inulin, has the lowest percentage of glucose and sucrose, compared to those obtained from other plants. This substance contributes to the normalization of blood sugar levels and is of real benefit to diabetics (Tanjor *et. al.*, 2012).

Jerusalem artichoke can grow in soils poor in fertility. However, the application of optimal technological links considerably increases crop productivity. Optimal technological links that increase the productivity of tubers and biomass include cultivar selection, planting date, fertilization, nutrition space, effective weed control, irrigation and harvest time.

MATERIAL AND METHOD

The trial was conducte on a typical cambic chernozem soil type, middle texture, acid: pH H2O–6.29, characterized as: well- supplied in phosphorus (39 ppm PAL), Ca (13.6 mEq/100 g soil Ca) and Mg (1.8 mEq/100 g soil Mg), middle supplied in active humus (1.88 %) and nitrogen (16.2 ppm N-NO3) and poorly supplied in potassium (124.6 ppm K2O). The experiment was organized in 2018-2019 in the experimental field of Agricultural Research - Development Station Secuieni, Neamt County, placed according to the method of subdivided plots in three replications.

Factor A was represented by the distance between plants in a row with two graduations: a1 - 40 cm and a2 - 50cm. Factor B was the fertilization system with five graduations: a1 - Unfertilized, a2 - N40P40K40, a3 - N80P80K80, a4 - N120P120K80 and a5 - N160P160K80.

RESULTS AND DISCUSSIONS

During the analyzed period, the studied factors influenced to a great extent the tuber production obtained. Thus, the average production varied in wide limits, being between 23.16 t/ha (40 cm x unfertilized variant) and 32.77 t/ha (50 cm x N120P120K80). Compared to the control variant (average experience), the non-fertilized variants achieved production differences between 5.38 t/ha and 2.14 t/ ha, interpreted as distinct and very significant.

Statistically assured production increases were within wide limits, from 1.83 t/ha (50 cm x N80P80K80), an increase interpreted as significant up to 4.24 t/ha (50 cm x N120P120K80), an increase interpreted as being distinct and very significant (tab. 1).

The biomass production of Jerusalem artichoke ranged from 25.15 t/ha (40 cm x unfertilized variant) to 34.45 t/ha (50 cm x N120P120K80). Compared to the control variant (average of experience), distinctly significant and very significant production increases were achieved at the interactions of 40 cm and 50 cm between tubers in a row at fertilization with N80P80K80 and N120P120K80 (2.03 t/ha - 4.53 t/ha), which means that Jerusalem artichoke responds favorably to planting 50 cm between tubers and higher doses of fertilizers (tab. 2).

Table 1

The influence of the interaction between the distance between tubers/row x fertilization on the tubers production at *Helianthus tuberosus* L. (Jerusalem artichoke), 2018-2019

Distance between tubers / row (cm) (A)	Fertilization (B)	Tubers production (t/ha)	%	Diff.	Sign.
40	Unfertilized	23.16	81.16	-5.38	ooo
	N40P40K40	25.99	91.08	-2.55	oo
	N80P80K80	28.43	99.63	-0.11	
	N120P120K80	30.81	107.97	2.28	**
	N160P160K80	28.28	99.11	-0.26	
50	Unfertilized	26.40	92.52	-2.14	oo
	N40P40K40	28.58	100.16	0.04	
	N80P80K80	30.36	106.40	1.83	**
	N120P120K80	32.77	114.86	4.24	***
	N160P160K80	30.51	106.94	1.98	**
Average		28.53	100	Ct.	
LSD A X B		5% = 1.13 t/ha 1% = 1.66 t/ha 0,1% = 3.01 t/ha			

Table 2

The influence of the interaction between the distance between tubers / row x fertilization on the biomass production at *Helianthus tuberosus* L. (Jerusalem artichoke), 2018-2019

Distance between tubers / row (cm) (A)	Fertilization (B)	Biomass production (t/ha)	%	Diff.	Sign.
40	Unfertilized	25.15	81.34	-5.77	ooo
	N40P40K40	28.13	90.96	-2.80	oo
	N80P80K80	30.57	98.85	-0.36	
	N120P120K80	32.95	106.55	2.03	**
	N160P160K80	30.42	98.38	-0.50	
50	Unfertilized	29.08	94.03	-1.85	oo
	N40P40K40	31.26	101.08	0.33	
	N80P80K80	33.04	106.84	2.11	**
	N120P120K80	35.45	114.63	4.53	**
	N160P160K80	33.18	107.31	2.26	**
Average		30.92	100	Ct.	
LSD A X B		5% = 1.16 t/ha 1% = 1.81 t/ha 0,1% = 3.47 t/ha			

CONCLUSIONS

1. Jerusalem artichoke can grow in poor soils in terms of fertility, but the application of optimal technological links considerably increases the production of tubers and biomass.

2. The application of the optimal technological links led to the obtaining of tuber productions of up to 32 t/ha and 35 t/ha of biomass production.

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REFERENCES

1. Baert J.R.A., 1995 - *The effect of sowing and harvest date and cultivar on inulin yield and composition of chicory (Cichorium intybus L.) roots*. Industrial Crops and Products, p.6, 195-199.

2. Fuchs A.,1987 - *Potentials for non-foods utilization of fructose and inulin, Starch*. Stă rke, p. 39, 335.

3. Grube M., Bekers D.U., Kaminska E., 2002 - *Infrared spectra of some fructans*. Spectroscopy, p. 16(3-4):289-296.4.

4.**Niness K.P., 1999** - *Nutitional and Health Benefits of Inulin and Oligofructose. Orafti Active ood Ingredients*. Malvern, PA 19355, American Society for Nutritional Science. J of Nutr, p. 129.

5.Tanjor S., Judprasong K., Chaito C., Jogloy S., 2012 - Inulin and Fructooligosaccharides in Different Varieties of Jerusalem Artichoke (*Helianthus tuberosus* L.). KKU Research Journal, p.17, 25-34.

INFLUENCE OF THE BIOLOGICAL PARTICULARITIES OF THE NEW VARIETIES INTRODUCED FROM THE WORLD COLLECTION ON FRUIT QUALITY

INFLUENȚA PARTICULARITĂȚILOR BIOLOGICE ALE SOIURILOR NOI INTRODUSE DE CAIS DIN COLECȚIA MONDIALĂ ASUPRA CALITĂȚII FRUCTELOR

NEGRU I. [1]*
*Corresponding author e-mail: negru.1989@mail.ru

Abstract. *The researches were carried out in the orchard of the company "Agroparc Management" LLC, during the 2019 year. Apricot trees were planted in the spring of 2015. The object of the research was the apricot trees Wonder Cot, Spring Blush, Magic Cot, Lilly Cot, Pinkcot, Perle Cot, Orange Red, Sweet Cot, Big Red, Kyoto, Faralia and Farbaly varieties , grafted on the Mirobalan 29C rootstock. It was established that the biological peculiarities of the variety influence on morphological parameters, shape index and redistribution of fruits in various quality classes.*
Key words: Apricot, variety, weight, shape index, quality.

Rezumat. *Cercetările s-au efectuat în livada întreprinderii SRL „Agroparc Management", în perioada anului 2019. Plantarea pomilor de cais s-a efectuat în primăvara anului 2015. Obiect al cercetărilor au fost pomii soiurilor de cais Wonder Cot, Spring Blush, Magic Cot, Lilly Cot, Pinkcot, Perle Cot, Orange Red, Sweet Cot, Big Red, Kioto, Faralia şi Farbaly, altoiți pe portaltoiul Mirobalan 29C. S-a stabilit că particularitățile biologice a soiului influențează parametrilor morfologici, indicele de formă şi redistribuirii fructelor în diverse clase de calitate.*
Cuvinte cheie: Cais, soi, greutate, indicele de formă, calitate.

INTRODUCTION

The culture of the apricot, whose fruits - apricots - are highly sought after, both for fresh consumption and in the food industry, has long been viewed with distrust, and considered risky, due to the traits related to low resistance to frost, sensitivity at specific diseases, premature loss of trees from plantations and short duration of fruit storage (Babuc, 2012; Balan *et al*., 2008; Cimpoieş, 2018; Cociu *et al*., 1993; Peşteanu *et al.,* 2018).

The primary task of fruit growers is to replace the old varieties, less corresponding to the requirements in force, with new ones, more suitable for the conditions of our country, more productive and already known by consumers in the markets we want to penetrate (Balan *et al.,* 2008; Lichou *et al*., 1988; Negru, 2018).

[1]State Agrarian University of Moldova, Chisinau, Republic of Moldova

This replacement may be possible based on the introduction of new modern varieties from the global range, which based on testing over 4-5 years on their adaptation to climatic, edaphic, biotic, abiotic and agrotechnical conditions in various areas of the country recommended in production (Cociu, 1993; Negru and Peşteanu, 2019; Pîntea, 2017).

Apricots being mostly intended for fresh consumption, they must meet certain requirements submitted by consumers, which are very difficult to achieve due to biological and technological features of the species (Cimpoieş, 2018, Cociu, 1993, Lichou *et al*., 1989; Peşteanu *et al.*, 2018).

In order to satisfy the consumer's necessities regarding the quality of the fruits and to penetrate new markets, the organoleptic apricots must be homogeneous in size, with a color specific to the variety, but priority is given to varieties where 60-80% of the fruit surface is red, medium weight, pulp firm, dry detachment, relatively small pips, attractive appearance and valuable nutritional biochemical composition (Balan *et al.* 2008; Cociu, 1993; Milatovic *et al*., 2013; Pîntea, 2019; Souty *et al*,. 1990).

The practical argumentation of the morphological characteristic and quality indices of fruits in various apricot varieties were the main objectives of the research in question.

MATERIAL AND METHOD

The researches carried out during the year 2019 in the intensive apricot orchard of the company "Agroparc Management". The plantation was founded in the spring of 2015, with one-year-old trees from the Wonder Cot, Spring Blush, Magic Cot, Lilly Cot, Pinkcot, Perle Cot, Orange Red, Sweet Cot, Big Red, Kyoto, Faralia and Farbaly varieties, grafted onto the Mirobalan 29C rootstock. The Kyoto variety, which has the same maturation period as the native Nadejda apricot variety, was taken as a witness. Planting distance 5.0x3.0m.

The average weight of the fruits was calculated by the weighing method, and the height, small and large diameter of the fruits by the measuring method. The shape of the fruits was expressed on the basis of the shape index, which was the correlation between the height of the fruit and the large diameter of the fruit.

The quality of apricots was determined by the method of measuring the large diameter in the equatorial area of the fruits. According to the quality and marketing requirements for fresh fruits and vegetables, apricots with a diameter of less than 30 mm may not be marketed. Apricots with a diameter of 30-35 mm are assigned to quality category I and II fruits, or are marked with the letter C, and those with a diameter greater than 35 mm to the extra quality category. Apricots of extra quality category are divided into the following classes: B - diameter 35-40 mm; A - diameter 40-45 mm; 2A - diameter 45-50 mm; 3A - diameter 50-55 mm and 4A - diameter 55 mm and larger.

The average value of the index under study was calculated at the main morphological parameters.

RESULTS AND DISCUSSIONS

The size and shape of the fruits influence the market value and are important indicators in the study of varieties, because they are directly related to

the quality of the product obtained, productivity in sorting and packaging of fruits.

The following study shows that the biological characteristics of the varieties also influenced the average weight of the fruits. By size, the apricot varieties studied can be divided into the following groups. The Sweet Cot variety is attributed to the group of very small varieties, weighing between 20-30 g, which has borne fruits in abundance and for the future in order to obtain competitive productions it is necessary to regulate the fruits load from the tree crown by manual thinning. The Lilly Cot, Perle Cot and Wonder Cot varieties are assigned to the group of those with small fruits whose average weight falls in the values of 31-40 g. To the group of varieties with medium fruits are placed the varieties Spring Blush, Orange Red, Big Red and Farbaly, whose average fruits weight was 41-50 g. The varieties Pinkcot and Faralia, according to the average weight of the fruits, belong to the group of varieties with large fruits (50-60 g), and the variety Magic Cot to the group of varieties with extra-large fruits, whose value was greater than 60 g.

The shape of the fruit is in strict accordance with the biological characteristics of the variety and can be from spherical, oval to ellipsoidal. Deviations from the fruit form indicate an incomplete development due to water insufficiency during fruit development (Mitrea, 2007; Piagnani, 2013).

Table 1

The morphological parameters of apricots according to the biological particularities of the variety, 2019

Variety	Weight, g	Height, mm	Large diameter, mm	Small diameter, mm	Shape index
Wonder Cot	38.5	49.7	39.3	36.4	1.26
Spring Blush	42.2	44.5	43.2	38.9	1.03
Magic Cot	62.2	53.0	46.1	45.7	1.15
Lilly Cot	31.1	40.2	38.4	32.8	1.05
Pinkcot	55.5	46.8	45.5	43.2	1.03
Perle Cot	31.5	40.8	39.6	35.6	1.03
Orange Red	41.2	46.8	44.5	37.8	1.05
Sweet Cot	24.7	37.6	36.3	32.7	1.04
Big Red	40.1	43.0	41.8	39.6	1.03
Kioto (w)	47.4	44.9	44.4	41.4	1.01
Faralia	50.6	54.7	46.9	42.0	1.07
Farbaly	40.1	47.1	36.1	39.6	1.12
Average	42.1	45.7	42.3	38.4	1.07

The height and large diameter of the apricots are the characteristics that define the shape of the fruit. Differences in fruit height are genetic in nature. The lowest fruit heights were recorded in the Sweet Cot variety (37.6 mm), and the highest in the Faralia variety (57.7 mm). In general, all apricot varieties studied can be divided according to the height of the fruits into 3 groups. That is, varieties with fruits height up to 40 mm are assigned the variety Sweet Cot, varieties with a height of 40-50 mm where most of the studied varieties include Wonder Cot, Spring Blush, Lilly Cot, Pinkcot, Perle Cot, Orange Red, Big Red, Kyoto and Farbaly. The Magic Cot and Faralia varieties recorded values higher than 50 mm.

The large diameter and small diameter of the varieties studied were influenced by the biological characteristics of the variety. If, for example, in most apricot varieties after the large diameter values greater than 40 mm were recorded, then in the varieties Wonder Cot, Lilly Cot, Sweet Cot and Perle Cot had a diameter between 36.3-39.6 mm. According to the values of the small diameter we register diametrically opposite correlations. In this case, only for the Magic Cot, Kyoto and Faralia varieties, the diameter of apricot fruits had values higher than 40 mm, and for the other varieties studied they varied from 32.7 to 39.6 mm.

The study carried out on the shape of the fruits by means of the shape index shows that in all the studied varieties values higher than 1.0 was registered. If in the varieties Spring Blush, Sweet Cot, Lilly Cot, Pinkcot, Perle Cot, Big Red, Orange Red and Kyoto the shape index varied from 1.01 to 1.05, which highlights the spherical shape of the fruits, then in the varieties Wonder Cot, Magic Cot, Faralia and Farbaly this index registered values of 1.15-1.26, that is, the fruits had a spherical elongated and cordiform shape.

The dimensions of the fruits are of special importance because depending on them the fruits are redistributed on different quality classes, on which then depends the selling price, so implicitly the economic efficiency. Particularly important is the diameter of the fruit in the equatorial plane, which is a very important quality element, which in addition to hereditary influences is strongly conditioned by environmental and cultural factors.

The investigations show that from the studied varieties, quality category I and II fruits (class C) are registered in the Wonder Cot varieties (2.11%) and in the Lilly Cot variety (22.0%). In the other varieties, the fruits had a diameter greater than 35 mm and were assigned to quality class B. More than 50% of the fruit in that class was registered in the Wonder Cot variety (58.47%), Lilly Cot (76.9%), Perle Cot (55.2%) and the Sweet Cot variety (78, 0%). In the Faralia (3.0%), Kyoto (6.0%), Big Red (10.7%) and Orange Red (10.8%) varieties, an insignificant share of fruits was registered in the respective class.

In quality class A, a higher share of fruits returned to the varieties Spring Blush (81.5%), Pinkcot (39.75%), Pearl elbow (44.8%), Big Red (89.3%) and Farbaly (96.7%). The varieties Magic Cot, Lilly Cot, Orange Red, Kyoto and Faralia formed a lower share of fruits in that class (16.3-34.6%) Apricot fruits

with a diameter greater than 45 mm (class 2A and 3A) enjoys a popularity among consumers. Values higher than 50% in class 2A were registered for the varieties Magic Cot (70.6%), Pinkcot (60.25%), Orange Red (63.4%), Kyoto (59.4%) and the Faralia variety. (74.8%). A limited amount of fruit was assigned to quality class 3A.

Table 2

The influence of the biological particularities of apricot varieties on the quality of fruits by diameter and weight, %, 2019

Variety	By diameter				
	C	B	A	AA	AAA
Wonder Cot	2.11	58.47	39.42	-	-
Spring Blush	-	-	81.50	18.50	-
Magic Cot	-	-	24.00	70.60	5.40
Pinkcot	-	-	22.75	62.41	14.84
Perle Cot	-	55.20	44.80	-	-
Orange Red	-	10.8	25.8	63.4	-
Sweet Cot	22.00	78.00	-	-	-
Lilly Cot	-	76.90	23.10	-	-
Big Red	-	10.70	89.30	-	-
Kioto (w)	-	6.00	34.60	59.40	-
Faralia	-	-	16.30	74.80	8.90
Farbaly	-	3.30	96.70	-	-

Thus, the biological characteristics of the variety and the conditions recorded during fruits development directly influence the quality of the fruits.

CONCLUSIONS

The biological particularities of the varieties and the temperatures during the optional rest and the vegetation period influence the onset of the phenophase, the beginning of the flowering and the maturation of the harvest.

Morphological parameters are a valuable tool in assessing fruits quality, which is valuable information for fruit growers, who need to pay more attention to technological elements for cultivated fruits to be successful among consumers.

Most of the studied apricot varieties have a spherical fruit shape and only in the Wonder Cot, Magic Cot, Faralia and Farbaly varieties did the fruits have an elongated spherical and cordiform shape.

Of the studied varieties, a higher share of quality class A and 2A fruits was registered in the varieties Spring Blush, Magic Cot, Pinkcot, Big Red, Orange

Red, Kyoto Faralia and Farbaly. The other varieties formed more quality class B fruits to the detriment of those with a larger diameter. In order to obtain higher quality harvests for the varieties in question, it is recommended to regulate the fruits load.

REFERENCES

1. Babuc V., 2012 - *Pomicultura.* Chişinău, p. 348-354.

2. Balan V., Stănică Fl., Chira L. et al., 2008 - *Caisul şi caisele.* Bucureşti: Ceres, 686 p.

3. Cimpoieş Gh., 2018 - *Pomicultura specială.* Chişinău: Gologra-com, 336 p.

4. Cociu, V. et al., 1993 - *Caisul.* Bucureşti: Editura Ceres, 401 p.

5. Lichou J., Albagnac G., Audergon J. M. et al., 1998 - *Abricot. Les variétiés, mode d`emploi*. Ctifl. Paris, 254 p.

6. Lichou J., Audubert A., Pratx M. et al., 1989. - *L' abricotier.* Ctifl . Paris, 386 p.

7. Milatovic D., Đurovic D., Zec G., 2013 - *Evaluation of french apricot cultivars in the region of Belgrade.* IV International Symposium „Agrosym 2013", p. 196-201.

8. Mitrea V., 2007 - *Pomologie.* Cluj Napoca. Edituta Todeco, p. 175-188.

9. Negru I., 2018 - *Dezvoltarea pomilor de cais altoiți pe portaltoiul Mirobalan 29C în funcție de modul de formare a coroanei în perioada de creştere a plantației.* Lucrări ştiințifice UASM. Chişinău Vol. 47. Horticultură, Viticultură și vinificație, Silvicultură și grădini publice, Protecția plantelor, p.77-82.

10. Negru I., Peşteanu, A., 2019 - *Comportarea unor soiuri de cais din colecția mondială cultivate în zona de sud a Republicii Moldova.* Ştiința Agricolă. Chişinău, nr. 2, p. 52-59.

11. Peşteanu A., Manziuc V., Cumpanici A., Gudumac E., Braghiş A., 2018 - *Producerea caiselor.* Manual tehnologic. Chişinău, 291 p.

12. Piagnani M. C., Castellari L., Sgarbi P., Bassi D., 2013 - *Fruit quality evaluation of diverse apricot cultivars.* Aspects of Applied Biology. Vol. 119, p. 139-144.

13. Pîntea M., 2017 - *Diversification of apricot (prunus armeniaca l.) assortment for sustainable production in the conditions of Republic of Moldova*. Conservation of plant diversity. Chişinău, p. 100.

14. Pîntea M., 2019 - *Cercetari agrobiologice asupra sortimentului modern de cais.* Ştiința în Nordul Republicii Moldova: realizări, probleme, perspective. Ediția a 3-a. Balti, p. 249-253.

15. Souty M.; Audergon J.M.; Chambroy L., 1990 - *Apricot, le critere de qualite.* L'arboriculture fruitiere, Nr. 91, p. 16-24.

THE INFLUENCE OF DIFFERENT FRUIT THINNING PRODUCTS ON PRODUCTIVITY AND QUALITY OF 'FUJI KIKU' VARIETY

INFLUENȚA DIFERITOR PRODUSE DE RĂRIRE A FRUCTELOR ASUPRA PRODUCTIVITĂȚII ŞI CALITĂȚII LA SOIUL 'FUJI KIKU'

PESTEANU A.*[1]*

*Corresponding author e-mail: a.pesteanu@uasm.md

Abstract. *The study subject was Fuji Kiku apple variety grafted on M9. To study thinning of apple fruits were experimented the following variants: 1. Control – without treatment; 2. Manual thinning; 3. Ger ATS LG, 12 L/ha; 4. Geramid New, 1.5 L/ha; 5. Dirager, 0.3 L/ha; 6. Goltex 700SC, 3.5 L/ha; 7. Dira Max LG, 2.5 L/ha; 8. Gerba 4 LG, 2.5 L/ha. It was established that, the good effect of thinning was after application with Ger ATS LG, 12 L/ha. In the case of no favorable conditions during the previous treatment, must to utilize Goltex 700SC, 3.5 L/ha, Dira Max LG, 2.50 L/ha and Gerba 4 LG in the dose 2.5 L/ha, when the size of the central flower of the inflorescence has a diameter of 10-15 mm. It not recommended for the Fuji Kiku variety to spray with NAD (Geramid New) and ANA (Dirager), because formed a large "pygmy" fruits.*
Key words: apple, growth regulator, thinning, yield, quality

Rezumat. *Obiect a studiului a fost soiul Fuji Kiku altoit pe M9. Pentru studia diferitor produse de răririe a fructelor s-au experimentat următoarele variante: 1. Martor - fără tratament; 2. Răririe manuală; 3. Ger ATS LG, 12 L/ha; 4. Geramid Nou, 1,5 L/ha; 5. Dirager, 0,3 l/ha; 6. Goltex 700SC, 3,5 L/ha; 7. Dira Max LG, 2,5 L/ha; 8. Gerba 4 LG, 2,5 L/ha. S-a stabilit că răririe eficace a fost înregistrată la tratarea cu Ger ATS LG, 12 L/ha. Când nu sunt condiții favorabile în timpul tratamentului anterior, de utilizat Goltex 700SC, 3,5 L/ha, Dira Max LG, 2,50 L/ha şi Gerba 4 LG în doza de 2,5 L/ha, când diametrul fructului central în inflorescență este de 10-15 mm. Nu se recomandă de tratat soiul Fuji Kiku cu produse pe bază de NAD (Geramid New) şi ANA (Dirager), deoarece se formează un număr mare de fructe „pygmy".*
Cuvinte cheie: măr, regulator de creştere, răririe, recoltă, calitate

INTRODUCTION

Large, high quality fruit production can be obtained only by implementing modern technologies in accordance with the natural, economic conditions, specific to each field sector of the enterprises (Babuc *et al.* 2013).

The normalization of the load fruit organs is the technological operation through which the fruit load is regulated in order to obtain the highest possible production constantly year by year and high quality (Peşteanu and Calestru, 2017).

Currently, a lot of apple varieties set a large amount of fruits. In order to

[1]State Agrarian University of Moldova, Chisinau, Republic of Moldova

normalized the amount of load fruit organs in apple trees, it is necessary to act on newly formed flowers and fruits by manual or chemical thinning (Balan and Vămă;escu, 2011; Basak, 2004; Cimpoieş, 2012; Vămăşescu, 2012).

Currently, for chemical thinning use products whose active ingredients are: NAD, ANA, 6-Benzyladenine, Metamitron, etc., or different combinations of these products: ANA + BA, Etefon + ANA, Etefon + BA etc. (Basak, 2004; Brunner, 2014; Gabardo *et al.* 2017; Peşteanu and Calestru, 2020; Stopar, 2006).

The amount of applications of growth regulators, as well as the terms of treatment, depending on the type of preparation used or their combination, variety, area, age of trees, climatic conditions, etc. (Babuc *et al.* 2013; Peşteanu, 2015).

MATERIAL AND METHOD

The research was carried out in the apple orchard of "Domulterra" LLC. The planting was carried out in the spring of 2013, with "Knip baum" type trees. During 2016, was studied the influence of different growth regulators on the Fuji Kiku variety grafted on the M9 rootstock. The planting distance is 3.5x0.8 m.

In accordance with the endowment growth regulators intended for the chemical thinning of fruits, the following scheme of spray was elaborated (tab. 1).

Table 1

The scheme of experiments on the normalization of the load of fruit organs by using different products and thinning methods for Fuji Kiku apple trees

Variants	Active ingredient	Application method
Without thinning, (control)	-	-
Manual thinning	-	Manual thinning of the fruits was performed when the fruits were 1.5-2.0 cm in diameter.
Ger ATS LG, 12 L/ha	N 12%, SO_3 65%	By spraying, when the central flowers on the perennial wood bloomed + 2-3 days.
Geramid New, 1,5 L/ha	NAD (40g/L)	By spraying, when the fall of 80% of the petals occurred, + 2-3 days
Dirager, 0,3 l/ha	ANA (37g/L)	By spraying, when the diameter of the central fruit in the inflorescence is 8-9 mm.
Goltex 700SC, 3,5 L/ha	Metamitron, 350 mg/L	When the diameter of the central fruit in the inflorescence is 10-12 mm.
Dira Max LG, 2,5 L/ha	6BA (41g/L) ANA (4,1g/L)	By spraying, when the diameter of the central fruit in the inflorescence is 10-15 mm.
Gerba 4 LG, 2,5 L/ha	6BA (41g/L)	By spraying, when the diameter of the central fruit in the inflorescence is 10-15 mm.

The research was performed in the field and laboratory conditions according to the accepted method of carrying out experiments on fruit crops with growth regulators.

RESULTS AND DISCUSSIONS

The investigations carried out during the rest period (tab. 2) show us that the Fuji Kiku variety trees differentiated a sufficient amount of fruit buds, which when the trees bloomed in spring formed 218-227 inflorescences. This constitutes 1090-1135 flowers, which as a result of a favorable pollination allow obtaining constant fruit harvests.

The whole range of products used to regulate the fruit load can be divided into 2 groups according to the amount of inflorescences tied in the crown of the trees. The first group includes Geramid New and Dirager products, and the second group includes Ger ATS LG, Goltex 700SC, Dira Max LG and Gerba 4 LG.

In the manual thinning version, all the fruits are placed one by one in the inflorescence and obtaining a higher quality production both from an organoleptic and biochemical point of view.

Lower values were recorded in the variants treated with Geramid New growth regulator at a dose of 1.5 L/ha and Dirager at a dose of 0.3 L/ha.

When using the Dira Max LG growth regulator at a dose of 2.5 L/ha, the share of one fruit in one inflorescence was 88.5%, of two fruits 10.3% and only 1.2% of the inflorescences formed three fruits each.

The most rational location of the fruits in an inflorescence with chemical thinning was registered in the variant where the Goltex 700SC product was used in the dose of 3.5 L/ha, where 94.4% of the fruits were one in the inflorescence, and 5.6% two fruits in inflorescence.

Table 2

The amount of total inflorescences (ATI), set (ASI) in the crown of Fuji Kiku apple trees and the share of fruits in an inflorescence according to the growth regulators used to thin the reproductive organs, 2016

Variants	ATI, pcs/tree	ASI, pcs/tree	The share of fruits in an inflorescence, %			
			1 pcs	2 pcs	3 pcs	4 pcs
Without thinning, (control)	220	100	36.0	30.0	20.0	14.0
Manual thinning	223	79	100.0	-	-	-
Ger ATS LG, 12 L/ha	218	90	81.1	13.3	5.6	-
Geramid New, 1.5 L/ha	221	76	65.8	19.7	13.1	1.4
Dirager, 0.3 L/ha	225	72	68.0	15.3	13.9	2.8
Goltex 700SC, 3.5 L/ha	218	89	94.4	5.6	-	-
Dira Max LG, 2.5 L/ha	227	87	88.5	10.3	1.2	-
Gerba 4 LG, 2.5 L/ha	224	84	92.8	7.1	-	-

Significantly lower values were recorded in the variant where the trees were treated with the Gerba 4 LG growth regulator at a dose of 2.5 L/ha.

The amount of fruits differs depending on the variants studied. The

highest amount of fruits was recorded in the control version, without thinning, where the index under study was 245 pcs/tree.

In the variant with manual thinning and the variants with chemical thinning of the fruits, an essential decrease of the quantity of fruits in the crown of the trees was registered, varying from 79 to 114 pcs. This shows us that different products intended for the normalization of the reproductive organs differently influenced the amount of fruits in the crown of the trees (tab. 3).

The amount of fruits left in the crown of the tree at manual thinning was determined by the cross-sectional area of the trunk and the fruiting capacity of the Fuji Kiku variety and constituted 7 pcs/cm^2 of SSTT. In this variant, the amount of fruits was 79 pcs/tree, or 3.2 times less, compared to the control variant.

In the case of treating the trees with Gerba 4 LG products at a dose of 2.5L/ha, Goltex 700SC at a dose of 3.5 l/ha and Dira Max at a dose of 2.5 L/ha, the amount of fruits in the crown of the trees constituted, respectively 90; 94 and 98 pcs/tree.

Variants treated with Dirager growth regulators at a dose of 0.3 L/ha, Geramid New at a dose of 1.5 L/ha and foliar fertilizer Ger ATS LG at a dose of 12.0 L/ha, the amount of fruits increased compared to the previous variants with chemical thinning, registering, respectively, 109; 114 and 112 pcs/tree.

Table 3

The influence of the growth regulator on the thinning of the reproductive organs on the fruit production in the crown of Fuji Kiku apple trees, 2016

Variants	The number of fruits, pcs/tree	Average weight, g	Fruit production		In % compared to control variant
			kg/tree	t/ha	
Without thinning, (control)	252	87.5	22.05	78,74	100.6
Manual thinning	79	178.4	14.09	50.31	63.8
Ger ATS LG, 12 L/ha	112	164.7	18.44	65.85	83.6
Geramid New, 1.5 L/ha	114	134.3	15.31	54.67	69.4
Dirager, 0.3 L/ha	109	130.7	14.25	50.88	64.6
Goltex 700SC, 3.5 L/ha	94	168.8	15.86	56.63	71.9
Dira Max LG, 2.5 L/ha	98	167.7	16.43	58.67	74.5
Gerba 4 LG, 2.5 L/ha	90	170.1	15.31	54.67	69.4
LDS 5%	8.7	7.7	1.03	2.87	-

Lower values of the average weight of a fruit were recorded in the control variant, where the mentioned index was 87.5 g. On the other variants studied only when using Geramid New growth regulators at a dose of 1.5 L/ha and Dirager in dose 0.3 L/ha, the average weight of a fruit was less than 150 g and amounted to 134.3 and 130.7 g, respectively. This decrease in the average weight of fruit in the Fuji Kiku variety was due to the fruit "pygmy" who was obtained as a result of treatment with products based on NAD and ANA meaning there was a blockage of fruit development.

On the other variants, the average weight of the fruits registered higher values constituting 164.7 - 178.4 g.

The obtained results show us that the use of products for the normalization of the reproductive organs increased by 188.2-194.4% the average weight of the fruits compared to the control variant.

Higher fruit productions per tree and per unit area were registered in the control variant, without thinning where the mentioned indexes constituted respectively 22.05 kg/tree and 78.74 t/ha. Next, the variant treated with the foliar fertilizer Ger ATS LG in the dose of 12.0 L/ha is placed in decrease, where the fruit production registered, respectively 18.44 kg/tree and 65.85 t/ha.

In the case of the manual thinning variant, the productivity of a tree constituted 14.09 kg, and at a surface unit 50.31 t/ha/was obtained, or a decrease by 56.5% compared to the control variant. Productions, identical as in the manual thinning variant, were also registered in the variant treated with the Dirager growth regulator at a dose of 0.3 l/ha, where it constituted - 50.88 t/ha.

In the other variants treated with Geramid New products, 1.5 L/ha; Gerba 4LG, 2.5 L/ha; Goltex 700SC, 3.5 L/ha and Dira Max LG, 2.5 L/ha, the fruit production was higher than 50 t/ha and constituted 54.67 respectively; 54.67; 56.63 and 58.67 t/ha.

In the case of the control variant, without thinning, the fruits that are attributed to category I of quality constituted 23.4%, to category II of quality - 33.4%, and the others were unconditioned (tab. 4).

Table 4

The influence of the method of thinning the reproductive organs on the redistribution of fruits according to their diameter in apple trees of the Fuji Kiku variety, 2016

Variants	The share of fruits (%) based on their diameter (mm)							Average diameter, mm
	>55	56-60	61-65	66-70	71-75	76-80	<80	
Without thinning, (control)	12.4	30.8	33.4	23.4	-	-	-	53.8
Manual thinning	-	-	-	4.7	20.3	28.7	46.3	78.4
Ger ATS LG, 12 L/ha	-	-	5.7	10.4	30.0	28.4	27.5	73.7
Geramid New, 1.5 L/ha	2.7	4.2	14.3	16.4	30.1	32.3	-	71.4
Dirager, 0.3 L/ha	1.0	2.4	16.7	18.1	29.0	32.8	-	71.7
Goltex 700SC, 3.5 L/ha	-	-	3.7	7.3	26.1	30.7	32.1	75.1
Dira Max LG, 2.5 L/ha	-	-	4.6	8.7	27.7	29.0	30.0	75.6
Gerba 4 LG, 2.5 L/ha	-	-	2.1	5.8	25.7	32.1	34.3	76.0

The variants treated with Goltex 700SC products at a dose of 3.5 L/ha and Dira Max LG in the amount of 2.5 L/ha registered insignificantly lower values compared to the manual thinning variant.

Variants where manual thinning and chemical thinning were performed with Ger ATS LG at a dose of 12.0 L/ha, Goltex 700SC at a dose of 3.5 L/ha, Dira Max at a dose of 2.5 L/ha and Gerba 4 LG at a dose 2.5 L/ha most fruits are assigned to category I and extra quality. Only in the variants treated with Dirager in the dose of 0.3 L/ha and Geramid New in the dose of 1.5 L/ha, a higher percentage of fruits is attributed to those with a diameter of less than 61-65 mm.

CONCLUSIONS

1. To normalize the load of apple fruits, the treatment of Fuji Kiku trees needs to be carried out with the foliar fertilizer Ger ATS LG in a dose of 12.0 L/ha, applied by the spraying method, when the central flowers on the wood older than two years of flowering plus 2-3 days.

2. If, during the previous treatment, there were no favorable conditions to spray with the foliar fertilizer Ger ATS LG , the treatment can be performed with Goltex 700SC products in a dose of 3.5 L/ha, Dira Max LG in a dose of 2.50 L/ha and Gerba 4 LG at a dose of 2.5 L/ha, when the size of the central fruit in the inflorescence is 10 - 15 mm in diameter. Since 2018, the product Brevis is registered in the Republic of Moldova, whose active ingredient is metamitron.

3. It is not recommended for Fuji Kiku variety to use growth regulators based on NAD (Geramid New) and ANA (Dirager), as a large amount of "pygmy" type fruits is formed.

REFERENCES

1. **Babuc V., Peşteanu A. Gudumac E., Cumpanici A., 2013** - *Producerea merelor.* Chişinău, 240 p.
2. **Balan V., Vămăşescu S., 2011** - *Increase quantity and quality of apple fruit by normalization of load by different methods of thinning.* Lucrari ştiinţifice Seria B- LV. UŞAMV. Bucureşti, Seria Hortcultură, p. 352 - 357.
3. **Basak A., 2004** - Fruit thinning by Using Benzyladenine (BA) with Ethephon, ATS, NAA, Urea and Carbaryl in Some Apple Cultivars. Acta hort. 653, p. 99-106.
4. **Brunner P., 2014** - Impact of metamitron as a thinning compound on apple plants. Acta Hort. 1042, p. 173-181.
5. **Gabardo G. C., Petri J. L., Hawerroth F. J., Couto M. et al., 2017** - *Use of Metamitron as an apple thinner.* Rev. Bras. Frutic. vol. 39, no. 3, p. 1-9.
6. **Cimpoieş Gh., 2012** - *Cultura mărului.* Chişinau, Editura „Bons Offices", 380 p.
7. **Peşteanu A., 2015** - *The influence of thinning agent on base of 6-BA and NAA on productivity and fruit quality of "Gala Must" variety.* In: Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, vol. 72(1), Horticulture, p. 151-156.
8. **Peşteanu A., Calestru O., 2017** - *Reglarea încărcăturii de rod la pomii de măr de soiul Golden Reinders prin diverse metode de rărire.* In: Ştiinţe Agricole. nr. 2, p. 37-42.
9. **Peşteanu A., Calestru O., 2020** - *Eficacitatea normării încărcăturii de rod la unele soiuri de măr în perioada precoce de dezvoltare a organelor reproductive.* In: Ştiinţe Agricole. nr. 1, p. 46-54.
10. **Stopar M., 2006** - *Thinning of "Fuji" apple trees with Ethephon, NAD and BA, alone and in combination.* Journal of Fruit and Ornamental Plant. vol. 14, p. 39-45.
11. **Vămăşescu S., 2012** - *Apple harvest based on the variety and the fruit thinning method system.* Annals of the University of Craiova. vol. XVII (LIII), p. 437 – 442.

NURSERY VEGETATIVE GROWTH OF 'AROMAT DE IAŞI' AND 'GOLIA' GRAPE VARIETIES, BY ANALYSIS OF FOLIARY PHOTOSYNTHETIC PIGMENTS

STUDIU PRIVIND CREŞTERILE VEGETATIVE ÎN ŞCOALA DE VIŢE LA SOIURILE PENTRU STRUGURI DE VIN 'AROMAT DE IAŞI' ŞI 'GOLIA', PRIN ANALIZA PIGMENŢILOR FOTOSINTETICI FOLIARI

CIMPOI V.I.[1]*, ROTARU Liliana[1], FILIMON R.V.[2], COLIBABA Lucia Cintia[1], ALEXANDRU L.C.[2], SCUTARAŞU Elena Cristina[1], CĂLIN Ioana[1]
*Corresponding author e-mail: cimpoivladut@gmail.com

Abstract.*The physiological role of the assimilating pigments is complex, being involved in the processes of oxidation-reduction, in the photosynthesis and protection processes against ultraviolet radiation. The study aims to track vegetative growth during the vegetation period by spectrophotometrically determining the content of chlorophylls (a and b) and carotenoids from the leaves of vine varieties (Vitis vinifera L.) for wine grapes Aromat de Iaşi and Golia, new varieties created within the Research and Development Station for Viticulture and Winemaking Iasi. The two varieties were grafted on three rootstocks (RipariaGloire, Berlandieri x Riparia Selection Oppenheim 4-clone 4 and Berlandieri x Riparia Selection Crăciunel 2), thus creating six working variants. Following the completion of the observations, Golia/SO_{4-4} variant recorded the best results in terms of vegetative growth in the vegetation period measuring 41.83 cm (before wood maturation) followed very close by Aromatde Iasi/RipariaGloire, which recorded 41,71 cm at the last measurement. Regarding the determination of the content of photosynthetic pigments (chlorophyll a and b, respectively carotenoids), the best results were obtained in the Aromat de Iaşi variety on almost all variants. Golia grape variety registered smaller values.*
Key words: carotenoids, chlorophyll *a* and *b*, photosynthetic pigments, vegetative growths

Rezumat. *Rolul fiziologic al pigmenţilor asimilatori este complex, fiind implicaţi în procesele de oxido-reducere, în procesele de fotosinteză, fructificare şi de protecţie faţă de radiaţiile ultraviolete. Studiul are ca scop urmărirea creşterilor vegetative în perioada de vegetaţie prin determinarea spectrofotometrică a conţinutului în clorofile (a şi b) şi carotenoizi din frunzele soiurilor de viţă de vie (Vitis vinifera L.) pentru struguri de vin Aromat de Iaşi şi Golia, soiuri nou create în cadrul Staţiunii de Cercetare şi Dezvoltare pentru viticultură şi vinificaţie Iaşi. Cele două soiuri au fost altoite pe trei portaltoi (Riparia Gloire, Berlandieri x Riparia Selectia Oppenheim 4-clona 4 şi*

[1]University of Agricultural Sciences and Veterinary Medicine Iasi, Romania
[2]Vine and Wine Research and Development Station of Iaşi, Romania

Berlandieri x Riparia Selecția Crăciunel 2), creindu-se astfel şase variante de lucru. În urma finalizării observațiilor efectuate s-a putut constata că varianta Golia/SO_{4-4} a înregistrat cel mai bun rezultat în ceea ce priveşte creşterile vegetative din perioada de vegetație, la ultima măsurătoare, făcută înainte de maturarea lemnului, având 41,81 cm, iar cea mai bună variantă pentru al doilea soi luat în studiu a fost Aromat de Iaşi/Riparia Gloire care a înregistrat la ultima măsurătoare 41,71 cm. În privința determinării conținutului pigmenților fotosintetici (clorofila a şi b, respectiv carotenoizi) cele mai bune rezultate au fost obținute la soiul Aromat de Iaşi pentru aproape toate variantele pe care a fost altoit, comparativ cu soiul Golia care a avut rezultate mai slabe.

Cuvinte cheie: pigmenți fotosintetici, clorofila a şi b, carotenoizi, creşteri vegetative

INTRODUCTION

Chlorophylls (Chl) are probably the most important organic compounds on earth, as they are required for photosynthesis (Davies, 2004; Willows, 2004).

Photosynthesis in plants is dependent upon capturing light energy in the pigment chlorophyll, and in particular chlorophyll *a* (Blankenship, 2014). Photosynthetic activity is a very intense process (5 to 11 μmol CO2/m2/s) that provides all the organic material needed for the growth and life activity of the plant (Popescu and Popescu, 2014). This is why photosynthesising cells have to contain large amounts of assimilatory pigments, up to 5% of total dry solids (Rabinowitch and Govindjee, 1969). In most species, the photosynthetic pigment content of the leaves provides valuable insight into the physiological performance of plants (Sims and Gamon, 2002). Moreover, the assessment of photosynthetic pigments, and consequently their relationships, is an important indicator of leaf senescence (Netto *et al*.,2005).

Chlorophyll is a bright green natural pigment found in all photosynthetic plants, allowing them to absorb energy from light (Hörtensteiner and Kräutler, 2011). Forms *a* and *b* are the major types of chlorophyll that predominate in the chloroplasts of all higher plants (Willows, 2004; Raven *et al*., 2005). Most analytical studies have reported the total chlorophyll contents as the sum of Chl *a* and Chl *b* (Lanfer Marquez and Sinnecker, 2008).

On the other hand, carotenoids are a large group of deeply red or yellow lipophilic accessory pigments (Pfander, 1992). Carotenoids are found in all photosynthetic organisms, being involved in photosystem assembly, and contribute to light harvesting by absorbing light energy in a region of the visible spectrum where chlorophyll absorption is lower and by transferring the energy to chlorophyll (Britton, 2008). Also, carotenoids provide protection from excess light, free-radical detoxification and limiting damage to membranes (Cuttriss and Pogson, 2004).

MATERIAL AND METHOD

In order to carry out this study, research was conducted within the Research and Development Station for Viticulture and Winemaking in Iaşi, in 2019. Two varieties of wine grapes, Aromat de Iaşi and Golia, obtained at SCDVV Iaşi (tab. 1), were grafted onthree rootstocks (Riparia Gloire, Berlandieri x Riparia Selection Oppenheim 4-clone 4 and Berlandieri x Riparia Selection Crăciunel 2), thus creating six working variants.

Table 1

Studied biological material

Grape variety	Genitors	Author	Year of homologation
Aromat de Iaș i 	Free fecundation of local grape variety Coarnăneagră and irradiation with X rays of its seeds	Dănulescu Dumitru Sandu-Ville Gorun Popescu Gheorghe	1980
Golia 	Intraspecific hybridation of Sauvignon x Şarbă	Dănulescu Dumitru Calistru Gheorghe Damian Doina Crăcană Alexandru	1999

Using the two varieties taken into consideration, respectively the three rootstocks on which the varieties were grafted, two series of determinations were made:

Determinations regarding the content in photosynthetic pigments, chlorophyll (a and b) and leaf carotenoids for each created variant and determinations on vegetative growth during the vegetation period.

The determination of the content in photosynthetic pigments from leaves was performed by the extraction of chlorophyll (*a* and *b*) and carotenoids (xanthophylls and carotenoids). The harvested leaves were crushed and 0.5 g was weighed for each variant, after which this amount was infused with 10 mL acetone 99.98%. 0.5

mg of $MgCO_3$ was added during extraction to neutralize the acids responsible for the formation of pheophytin a in chlorophyll *a*. The samples thus obtained were stored overnight in a cold environment. The fractions obtained were subsequently centrifuged using a Nahita 2816 cooling centrifuge for 15 minutes, at 3000 rotations per minute, at a temperature of 10 °C. The analytical determinations were performed using a Shimadzu 1700 Pharmaspec UV-vis spectrophotometer at wavelengths 662, 645 and 710 nm for chlorophyll a and b, respectively 470 nm for carotenoids. The pigment content was calculated inmg/g fresh substance, using the equations proposed by Lichtenthaler and Buschmann and completed by the Carnegie Institute of Science by Spectranomis Protocol.

Chl *a* (µg mL-1) = 11.24 × (A662 – A710) – 2.04 × (A645–A710);
Chl *b* (µg mL-1) = 20.13 × (A645–A710) – 4.19 × (A662–A710);
Carotenoids (µg mL-1) = (1000 × (A470–A710) – 1.90× Chl *a* – 63.14 × Chl *b*)/214.

Simultaneously with the determination of the content in photosynthetic pigments from the leaves, the humidity of the harvested leaves was determined, by drying for four hours in the oven, at a temperature of 105 °C.

The determinations on the vegetative growths during the vegetation period were made by measuring the shoots every 15 days starting with 1st June 2019, the last measurement being on 15th August 2019.

RESULTS AND DISCUSSIONS

In order to determine the content of chlorophyll pigments, the leaves moisture content was also determined (tab. 2).

From the table below it can be observed that the leaf moisture for all six variants takeninto account registered higher values in June, gradually decreasing in July and August respectively.

Table 2

Leaves moisture (%)

Scion	Rootstock	Humidity (%)		
		June	July	August
Aromat de Iaşi	Riparia Gloire	73.31	73.21	69.23
	Selection Oppenheim 4-clone 4 (SO_{4-4})	73.73	72.47	70.61
	Berlandieri x Riparia Selection Crăciunel 2	76.45	75.59	72.55
Golia	Riparia Gloire	73.32	70.51	68.58
	Selection Oppenheim 4-clone 4 (SO_{4-4})	73.00	72.28	70.79
	Berlandieri x Riparia Selection Crăciunel 2	74.25	72.37	69.71

In June, the highest values were recorded for the variants Aromat de Iaşi/Crăciunel 2 (76.45%) and Golia/Crăciunel 2 (74.25%), after which they decreased slightly and the best results were in July registered in the Aromat de Iaşi/Crăciunel 2 (75.59%) and Golia/Crăciunel 2 (72.37%) variants. In August the results were even lower compared to the previous months, the best values being obtained at Aromatde Iaşi/Crăciunel 2 (72.55 %) and Golia/$SO_{4\text{-}4}$ (70.79%).

After determining the humidity of the harvested leaves, the analysis of the foliar photosynthetic pigments was studied (fig. 1).

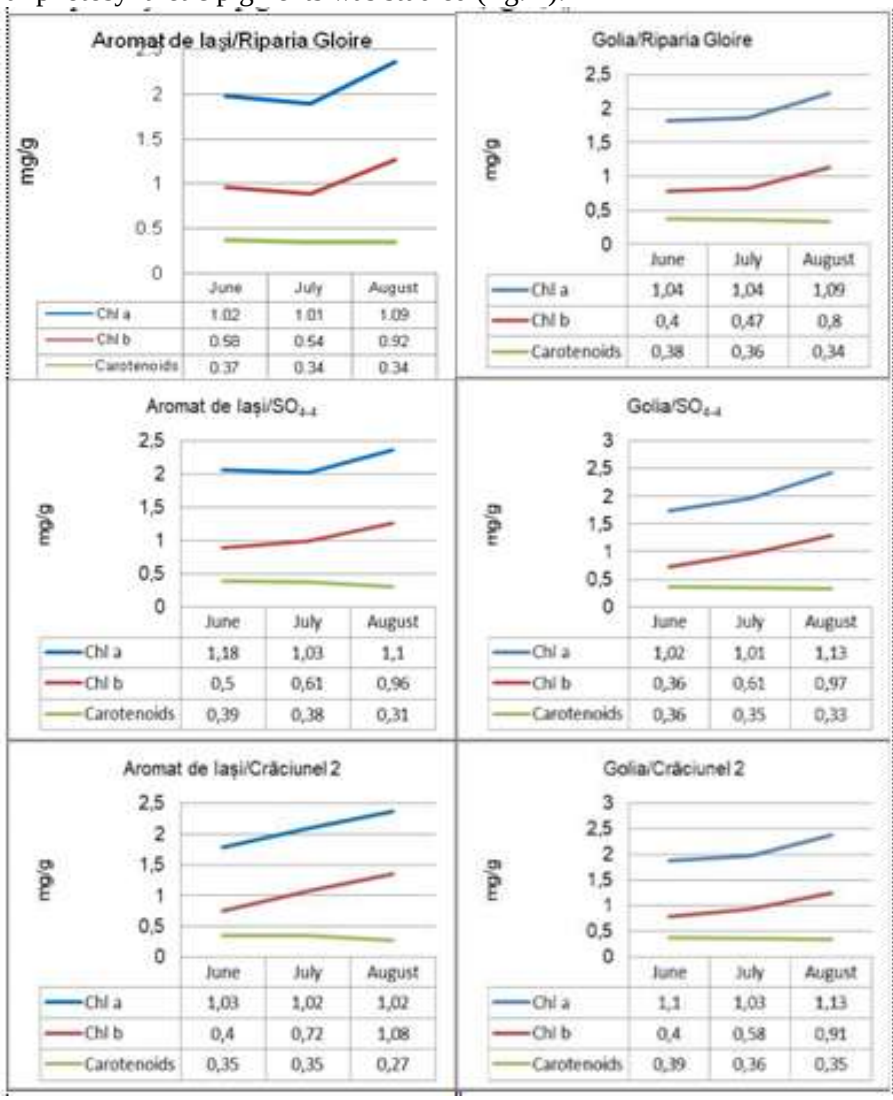


Fig.1 Dynamics of the content of photosynthetic pigments

Chlorophyll a, in June, in the variant Aromat de Iaşi/SO_{4-4} had the highest values of 1.18 mg/g fresh substance, and in the Golia variety the best result was recorded at the grafting with Crăciunel 2 having 1.10 mg/g fresh substance. For chlorophyll *b*, the best results were recorded for the variants Aromat de Iaşi/Ripariagloire (0.58 mg/g) and Golia grafted on Ripariagloire and Crăciunel 2 (0.40 mg/g), and for the carotenoids the best results were recorded at Aromat de Iaşi/SO_{4-4} (0.39 mg/g) and Golia/Crăciunel (0.39 mg/g).

The determination of the content of photosynthetic pigments from the leaves was carried out in July, where for the chlorophyll the best results were obtained by the variants Golia/Riparia gloire (1.04 mg/g), respectively Aromat de Iaşi/SO_{4-4} (1.03 mg / g). Chlorophyll *b*, recorded higher values compared to the previous month for almost all variants taken into consideration, and the best results were obtained at Aromat de Iaşi/Crăciunel 2 (0.72 mg/g) and Golia/SO_{4-4} (0.61 mg/g). For the last pigment analyzed, the carotenoids, the variants that were highlighted were Aromat de Iaşi/SO_{4-4} (0.38 mg/g) and Golia grafted on Riparia gloire and Crăciunel 2 (0.36 mg/g).

The last determination of the content of the photosynthetic pigments from the leaves was made in August, before the process of maturation of the shoots and of the appearance of the phellogen, the results obtained being higher in comparison with the other two months in which they were analyzed for Golia grape variety and smaller for Aromat de Iaşi. For chlorophyll *a*, the best results were recorded for the variants Golia/SO_{4-4} respectively Golia/Crăciunel 2 (1.13 mg/g) and Aromat de Iaşi/SO_{4-4} (1.10 mg/g). Chlorophyll *b* was found in the leaves of the Golia/SO_{4-4} variant (0.97 mg/g) and Aromat de Iaşi//SO_{4-4} (1.08 mg/g), and the last pigment analyzed, the carotenoids, had the highest results in the Golia/Crăciunel 2 variant (0.35 mg/g) and Aromat de Iaşi/Riparia gloire (0.34 mg/g).

The vine is a plant adapted to the conditions of insolation or semi-shade (Warren, 2013). Mittal *et al*. (2011), states that the ratio of chlorophyll *a* and *b* varies between 2.0 and 3.2 for plants adapted to shade conditions and 3.5 to 4.9 for plants adapted to insulation conditions.

According to Toma and Jitareanu (2007), the ratio of chlorophyll *a* / *b*, to the species *Vitis vinifera* L. is maximum at the beginning of the vegetation period, reaching up to a ratio of 3/1 and decreases during the maturation period of the grapes, while the ratio chlorophyll / carotenoids can record ratiosof 4/1.

After determining the content of photosynthetic pigments, two reports were made between the analyzed pigments, the first being between chlorophyll *a* and *b*, and the second one was between the sum of the two chlorophyll pigments and carotenoids (tab. 3).

The chlorophyll *a* / *b* ratio for the Golia variety in June registered the highest value (2.83) at grafting on the SO_{4-4} rootstock while the same ratio for the Aromat de Iaşi variety, obtained the best result (2.57), at the grafting on the rootstock Crăciunel 2. In July both varieties had the best values of the ratio of chlorophyll *a* / *b* to the variants Golia/Riparia gloire (2.12) and Aromat de

Iaşi/Ripariagloire (1.87), and in August the variants with the highest values were Aromat de Iaşi/Ripariagloire (1.18) and Golia/Riparia gloire (1.36).

For the second report, between chlorophyll (*a* + *b*) / carotenoids, the variant that was highlighted in June, Aromat de Iaşi/Riparia gloire (4.32), was followed by Golia/Crăciunel 2 (3.84). In July the variants grafted on the Crăciunel 2 and SO_{4-4} rootstock recorded the highest values, Aromat de Iaşi (4.97) and Golia (4.62). In the last analysis in August the variant Aromat de Iaşi/Crăciunel 2 (7.77), had the best result, while in the other variety taken into account the variant Golia/SO_{4-4} (6.36) was highlighted.

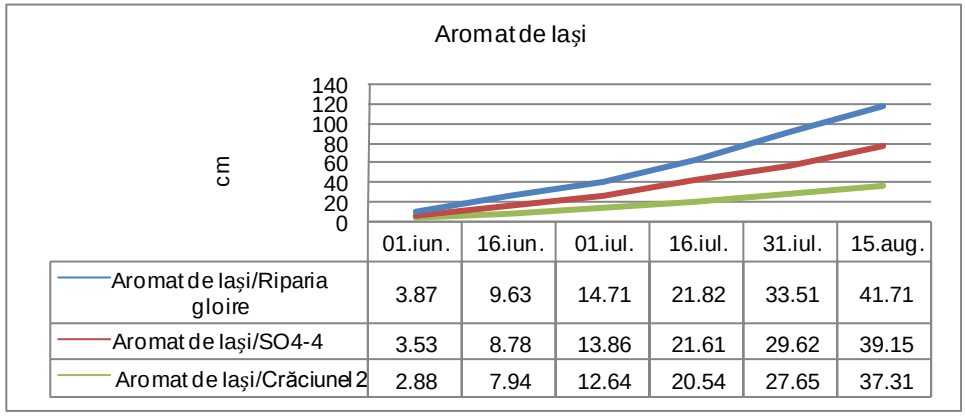
Table 3

Photosynthetic pigment reports

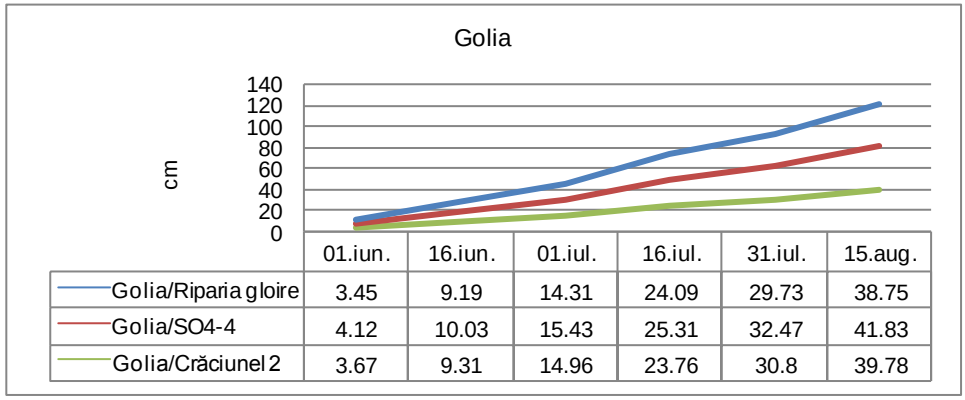
Scion	Rootstock	Chlorophyll *a* / *b* ratio			Chlorophyll ratio (*a* + *b*) / carotenoids		
		June	July	August	June	July	August
Aromat de Iaşi	Riparia Gloire	1.75	1.87	1.18	4.32	4.55	5.91
	Selection Oppenheim 4-clone 4 (SO_{4-4})	2.36	1.68	1.14	4.30	4.31	6.64
	Berlandieri x Riparia Selection Crăciunel 2	2.57	1.41	0.94	4.08	4.97	7.77
Golia	Riparia Gloire	2.60	2.12	1.36	3.78	4.19	5.55
	Selection Oppenheim 4-clone 4 (SO_{4-4})	2.83	1.65	1.16	3.83	4.62	6.36
	Berlandieri x Riparia Selection Crăciunel 2	2.75	1.77	1.24	3.84	4.47	5.82

In parallel with determining the content of foliar photosynthetic pigments, measurements were also made on the vegetative growths of the vines nursery. Six measurements were made, the first being on 01/06/2019. The measurements were made at an interval of 15 days from each other, the last being on 15/08/2019 (fig. 2).

From the above figure it can be observed that in the Aromat de Iaşi variety, the best results were recorded by the Aromat de Iaşi/Riparia gloire, on the other hand, in the Paula variety, the best results were recorded by the Golia/SO_{4-4} variant for all the measurements made.



	01.iun.	16.iun.	01.iul.	16.iul.	31.iul.	15.aug.
Aromat de Iaşi/Riparia gloire	3.87	9.63	14.71	21.82	33.51	41.71
Aromat de Iaşi/SO4-4	3.53	8.78	13.86	21.61	29.62	39.15
Aromat de Iaşi/Crăciunel 2	2.88	7.94	12.64	20.54	27.65	37.31



	01.iun.	16.iun.	01.iul.	16.iul.	31.iul.	15.aug.
Golia/Riparia gloire	3.45	9.19	14.31	24.09	29.73	38.75
Golia/SO4-4	4.12	10.03	15.43	25.31	32.47	41.83
Golia/Crăciunel 2	3.67	9.31	14.96	23.76	30.8	39.78

Fig. 2 Dynamics of vegetative growth

At the first measurement performed on 01/06 the best results were recorded by the Golia/$SO_{4\text{-}4}$ variant which was 4.12 cm, and Aromat de Iaşi/Riparia gloire was 3.87 cm. The second measurement was made after 15 days, more precisely on 16/06, and the variants that had the largest increases were Golia/$SO_{4\text{-}4}$ (10.03 cm) and Aromat de Iaşi/Riparia gloire (9.63 cm). After another 15 days, the third measurement was made on 01/07, where the highest results were recorded in the Golia/$SO_{4\text{-}4}$ variant (15.43 cm), respectively Aromat de Iaşi/Riparia gloire (14.71 cm). The fourth measurement on 16/07 highlighted the variants Golia/$SO_{4\text{-}4}$ (25.31 cm) and Aromat de Iaşi/Riparia gloire (21.82). The fifth measurement on 31/07, highlighted the variants Golia/$SO_{4\text{-}4}$ (32.47 cm) and Aromat de Iaşi/Riparia gloire (33.51 cm), and on the last measurement on 15/08, the highest vegetative growths were in the Golia/$SO_{4\text{-}4}$ (41.83 cm) and Aromat de Iaşi/Riparia gloire (41.71 cm) variants.

Following the correlation between the vegetative growths and the amount of chlorophyll (*a* + *b*), a direct and linear relation is found, in the sense that the higher the content in the chlorophyll the higher the vegetative growths. This behavior was observed also in other situations, probably because of the mineral uptake stimulation by rootstocks (Fekete *et al.,* 2013). From the analysis of figure 3, it can be seen that the

values of the correlation coefficient (R2) for the Aromat de Iaşi variety were 0.7826 for the grafted variant on the Riparia gloire rootstock, 0.7525 on the SO_{4-4} rootstock and 0.9985 on the Crăciunel rootstock 2. For the other variety taken into consideration, Golia, the values of the correlation coefficient had values of 0.8602 in the variant grafted on the rootstock Riparia gloire, 0.9721 on the rootstock SO_{4-4} and 0.9127 on the rootstock Crăciunel 2. In both cases the value of the coefficient correlation was over 75%, indicating that there is a direct linear correlation between the two factors analyzed.

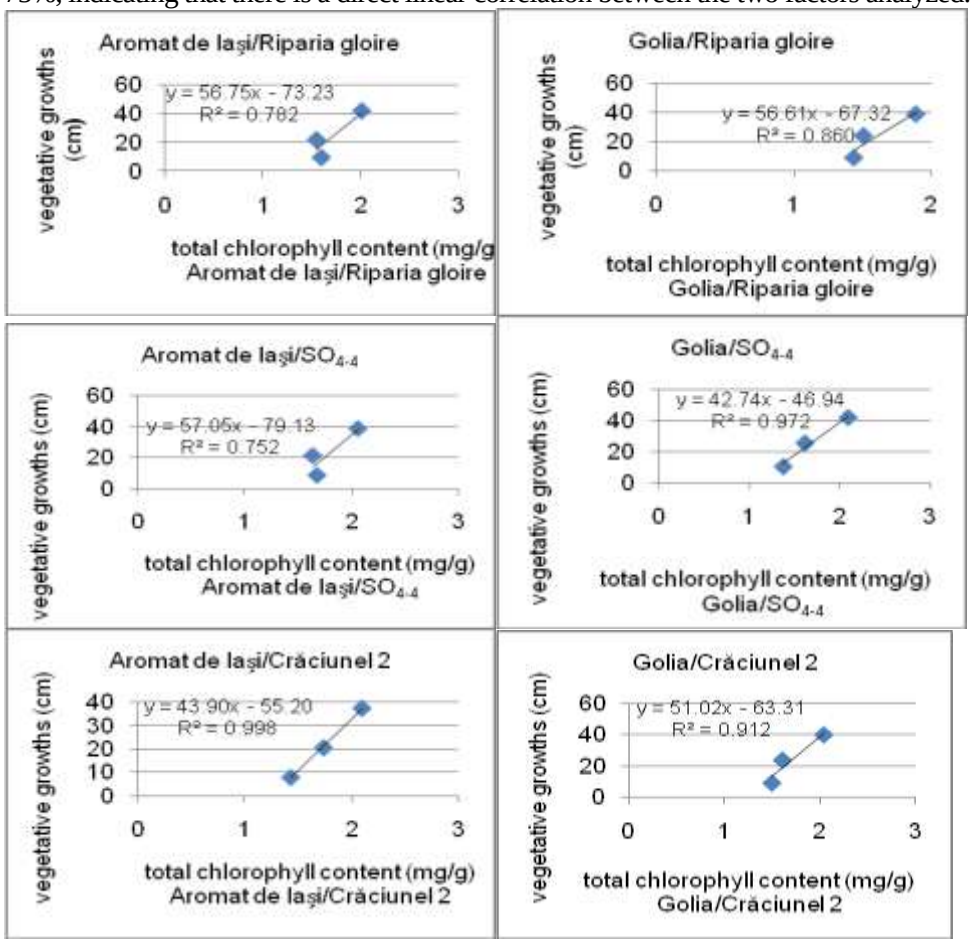


Fig. 3 Correlation between total chlorophyll content and vegetative growth of vines

CONCLUSION

From the analysis of the moisture of the vines, it is ascertained that it decreases as they go towards the senescence phase, however, they are kept within the physiological limits of the plant. The highest humidity was recorded in June on the Aromat de Iaşi/Crăciunel 2 version, and the lowest on the Golia/Riparia gloire version, in August.

Regarding the ratio of chlorophyll *a*/chlorophyll *b*, it is found that it is specific to a semi-shade plant, being the highest in June, between 1.75-2.57 in the variety Aromat de Iaşi and 2.60-2.80 in the Golia variety. As the plant grows older, it has lower values, due to the fact that here we are witnessing the development of a vine and an adult plant.

The ratio of chlorophyll (*a* + *b*)/carotenoids has been 4/1 higher since June, increasing as the age progresses, to 7.77 in the Aromat de Iaşi/Crăciunel 2 variant.

The correlation coefficient R2 was calculated in order to establish the direct correlation between the vegetative growths and the total chlorophyll content. It had values indicating the existence of a direct and linear correlation between increasing the content of chlorophyll pigments and the vegetative growths of the vines, having values of over 0.75.

REFERENCES

1. **Blankenship R.E., 2014** – *Molecular mechanisms of photosynthesis.Wiley-Blackwell*, Oxford. (2nd ed)
2. **Britton G., 2008** - *Functions of intact carotenoids. InBritton, G., Liaaen- Jensen, S. &Pfander, H. (eds). Carotenoids, vol. IV: Natural Functions.* BirkhäuserVerlag, Basel. pp. 189 – 211.
3. **Cuttriss A., Pogson, B., 2004.** *Carotenoids.In Plant pigments and their manipulation*. Vol. 14, CRCPress, Boca Raton, Florida, USA, 57-92.
4. **Davies, K.M., 2004** - *An introduction to plant pigmentsin biology and commerce. In Davies, K.M. (ed). Plant pigments and their manipulation.* CRCPress, Boca Raton. pp. 1 – 23.
5. **Fekete I., Kovács B., Andrási D., Bódi É, Rakonczás N., 2013** - *Effects of the different graperootstocks on berry skin B, Cu, Fe, Mn and Zn contents of 'CserszegiF..Szeres' cultivar.*Scientific Papers. Series B. Horticulture., Vol. LVII, ISSN 2285-5653, 55-60.
6. **Hörtensteiner, S. &Kräutler, B., 2011** – *Chlorophyll breakdown in higher plants*. Biochim.Biophys.Acta 1807, 977-988.
7. **Lanfer Marquez, U.M. Sinnecker P., 2008 -***Chlorophylls in foods: Sources and stability. InSocaciu, C. (ed). Food colorants: Chemical and functional properties.* CRC Press, Boca Raton.pp. 195 – 212.
8. **Mittal S., Kumari N., Sharma V., 2011 –** *Differential responses of seven contrasting species to high light using pigment and chlorophyll a fluorescence*. J. Stress Physiol. Biochem. 7(2),20-33.
9. **Netto A.T., Campostrini E., De Oliveira J.G., Bressan-Smith R.E., 2005** –*Photosynthetic pigments, nitrogen, chlorophyll a fluorescence and SPAD-502 readings in coffee leaves*. Sci.Hortic. 104, 199-209.
10. **Pfander H., 1992** - *Carotenoids: An overview.*MethodsEnzymol. 213, 3-13.
11. **Popescu M., Popescu G.C., 2014** - *Diurnal changesin leaf photosynthesis and relative water content of grapevine*. Current Trends inNatural Sciences (CTNS) 3(6), 74-81.
12. **Rabinowitch E., Govindjee R. 1969** - Photosynthesis.Wiley, New York. pp. 102-123.
13. **Raven P.H., Evert R.F., Eichhorn S.E., 2005** - *Photosynthesis, light, and life. In Freeman, W.H. (ed).* Biology of plants. Freeman W.H.,New York. pp. 119-127.
14. **Sims D.A., Gamon J.A., 2002** – *Relationships between leaf pigment content and spectral reflectance across a wide range of species, leaf structures and developmental stages.* Remote Sens. Environ. 81(2-3), 337- 354.
15. **Toma Liana Doina, Jităreanu Doina, 2007** – *Fiziologie vegetală*. Ed. Ion Ionescu de la Brad, Iasi.
16. **Warren P.L., 2013** - *Landscape vines for Southern Arizona.* The University of Arizona, College ofAgriculture and Life Sciences - Cooperative Extension. Tucson, Arizona, USA.
17. **Willows R.D., 2004** - *Chlorophylls. In Davies, K.M. (ed).Plant pigments and their manipulation.*CRC.Press,Boca Raton p.23–57.

AGROBIOLOGICAL AND TEHNOLOGICAL CHARACTERIZATION OF SOME NEWTABLE GRAPES VARIETIES GROWN IN THE COPOU IASI WINE CENTER

CARACTERIZAREA AGROBIOLOGICĂ ŞI TEHNOLOGICĂ A UNOR SOIURI NOI DE VIŢĂ DE VIE CULTIVATE ÎN CENTRUL VITICOL COPOU IAŞI

FILIMON Roxana[1]*, DAMIAN Doina[1], NECHITA Ancuța[1], FILIMON V.R. [1]
*Corresponding author e-mail: roxanacotovanu@yahoo.com

Abstract. *Climatic factors of the ecosystem directly influence the vegetative development of the grapevine, the production obtained and its quality. The present paper aimed the agrobiological and technological characterization of two varieties for table grapes, Azur and Transilvania, created in Romania, cultivated in the climatic area of the Copou – Iasi wine center,productive and ameliorating valuable varieties, but less widespread in the N-E area of the country. The study was carried out in the period 2018-2019, being made observations and determinations on the vegetation phenophases, grape yield and quality, in relation to the ecological factors. The analysed grapevine varieties riped the grapes in the first half of September (IVth epoch), being notable for their good fertility, high yield and quality, efficiently capitalizing the climatic and pedological resources of Iasi vineyard.*
Key words: table grapes, new varieties,phenology, grape yield

Rezumat. *Factorii climatici din ecosisteminfluențează în mod direct dezvoltarea vegetativă a viței de vie, producția obținută şi calitatea acesteia. Lucrarea de față avut ca scop caracterizarea agrobiologică şi tehnologică a două soiuri pentru struguri de masă create în țara noastră, Azur şi Transilvania, cultivate în arealul climatic al centrului viticol Copou - Iaşi, soiuri valoroase productiv şi ameliorativ,dar mai puțin răspândite în zona de N-E a țării. Studiul s-a desfăşurat în perioada 2018-2019, fiind efectuate observații şi determinări privind parcurgerea fenofazelor de vegetație, productivitatea şi calitatea recoltei, în relație cu factorii ecologici. Soiurile de viță de vie analizate aumaturat strugurii în prima jumătate a lunii septembrie (epoca a IV-a), remarcându-se prin fertilitate bună, producții ridicate şi de calitate, valorificând eficient resursele climatice şi pedologice ale Podgoriei Iaşi.*
Cuvinte cheie: struguri de masă,soiuri noi, fenologie, productivitate.

INTRODUCTION

Knowing the agrobiological and technological profile of grape cultivars is indispensable for the selection and maintenance in culture of genotypes with

[1]Research - Development Station for Viticulture and Winemaking Iasi, Romania

superior features in terms of grape yield and quality, as well as for the expansion in culture of varieties well adapted to climate conditions and corresponding to consumer requirements (Filimon *et al*., 2016). Grapevine genotypes behave differently under the influence of climate change, depending on their ability to adapt to higher temperatures and drought stress (Creasy and Creasy, 2009).

The aim of this study was to evaluate the agrobiological and technological characteristics of the new table grape autochthonousvarieties Azur and Transilvaniain the pedoclimatic conditions of the N-E area of Romania (Iasi vineyard),in order to capitalize the genetic potential of these varieties and to a better understandingof their capacity to adapt to the climatic conditions of the mentioned vineyard.

MATERIAL AND METHOD

The study was conducted in the years 2018 and 2019, the plant material being represented by two Romanian varieties for table grapes: Azur (Coarnă neagră × Cardinal), created at the Drăgăşani Grapevine Research Station and Transilvania (Black rose × Cardinal), created at the Cluj-Napoca Horticultural Research Station.

The vineyard soil is chernozem, the planting distances are 2.2/1.2 m in the semi-high cultivation system, semi-protected over the winter.The research focused on observations and determinations regarding the vegetation phenophases, productivity, quantity and quality of the crop, in direct relation with ecological factors. Total acidity (g/L tartaric acid) and sugars (g/L) were determined according to OIV (2016).

RESULTS AND DISCUSSIONS

From the climatic point of view, in the period 2018 - 2019 the average of annual temperatures were higher than the multiannual (30 years) value (9.8 °C) reaching10.6°C, in 2018 and 11.6°C, in 2019. Winter of the year 2018 was classified as hot, due to higher temperature registered, with a maximum airtemperatureof 10.7 °C, registered in January and an absolute minimum temperature of −19.7 °C, recorded on 24.01.2018. Winter of the year 2019 was thermally normal, the absolute minimum temperature not exceeding −12.0°C, without affecting the viability of winter buds.

In the Copou - Iaşi wine center, the year 2018 was considered normal in terms of air temperature and amount of precipitations.However, rainfall were unevenly distributed during the vegetation period, with more than half of the annual amount recorded in the June and July (403.8 mm, from a total of 727.8 mm).The year 2019 was classified as dry, with a rainfall deficit. The presence of high temperatures and rainfall during the vegetation period favored the harmonious development of the foliar apparatus, with a positive influence on sugar and phenolic compounds accumulation in grapes.

The climatic conditions directly influenced the vegetation phenophases, starting with budding, between 16th and 27thApril, followed by flowering, between 24thMay and 12thJune and grape harvest, between 23rdJuly and 3rdAugust. The data presented in table 1 indicates that in the year 2018, under the influence of

annual meteorological factors, the vegetation phenophases occurred with 2 to 15 days earlier, compared to 2019.

Table 1

Phenological data of Azur and Transilvaniavarieties in Iasi vineyard (2018-2019)

Variety	Azur		Transilvania	
Phenophase / Year	**2018**	**2019**	**2018**	**2019**
Budburst	16.IV	25.IV	19.IV	27.IV
Blooming	24.V	09.VI	26.V	12.VI
Veraison	23.VII	03.VIII	25.VII	03.VIII
Grape maturation	11.IX	18.IX	15.IX	19.IX
Leaf fall	5. XI	7.XI	5. XI	7.XI

In the conditions of the Copou - Iaşi viticultural ecosystem the technological maturity of grapes occurred in the first half of September, the harvesting being established at a gluco-acidimetric index between 25 and 30. The cycle of the active vegetation period totaled a number of 183 - 195 days, ending with the normal cessation of metabolic processes (leaf fall), between 5th and 7th November.

In the period 2018-2019, the grapes weight of Azur variety was 335 g, the weight of 100 berries was 350-390g and the value of the berry index, represented by the number of berries per 100 g of grapes, was 27.11, confirming the inclusion of this genotype in the category of table grape varieties (tab. 2).

Table 2

The main physico - chemicaland productivity characteristics of the studied varieties (2018-2019)

Variety	Azur			Transilvania		
Features /Year	**2018**	**2019**	**Mean**	**2018**	**2019**	**Mean**
Grape weight (g)	318.00	352.00	335.00±24.04	430.00	518.00	474.00±62.23
Rachis weight (g)	8.00	11.00	9.50±2.12	11.30	12.50	11.90±0.85
Berries weight per cluster (g)	310.00	341.00	325.50±21.92	418.70	505.50	462.10±61.38
Weight of 100 berries (g)	350.00	390.00	370.00±28.28	657.00	710.00	683.50±37.48
Berry weight (g)	3.50	3.90	3.70±0.28	6.50	7.10	6.80±0.42
Skin weight (g)	20.00	22.00	21.00±1.41	30.00	32.00	31.00±1.41
Pulp weight (g)	318.00	355.00	336.50±26.16	612.00	662.00	637.00±35.36
Seeds weight (g)	12.00	13.00	12.50±0.71	15.00	16.00	15.50±0.71
Structure index	38.75	31.00	34.88±5.48	37.05	40.44	38.75±2.40
Composition index	9.94	10.14	10.04±0.14	13.60	13.79	13.70±0.13
Berry index	28.57	25.64	27.11±2.07	15.38	14.08	14.73±0.92
Yield (kg/vine stock)	3.82	4.22	4.02±0.28	4.73	5.18	4.96±0.32
Sugars (g/L)	175.00	172.00	173.50±2.12	165.00	153.00	159.00±8.49
Total acidity (g/L tartric acid)	5.79	5.58	5.69±0.15	5.87	6.07	5.97±0.14
Sugar/ acidity ratio	30.22	30.82	30.52±0.42	28.11	25.20	26.66±2.06

In the case of the Transilvania variety, the grape weight exceeded 430 g, reaching 518 g in 2019, with an average berry weight of 6.80 ± 0.42 g. The value

of the structure index, represented by the ratio between the berries weight and the rachis weight, was 38.75± 2.40, specific to large berry table grape varieties.

For both studied varieties, the physico-chemical characteristics of grapes, including grape wheight and sugar accumulation, were higher compared to the data presented by Stroe (2012), in the ecopedoclimatical conditions of western (Cluj-Napoca) and southern (Drăgăşani and Bucharest) wineyards of Romania.

In the climatic conditions of the Copou - Iaşi wine center, the average production per grapevine stock of the studied varieties varied between 3.82 kg (Azur variety) and 5.18kg for the Transilvania variety.

The potential of sugar accumulation in must at grape full maturity showed values specific to varieties for table grapes, respectively 173.50 ± 2.12 g/L for the Azur variety and 159.00 ± 8.49 g/L for the Transilvania variety.

CONCLUSIONS

1. The climatic conditions in the reference years have positively influenced the development of vegetation phenophases of the analyzed table grape varieties, high temperatures during the summer and the presence of precipitations favoring the maturation of grapes, with a balanced sugar/acidity ratio.

2. In the climatic conditions of the Copou - Iaşi wine center, the Transilvania variety was characterised by high yield and quality grapes.

3. The Azur variety was defined by an earlier maturation of grapes, compared to the Transilvania variety and medium-sized grapes (335g), with anaverage sugar concentration of over 173 g/L.

4. The experimental results obtained indicate that the studied varieties can successfully complete the conveyor of table grapes varieties in the N-E area of Romania.

REFERENCES

1.Creasy G. L., Creasy L. L., 2009 – *Grapes*. CAB International, UK.

2.Filimon R.V., Damian Doina, Filimon Roxana, Rotaru Liliana, 2016 – *Assessment of consumer preferences on table grapes of new Vitis vinifera L. cultivars*. Cercetări Agronomice în Moldova, vol. XLIX, 3 (167), pp. 97-110.

3. OIV, 2016 – *Compendium of international methods of wine and must analysis.* Vol.I International Organisation of Vine and Wine (OIV), Paris, France.

4. Stroe Marinela, 2012 – *Ampelografie*. Editura Ceres, Bucureşti.

THE EVOLUTION OVER TIME OF THE DEVELOPMENT OF VEGETATION PHENOPHASES OF THE VINE VARIETIES CULTIVATED IN THE COPOU IAŞI WINE CENTER IN THE CONTEXT OF CLIMATE CHANGE

EVOLUȚIA ÎN TIMP A DESFĂŞURĂRII FENOFAZELOR DE VEGETAȚIE A SOIURILOR DE VIȚA DE VIE CULTIVATE ÎN CENTRUL VITICOL COPOU IAŞI, ÎN CONTEXTUL SCHIMBĂRILOR CLIMATICE

NECHITA Ancuța[1]*, ZALDEA Gabi[1], DAMIAN Doina[1], FILIMON Roxana[1], PISTICIUC I.[1], FILIMON V.R.[1]
*Corresponding author e-mail: ancuta.vasile@yahoo.com

Abstract. *In the last 20 years there has been a tendency of change in the evolution of climatic factors, which makes it increasingly difficult to accurately predict the timing of vegetation phenophases in vines. Their dynamic analysis, in close correlation with the evolution of climatic factors specific to Iasi vineyard, from 2000 to 2019, showed that they were conditioned by the level and action of climatic factors and the hereditary specificity of cultivated varieties. The increase of temperature values (average annual temperature, average temperature in the first and second decades of June, average temperature in July, etc.), determined the advance of the onset of phenophases and shortened their duration, especially in dry years.*
Key words: climate change, phenology, grapevine

Rezumat. *În ultimii 20 de ani s-a constatat o tendință de modificare în evoluția factorilor climatici, ceea ce face tot mai dificilă prognozarea exactă a momentului declanşării fenofazelor de vegetație la vița de vie. Analiza în dinamică a acestora, în strânsă corelație cu evoluția factorilor climatici specifici podgoriei Iaşi, din perioada 2000 – 2019, a evidențiat faptul că acestea au fost condiționate atât de nivelul şi acțiunea factorilor climatici cât şi de specificul ereditar al soiurilor cultivate. Creşterea valorilor temperaturilor (temperatura medie anuală, temperatura medie din decadele I şi II ale lunii iunie, temperatura medie din luna iulie, etc.), a determinat devansarea momentului declanşării fenofazelor şi scurtarea duratei de derulare a acestora, cu precădere în anii secetoşi.*
Cuvinte cheie: schimbări climatice, fenologie, viță de vie

INTRODUCTION

Climate change, which is currently occurring globally, experts say will become more pronounced in the coming decades and will obviously influence the biology of horticultural species, especially vines. Thus, there will be important changes in the zoning of vine and rootstock varieties (Condei *et al.,* 2017). The

[1]Viticulture and Oenology Research and Development Station in Iasi, Romania

long-term study of the dynamics of vegetation phenophases in close correlation with environmental conditions is one of the best ways to quantify climate change (Jones *et al*., 2010; Tomasi *et al.*, 2011; Biasi *et a*l., 2019). The researches carried out in our country have highlighted changes regarding the development and duration of the main vegetation phenophases, the quality of grape production and implicitly the physico-chemical and organoleptic characteristics of the obtained wines (Dobrei *et al*, 2015; Irimia *et al.*, 2017; Nistor *et al*., 2019).

MATERIAL AND METHOD

In order to study the impact of climate change on the viticultural ecosystem of Iaşi vineyard - Copou viticultural center, the climatic data from 2000 - 2019 were analyzed in correlation with the development of vegetation phenophases (budding, flowering, entering in ripening and grape maturation) in mainly cultivated varieties: Aligote , Fetească albă, Fetească regală, Muscat Ottonel, Chardonnay, Sauvignon blanc, Cabernet Savignon, Arcaş, Chasselas dore.

RESULTS AND DISCUSSIONS

Climate change produced globally has determined certain trends in our country as well. Temperature is the climatic factor that determines the area of spread of the vine culture, the onset and passage of vegetation phenophases, the establishment of the crop system, the quantity and quality of production. In recent years, there has been an increase in its temperature values throughout the country. Thus, for the vineyards located at the northern limit of vine cultivation, such as the Iaşi vineyard, the average annual temperature registered, in certain years, values of over 11°C, which determines the displacement of the favorable area for vine cultivation. to the north of the country, increasing the suitability for red varieties and obtaining quality wines.

The climate analysis of the last 20 years indicates an a*verage annual temperature* of 10.5°C, with a maximum value of 11.6°C in 2019 and a minimum of 9.5°C in 2001, a significant warming recording especially in the winter and summer seasons (tab. 1). *The average temperature in the first and second decades of June*, an important factor in the onset, intensity and duration of flowering, recorded an average value of 20.1°C, with a minimum of 16.9°C in 2006 and a maximum of 22,8°C in 2007. *The average temperature in the warmest month (July)*, which is a criterion for assessing the conditions for increasing the quality of grapes, was, on average, 22.3°C, with an increasing trend in recent years reaching a maximum value of 25.4°C in 2012. As this indicator increases, higher concentrations in sugars, flavors, color, phenolic substances, etc. can be obtained.

Another vegetation factor that influences the growth and development of vines is humidity. Excess precipitation has a negative influence on the flowering phenophase, when the phenomenon of millet and beading occurs frequently, the percentage of tied flowers decreases, and in the leek phenophase it leads to grain cracking. In periods of poor rainfall, the growth of shoots is slowed, the grains

remain small and withered, and yields are diminished quantitatively and qualitatively. In recent years there has been a reduction in the volume of rainfall, especially during the growing season and a very uneven distribution. During the study period, the smallest amount was 180.6 mm in 2015 and the highest was 533.2 mm in 2001.

Table 1

Values of climatic elements with direct influence on vine phenology from the period 2000 - 2019

Climatic elements analyzed	Iasi vineyard		
	Media	**Min.**	**Max.**
Global heat balance, (Σt°g)	**3321.7**	3099.9	3652.8
Active heat balance, Σt°a)	**3222.2**	2984.1	3596.3
Useful thermal balance, (Σt°u)	**1523.8**	1298.4	1856.3
Average temperature in I and II decades of June	**20.1**	16.9	22.8
The average temperature in July, °C	**22.3**	20.5	25.4
The average temperature in August, °C	**21.7**	19.8	23.5
The average temperature in September, °C	**16.3**	14.2	18.9
Average annual temperature T°C	**10.5**	9.5	11.6
Average maximum temperatures in August,°C	**28.2**	25	31.1
Number of days with temp. maximum > 30°C	**33.4**	9	60
Σ annual rainfall, mm	**572.1**	365.5	748
Σ precipitation during the growing season, mm	**363.9**	**180.6**	533.2
Σ hours of insolation in the vegetation, hours	**1482.1**	1336.7	1603.2
Duration of the bioactive period, number of days	**175.2**	165	189
The real heliothermal index (RHI)	**2.3**	1.8	2.8
Hydrothermal coefficient (HC)	**1.1**	0.5	1.8
Bioclimatic index (Ibcv)	**8.3**	4.5	16.3
Oenoclimatic aptitude index (OAI)	**4592.7**	4107.8	5058.2
Huglin heliothermal index (HI)	**2181.1**	1900.4	2541
Night cooling index (NC)	**11.5**	10.1	13.9

The values of the synthetic indicators from the Copou-Iass wine center indicate a favorable area for the cultivation of vines, balanced, with very good favorability for the cultivation of varieties for quality white and red wines.

The observations made between 2000 and 2019, regarding the evolution of the vegetation phenophases traversed by the main varieties in the assortment, in direct relation with climatic factors, highlight the fact that they were conditioned by the level and action of climatic factors and hereditary specificities of varieties.

For the varieties from the Iasi vineyard assortment (Aligoté, Fetească albă, Fetească regală, Sauvignon blanc, Chardonnay, Muscat Ottonel, Cabernet Sauvignon and Chasselas doré), **the budding** occurred in the last decade of April or in the first decade of May. It took place at the earliest on April 10, 2016 at the Fetească alba variety and at the latest at Cabernet Sauvignon on May 7, 2011 (tab. 2).

The useful thermal balance that conditioned the budding phenophase was variable from one year to another, with values, on average, of 32.1°C for the early varieties and up to 56.5°C for the late ones.

Table 2

The evolution of the development of budding and flowering phenophases

Year	Budding				Flowering			
	White varieties		Red varieties		White varieties		Red varieties	
	Date	Σ t° useful	Date	Σ t° useful	Date	Σ t° useful	Date	Σ t° useful
2000	17-Apr	47.4	20-Apr	73.3	27-May	279.9	30-May	292.3
2001	21-Apr	25.4	26-Apr	34.0	9-Jun	230.0	17-Jun	295.4
2002	24-Apr	32.1	30-Apr	50.8	2-Jun	282.9	9-Jun	300.6
2003	29-Apr	30.9	4-May	74.9	3-Jun	374.7	9-Jun	397.6
2004	23-Apr	26.8	27-Apr	35.8	10-Jun	263.0	16-Jun	318.8
2005	23-Apr	30.3	28-Apr	39.0	15-Jun	304.8	19-Jun	338.8
2006	25-Apr	39.9	29-Apr	50.3	13-Jun	249.5	18-Jun	280.9
2007	12-Apr	18.4	28-Apr	30.3	2-Jun	330.3	5-Jun	345.0
2008	14-Apr	25.5	22-Apr	45.6	7-Jun	253.3	12-Jun	286.4
2009	21-Apr	40.8	25-Apr	41.1	2-Jun	242.7	7-Jun	287.5
2010	25-Apr	19.5	30-Apr	33.2	6-Jun	278.9	11-Jun	335.2
2011	28-Apr	34.5	7-May	53.9	5-Jun	270.6	8-Jun	290.4
2012	25-Apr	63.2	2-May	147.9	25-May	257.6	6-Jun	269.0
2013	22-Apr	23.9	27-Apr	68.2	21-May	283.4	30-May	295.7
2014	20-Apr	18.6	27-Apr	47.2	4-Jun	248.9	8-Jun	261.5
2015	21-Apr	27.7	27-Apr	55.4	3-Jun	299.5	9-Jun	344.5
2016	**10-Apr**	42.9	17-Apr	74.1	2-Jun	255.4	7-Jun	260.8
2017	12-Apr	19.0	27-Apr	31.7	2-Jun	250.8	7-Jun	298.3
2018	14-Apr	60.1	21-Apr	95.5	21-May	267.4	26-May	289.6
2019	22-Apr	15.0	29-Apr	48.7	7-Jun	292.2	11-Jun	308.6
X	-	32.1	-	56.5	-	275.8	-	304.8

In recent years, as a result of the increase in air temperature values, there is a tendency to delay the moment of budding and a shortening of the period of its development. Thus, in the dry years, implicitly in those with milder winters, the budding took place in the first and second decade of April (2000, 2007, 2008, 2016, 2017, 2018).

In order for **the flowering** to start, the vine varieties need a certain amount of heat, the minimum level at which the flowers open is 15°C, and the optimum is 25...26°C. High temperatures, above 30°C, around the flowering period, determine the development of this phenophase in an accelerated rhythm, over a short period of time, considerably reducing the gap between varieties (varieties bloom simultaneously). Lower temperatures stagger flowering over a longer period of time, extending the duration of the phenophase.

The multiannual phenological observations performed on the varieties in the assortment attest that the beginning of flowering took place at the earliest at the end of May in the years: 2000, 2012, 2013 and 2018, and in the other years in the first and second decade of June (tab. 2). It was noted that within the same variety, flowering can last between 6 and 12 days, the sum of the useful temperatures required to start flowering being, on average, 275.8°C for white varieties and 304.8°C for red varieties. In the case of this phenophase, too, there is a tendency to overtake due to the increasing values of air temperatures and a shortening of its development period. Regarding the analyzed varieties, Feteasca

alba blossomed the earliest on May 21, 2018, followed by Feteasca regală and Aligoté varieties, and the latest was June 18, 2006, when all varieties bloomed almost simultaneously.

The verraison is the beginning of the ripening of the grapes and is a process that appears suddenly, marked by the accumulation of sugars in the grains, the epicarp changes color, the grain becomes transparent and begins to soften. In the Copou Iasi wine center, the verraison between 2000 and 2019 occurred between July 20 (2013) and August 10 (2005) and lasted between 5 and 19 days depending on the variety and year. In the dry years, the ripening started faster, respectively in the last decade of July (2003, 2004, 2007, 2009, 2010, 2012, 2013, 2017 and 2018) and occurred in a shorter time, and in the rainy years (2001, 2005) in the second decade of August (tab. 3). The useful thermal balance that conditioned the lever phenophase had average values between 661.1°C and 733.5 ° C.

Table 3

The evolution of the development of leech and maturation phenophases

Year	Verraison				Ripening			
	White varieties		Red varieties		White varieties		Red varieties	
	Date	Σ t° useful	Date	Σ t° useful	Date	Σ t° useful	Date	Σ t° useful
2000	5-Aug	744.1	16-Aug	853.3	17-Sep	433.5	25-Sep	304.2
2001	6-Aug	627.7	24-Aug	778.9	17-Sep	386.6	25-Sep	224.3
2002	1-Aug	697.8	5-Aug	713.1	10-Sep	388.7	28-Sep	400.9
2003	27-Jul	608.5	10-Aug	681.9	14-Sep	455.8	23-Sep	368.6
2004	28-Jul	519.0	6-Aug	551.2	20-Sep	450.5	6-Oct	410.9
2005	10-Aug	618.4	28-Aug	753.6	10-Sep	289.3	30-Sep	232.0
2006	5-Aug	628.1	15-Aug	694.6	20-Sep	403.5	3-Oct	372.3
2007	23-iul	708.9	29-iul	767.0	3-Sep	512.7	16-Sep	484.6
2008	2-Aug	611.7	8-Aug	628.7	15-Sep	458.7	10-Oct	437.5
2009	29-Jul	691.2	5-Aug	740.9	9-Sep	446.9	30-Sep	506.9
2010	25-Jul	589.7	1-Aug	608.9	9-Sep	523.6	16-Sep	477.0
2011	2-Aug	631.7	8-Aug	659.7	20-Sep	497.1	26-Sep	467.1
2012	23-Jul	752.3	1-Aug	804.8	2-Sep	546.7	10-Sep	473.7
2013	20-iul	564.7	31-iul	631.5	10-Sep	528.7	17-Sep	446.1
2014	3-Aug	633.3	12-Aug	718.5	22-Sep	513.3	30-Sep	399.5
2015	4-Aug	768.4	14-Aug	862.3	12-Sep	483.5	23-Sep	426.1
2016	5-Aug	792.1	15-Aug	862.1	10-Sep	419.1	27-Sep	426.5
2017	31-Jul	686.2	12-Aug	816.4	11-Sep	500.5	29-Sep	420.5
2018	21-Jul	665.2	6-Aug	806.8	13-Sep	628.3	3-Oct	530.7
2019	2-Aug	683.3	11-Aug	734.9	13-Sep	500.5	4-Oct	508.5
	-	661,1	-	733,5	-	468,4	-	415,9

Due to the high values of air temperatures, the large number of days with maximum temperatures higher than 30°C in July and August (eg 60 days in 2007) and the water deficit in the soil, there was an obvious tendency to overtake ripening phenophase.

The full maturity of the grapes evolves depending on the variety and climatic conditions. The varieties from the Iasi vineyard assortment, during the analyzed period, reached full maturity at the earliest in the first decade of

September, and at the latest in the first decade of October. The useful thermal balance that conditioned the maturation phenophase had average values between 415.9°C and 468.4°C. This phenophase took place over 3-5 weeks.

CONCLUSIONS

The climate analysis of the last 20 years indicates an increase in the average annual temperature of up to 10.5°C, with a maximum value of 11.6°C in 2019 and a minimum of 9.5°C in 2001, compared to 9.8°C normal value, a significant warming being registered, especially in the winter and summer seasons.

The multiannual phenological observations made on the varieties in the assortment show that, in the dry years, implicitly in those with milder winters, the budding took place in the first and second decade of April, the flowering took place at the earliest at the end of May, and in other years in the first and second decades of June. The verraison also began in the last decade of July, and ripening at its earliest in the first decade of September and by the first decade of October.

The creation and permanent updating of climate and phenological databases is an important step in optimizing the zoning of the vine, as well as a starting point in issuing possible scenarios in the context of climate change.

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REFERENCES

1. **Biasi R., Brunori E., Ferrara C., Salvati L., 2019** - *Assessing Impacts of Climate Change on Phenology and Quality Traits of Vitis vinifera L.: The Contribution of Local Knowledge*. Plants no.8, 121.
2. **Condei Ghe., Serdinescu A., Pîrcălabu L, Ciolacu M., Toti M., 2017** – *Terroir-ul viticol- de la concept la implementare*. Editura Ceres, 127 **p**
3. **Dobrei A.G., Dobrei A., Nistor, E., Sala F., Mălăescu M., Drăgunescu A., Camen D., 2015** - *Research concerning the qualitative potential of the wines obtained from different grape-growing ecosystems*. J. Hort. Forest. Biotech. 19, 103- 107.
4. **Irimia L.M., Patriche C.V., Roşca B., Cotea V., 2017** - *Modifications in climate suitability for wine production of Romanian wine regions as a result of climate chan*ge. 40th World Vine and Wine Congress, June 2017, Sofia, Bulgaria. pp. 32-33.
5. **Jones G. V., Webb L. B., 2010** - *Climate Change, Viticulture, and Wine: Challenges and Opportunities',* Journal of Wine Research, 21: 2, pp: 103 — 106.
6. **Nistor E., Dobrei A.G., Dobrei A., Camen D., 2019 -** *Growing Season Climate Variability and its Influence on Sauvignon Blanc and Pinot Gris Berries and Wine Quality: Study Case in Romania (2005-2015)*. S. Afr. J. Enol. Vitic., Vol. 39, No. 2, pp 196- 207
7. **Tomasi D., Jones G.V., Giust M., Lovat L., Gaiotti,F., 2011** - *Grapevine phenology and climate change: relationships and trendsin the Veneto Region of Italy for 1964–2009*. American Journal of Enology and Viticulture 62, 329–339

METHODS FOR PRODUCING LOW-ALCOHOL WINE I. VITICULTURAL AND PRE-FERMENTATION STRATEGIES

METODE DE PRODUCERE A VINURILOR CU GRAD ALCOOLIC SCĂZUT. I. STRATEGII VITICOLE ŞI PRE-FERMENTATIVE

FILIMON V.R.[1]*, SANDU-VILLE Şt.[2], BORA F. D.[3], TUDOR Georgeta[4], FILIMON Roxana[1], NECHITA Ancuța[1], DAMIAN Doina[1]
*Corresponding author e-mail:razvan_f80@yahoo.com

Abstract. *Wine is defined as a food product obtained exclusively by fermentation of grapes or grape must, with an alcoholic strength of minimum 8.5% (v/v). Climate change, advanced viticultural practices, improved plant material and modern vinification techniques lead to elevated sugar levels in grapes and furthermore to an increase in alcohol content of wine. Although wine showed notable health benefits, due to higher ethanol content obtained in recent years wine consumption is more often restricted. In this context, the aim of this work was to present the currently known technological possibilities for the production of low-alcohol wines, with an emphasis on viticultural and pre-fermentation strategies to reduce sugar concentrations in grapes and must.*
Key words: alcohol content, glucose oxidase, grape sugars, reverse osmosis, technological maturity.

Rezumat. *Vinul este definit ca produsul alimentar obținut prin fermentarea strugurilor sau a mustului de struguri, cu o concentrație alcoolică dobândită de minim 8,5% (v/v). Modificările climatice, utilizarea de material biologic ameliorat, alături de dezvoltarea tehnologiilor viti-vinicole, au condus treptat la o creştere semnificativă a nivelului de zahăr în struguri şi, implicit, la creşterea concentrației alcoolice a vinurilor obținute. Deşi vinul prezintă beneficii importante pentru sănătate, datorită conținutului ridicat de etanol, consumul acestuia este deseori restricționat. In acest context, scopul prezentei lucrări a fost expunerea posibilităților tehnologice actuale de producere a vinurilor cu grad alcoolic scăzut, respectiv a unor strategii viticole şi practici pre-fermentative de reducere a concentrațiilor de zaharuri din struguri şi must.*
Cuvinte cheie: concentrație alcoolică, glucozoxidaza, maturitate tehnologică, osmoză inversă, zaharuri din struguri.

INTRODUCTION

Although current legislation defines wine as a food product obtained exclusively by the alcoholic fermentation of fresh grapes or grape must, with a

[1]Research and Development Station for Viticulture and Winemaking Iasi, Romania
[2]University of Agricultural Sciences and Veterinary Medicine Iasi, Romania
[3]Research and Development Station for Viticulture and Winemaking Bujoru, Romania
[4]Research and Development Institute for Viticulture and Winemaking Valea Călugărească, Romania

minimum ethanol content of 8.5% (v/v), actually, the alcoholic concentration of the worldwide wines is always much higher. Throughout time the alcoholic concentration of wines has increased progressively, a trend that was initially attributed to climate changes (a gradual increase in average air and soil temperatures) and afterwards to new developed viticultural practices, improved plant material and modern vinification techniques, that lead to obtaining elevated sugar levels in grapes and furthermore to an increase in alcohol content of wine.

Besides its negative psychological and physiological effects on human health, ethanol is indispensable for the aging, stability and organoleptic properties of wine (Ozturk and Anli, 2014). Considering all these aspects, the production of wines with low or reduced ethanol concentration has become a great challenge for wine producers, that has gained considerable attention over the past 10 years. Consumer demand is apparent for wines with lower ethanol levels, perceived as healthier. Wines with a reduced alcohol content can be classified as dealcoholised or no-alcohol (< 0.5% v/v), low-alcohol (0.5 - 1.2 % v/v) or reduced-alcohol (1.2 to 6.5 % v/v), but this classification system may vary between countries.

Viticultural strategies for limiting sugar accumulation in grape berries include "short term" changes (reducing leaf area and leaf removal, summer pruning, defoliation, aplication of growth regulators, managing harvest dates or modification of irrigation regime) and "long term" changes in vineyard (selection of root stock, grape varieties and vineyard site, soil composition). Pre-fermentation practices refer to dilution and blending of grape must with elevated sugar concentration with must from early harvests (low-sugar grapes) or the treatment of grape must to remove sugars (membrane processes and enzyme addition). These aspects will be briefly presented in this paper, focusing on the details that are of interest to technologists, oenologists and field researchers.

MATERIAL AND METHOD

In order to present relevant and recent data regarding production of low-alcohol wine (LAW), these approaches summarizes international literature data on viticultural strategies and pre-fermentation practices for producing LAW, to a better understanding of the concept and its easier implementation by winemakers.

RESULTS AND DISCUSSIONS

a. Viticultural strategies

1. Leaf area reduction

Leaf area to fruit mass ratio is a viticultural index for producing high-quality grapes and wine. According to Stoll *et al.* (2010) the rate of sugar accumulation in grapes is largely influenced by this ratio. A value between 0.8 and 1.2 m^2/kg allows grapes to achieve good ripeness. Leaf area reduction can be achieved through severe trimming or leaf removal treatments, performed at different stages of berry growth, thereby influencing the sugar content in must. Martinez de Toda *et al*. (2013) conducted a severe shoot trimming over a three-

year period. Véraison was delayed by about 20 days, while soluble solids were reduced by 12 to 15% (alcohol reduction of 2% v/v). Also, the pH, anthocyanin content and grape size and yield were reduced by about 10%. Until a leaf area to fruit ratio index below 0.50 m^2/kg was no negative impact on grapevine development in the next year. Increasing leaf removal up to 50% in Sangiovese cultivar grapes resulted in a soluble solids reduction, but with negative effect on yield in the following season (Palliotti *et al*., 2013).

2. Application of growth regulators

Application of exogenous growth regulators (e.g. 1-naphthaleneacetic acid) may be a useful tool for delaying sugar accumulation in grapes (Varela *et al*., 2013). Post veraison anti-transpirant treatments, with conifer resins like pinolene, induced a significant reduction of sugar concentration, regardless of the cultivar and the vine productivity (Palliotti *et al*., 2010). Also, application of inhibitors of natural ripening hormones were reported to delay grape ripening.

3. Optimization of harvest date

Harvest date largely determines grape must composition and therefore influences wine sensory profile. Winemakers tend to delay harvest in the search of flavour or phenolic maturity. Cabernet Sauvignon wines showed both vegetative and fruity characters, whereas vegetative attributes where dominant in wines made from earlier harvested (Bindon *et al.* 2013). Sensory quality of wines changes with different harvest dates and it is necessary that grapes to reach a certain level of maturity. Obtaining LAW from early harvest is still limited due to associated quality losses (flavour and phenolic compounds). Pickering *et al*. (2000) concluded that harvesting grapes at an early stage of development and subsequent vinification resulted in LAW with "unripe" aromas and unacceptably high acidity.

4. Water management

Modification of irrigation regime is a short-term viticultural practice that consists in increasing irrigation during the last few weeks before harvest that may cause a significant delay in grape ripening, with a small reduction in final wine alcohol content. Also, plant irrigation before harvest has been claimed to cause a significant delay in grape ripening with concomitant reduction in wine quality (Varela *et al*., 2015). However, the results were not confirmed in different years. On the other hand, different irrigation volumes showed no significant effect on wine perception and composition (Mendez-Costabel, 2007).

5. Long-term vineyard strategies

These preventive strategies are employed to regulate sugar concentration and raise grape yield based on grapevine breeding and selection of clones and require a careful consideration of climate favorability (Schmitt and Christmann, 2019). Low to moderate vigorous rootstocks may be chosen to lower the alcohol content in wines. Also, soil composition influenced grape ripening in terms of acidity and mineral content. Magnesium deficiency and an excess of nitrogen resulted in delayed ripening and lower sugar accumulation (Ozturk and Anli, 2014).

b. Pre-fermentation practices

1. Dilution and blending

Pre-fermentation practices like blending of high sugar grape must with must from early harvest (low sugar content) or dilution are often used. Wines obtained by "double harvest" (blending wines from green and mature grapes) showed significant differences on alcohol level (Martinez de Toda and Balda, 2011).

However, dilution with exogenous water is probably the oldest form of wine fraud and was formerly used for volume increase. The addition of water to reduce the sugar in must in order to reduce the alcohol content in wine is not legal in most wine-producing countries, including Romania. Anyway, beyond reducing sugar concentration, water addition may have as opposite effects lowering must acidity and negatively affecting appearance and taste of the future wine (colour, tannins, flavour compounds) (Schmitt and Christmann, 2019).

2. Enzyme addition

One of the most promising techniques for lowering sugar in the must is the oxidation of glucose by the enzyme glucose oxidase (GOX) (EC 1.1.3.4). The enzyme obtained from the fungus *Aspergillus niger* converts glucose into gluconic acid and hydrogen peroxide (Varela *et al.* 2015). Grape must contains approximately equal amounts of glucose and fructose, therefore, the theoretical maximal reduction on alcohol production can be 50%. In practice, alcohol reductions range from 4 to 40% (Petkova *et al.*, 2016). Pickering *et al.* (1999) reported that the alcoholic fermentation of GOX-treated grape musts proceeded normally and was obtained a 36 to 40% reduction in alcohol. Large amounts of gluconic acid are formed during treatment with GOX and that are present in the finished wine since it cannot be metabolized by yeasts. At bottling the pH of GOX wines are very similar to those of control wines, although titratable acidity remains significantly higher (Pickering *et al.*, 1999). The effectiveness of GOX largely depends on whether it is used as a sole or in combination with catalase (conversion of 1.32% of glucose and 49.25% respectively) (Petkova *et al.*, 2016). Also, GOX can be inhibited by SO_2 in wine (Pickering *et al*., 1999).

3. Membrane processes

Membrane technologies applied before fermentation have as purpose the reduction of grape must sugar. *Nanofiltration*, described as a technique between *ultrafiltration* and *reverse osmosis* have been used to concentrate and remove sugar from grape must after 1980. Nanofiltration usually retains molecules such as sugars and organic acids (pore size 1–10 nm, pressure up to 40 bar) (Schmitt and Christmann, 2019). To reduce the sugar content in the must the permeate of an ultrafiltration process containing water, acid and sugars is separated and concentrated by nanofiltration. This aqueous solution is finally blended back to the retentate of the ultrafiltration.

In principle, *reverse osmosis* is a filtration method that removes water from unfermented grape must (semi-permeable polymer membrane; pore size 0.1 - 1 nm), used since 1970. Water molecules are the smallest components of the grape must and

can pass from the high concentration solution across the membrane to the lower concentration solution. A transmembranar pressure of up to 90 atm removes water from the must through the membrane pores (permeate), while the aroma, sugar and tannin molecules are not filtered (retentate). Low alcohol beverages result from the blending in different proportions of the two phases resulting from the osmosis process and subsequent fermentation. Usually, the analyzed variables are: transmembrane pressure (40 - 60 bar), temperature of the process (20 - 40°C), changes in the must pH, soluble solids, acidity, minerals, phenolic compounds and anthocyanins, colour index and colour density. None of the experiments reported a significant changes in the must characteristics. Gurak *et al.* (2010) indicated that the best process conditions was 60 bar pressure and 40°C, resulting in high permeate flux values. These procedures can be followed by *osmotic* membrane *distillation*, that is a low-temperature method used for grape must concentration by water evaporation, using a porous hydrophobic membrane. Compared to other treatments for alcohol reduction, the sugar reduction involve relatively high volume losses. The reduction of 17 g/L sugars, which corresponds to approximately 1% (v/v) less alcohol, means a volume loss of 7% from the initial volume (Schmitt and Christmann, 2019).

4. Other approaches

Lang and Casimir (1986) developed a method which involves separation of juice into a high-sugar and a low-sugar fraction by freezing, to form a slush. The slush is then filtered using an extractor. Volatile components from the juice of the high-sugar fraction are taken over using a spinning cone fractional distillation column and added to the low-sugar fraction, which is subsequently fermented.

CONCLUSIONS

1. Viticultural strategies are preventative interventions for moderating the concentration of fermentable carbohydrates in wine grapes, imbalancing carbohydrate accumulation and maintaining the development of sensorially grape constituents, resulting in wines with less alcohol concentration. These strategies may allow a good must composition, but they can cause excessively delayed ripening or excessive grape exposure, obtaining beverages of inferior quality.

2. Pre-fermentation practices can be successfully applied by small wineries, the sensory perception of the obtained wine varying widely depending on the process involved. Treatments of grape must to remove sugars (reverse osmosis or the addition of glucose oxidase) are efficient technologies that allow grapes to reach full maturity, with higher chances to obtain quality low alcohol wines. Further studies are still necessary in order to compare or combine these practices.

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REFERENCES

1. **Bindon K., Varela C., Kennedy J., Holt H., Herderich M., 2013** - *Relationships between harvest time and wine composition in Vitis vinifera L. cv. Cabernet Sauvignon. Grape and wine chemistry.* Food Chemistry**,** 138 (1), pp. 1696–1705.
2. **Gurak P.D., Cabral L.M.C., Rocha-Leão M.H.M., Matta V.M., Freitas S.P., 2010** - *Quality evaluation of grape juice concentrated by reverse osmosis.* Journal of Food Engineering**,** 96 (3), pp. 421-426.
3. **Lang T.R., Casimir D.J., 1986** - *Low alcohol wine*. European Patent Application EP 0177282 A2.
4. **Martinez de Toda F., Balda P., 2011** - *Decreasing the alcohol level in quality red wines by the "double harvest" technique.* Proceedings 17th International Symposium GiESCO, Asti - Alba (CN), Italy, pp. 463-466.
5. **Martínez de Toda F., Sancha J.C., Balda P., 2013 -** *Reducing the sugar and pH of the grape (Vitis vinifera L. cvs. 'Grenache' and 'Tempranillo') through a single shoot trimming*. S. Afr. J. Enol. Vitic., 34 (2), pp. 246-251**.**
6. **Mendez-Costabel M., 2007 -** *Impact of irrigation levels during the latter stages of fruit ripening on the yield components, physiology and berry and wine composition of Vitis vinifera L.* MS thesis. University of California, Davis, CA, USA.
7. **Ozturk B., Anli E., 2014** - *Different techniques for reducing alcohol levels in wine: A review*. BIO Web of Conferences 3, 02012. https://doi.org/10.1051/bioconf/20140302012.
8. **Palliotti A., Panara F., Silvestroni O., Lanari V., Sabbatini P., Howell G.S., Gatti M., Poni S., 2013** - *Influence of mechanical postveraison leaf removal apical to the cluster zone on delay of fruit ripening in Sangiovese (Vitis vinifera L.) grapevines*. Australian Journal of Grape and Wine Research 19, 369–377.
9. **Palliotti A., Poni S., Berrios J.G., Bernizzoni F., 2010** - *Vine performance and grape composition as affected by early-season source limitation induced with anti-transpirants in two red Vitis vinifera L. cultivars.* Aust. J. Grape Wine Res., 16 (3), pp. 426-423.
10. **Petkova V., Mladenoska I., Gjuladin-Hellon T., 2016 -** *Utilization of different types of glucose oxidase for reduction of glucose concentration in synthetic grape juice* Agro-knowledge Journal, 17 (1), pp. 47-58**.**
11. **Pickering G.J., 2000 -** *Low and reduced-alcohol wine: a review*. Journal of Wine Research, 11 (2), pp. 129–144.
12. **Pickering G.J., Heatherbell D.A., Barnes M.F., 1999** - *The production of reduced-alcohol wine using glucose oxidase treated juice. Part I. Composition*. Am. J. Enol. Vitic., 50 (3), pp. 291-298.
13. **Schmidtke L.M., Blackman J.W., Agboola S.O., 2012** - *Production technologies for reduced alcoholic wines***.** Journal of Food Science, 71 (1), pp. R25-R41**.**
14. **Schmitt M., Christmann M., 2019 -** *Alcohol reduction by physical methods.* In Morata A., Loira I. (eds.), Advances in Grape and Wine Biotechnology, Edit. IntechOpen, pp. 1-18. DOI: 10.5772/intechopen.85989.
15. **Stoll M., Lafontaine M., Schultz H.R., 2010 -** *Possibilities to reduce the velocity of berry maturation through various leaf area to fruit ratio modifications in Vitis vinifera L. Riesling***.** Le Progrès Agricole et Viticole, 127 (3), pp. 68-71.
16. **Varela C., Dry P.R., Kutyna D.R., Francis I.L., Henschke P.A., Curtin C.D., Chambers P.J., 2015** - *Strategies for reducing alcohol concentration in wine*. Aust. J. Grape Wine Res., 21, pp. 670–679.

METHODS FOR PRODUCING LOW-ALCOHOL WINE II. FERMENTATION AND POST-FERMENTATION STRATEGIES

METODE DE PRODUCERE A VINURILOR CU GRAD ALCOOLIC SCĂZUT. II. STRATEGII FERMENTATIVE ŞI POST-FERMENTATIVE

FILIMON V.R.[1]*, SANDU-VILLE Şt.[2], BORA F.D.[3], TUDOR Georgeta[4], FILIMON Roxana[1], NECHITA Ancuța[1], ZAIȚ Monica[1]
*Corresponding author e-mail: razvan_f80@yahoo.com

Abstract. *According to current legislation, wine is defined as the alcoholic beverage resulted from fermentation of grapes or grape must, with an ethanol concentration of minimum 8.5% (v/v). Climate change, modern viticultural practices and the use of selected yeast strains gradually lead to wines with increased alcohol concentrations. Moreover, consumer demand is apparent for wines with lower ethanol levels, perceived as healthier. Since viticultural and pre-fermentation practices not always lead to high quality products, the aim of this paper was to provide technological data on the currently available microbiological and post-fermentation practices to produce low alcohol wine from well-ripened grapes. However, the most efficient strategies involves a compromise between ethanol removal, energy consumption and potential impact on wine composition.*
Key words: alcoholic fermentation, grape must, membrane processes, wine yeasts

Rezumat. *Conform legislației actuale, vinul este produsul alimentar obținut exclusiv prin fermentarea strugurilor sau a mustului de struguri, cu o concentrație alcoolică de minimum 8,5% (v/v). Modificările climatice, aplicarea unor tehnologii viticole moderne şi utilizarea tulpinilor de levuri selecționate au condus treptat la obținerea unor vinuri cu concentrații alcoolice tot mai ridicate. In mod contrar, este tot mai evidentă preferința consumatorilor pentru vinuri cu un conținut mai scăzut de etanol, percepute, în general, ca fiind mai sănătoase. Întrucât practicile viticole şi cele pre-fermentative de reducere a concentrațiilor de zaharuri din struguri şi must nu conduc întotdeauna la obținerea unor vinuri conforme calitativ, scopul acestui studiu a fost prezentarea unor practici microbiologice (fermentative) şi post-fermentative de reducere a titrului alcoolic natural al vinului. Cele mai eficiente strategii implică identificarea unui echilibru între eliminarea etanolului, consumul de energie şi impactul potențial asupra compoziției vinului.*
Cuvinte cheie: levuri selecționate, fermentație alcoolică, must de struguri, procese membranare

[1]Research and Development Station for Viticulture and Winemaking Iasi, Romania
[2]University of Agricultural Sciences and Veterinary Medicine Iasi, Romania
[3]Research and Development Station for Viticulture and Winemaking Bujoru, Romania
[4]Research and Development Institute for Viticulture and Winemaking Valea Călugărească, Romania

INTRODUCTION

Throughout time the alcoholic concentration of wines has increased gradually, a trend attributed to climate change, advanced viticultural practices, improved plant material and modern vinification techniques, all leading to obtaining elevated sugar levels in grapes and implicitly to an increase in alcohol content of wine. In warmer regions, the average alcohol content has risen by approximately 2% (v/v) over the past 30 years (Varela *et al*., 2015). As an alternative to high alcohol wines currently marketed worldwide, dealcoholised or low-alcohol wines (LAW) may offer a number of potential social and health benefits for consumers: improved productivity, lower risk of driving accidents, a better social acceptance and important health advantages (reduced calorie intake, decreased risk from alcohol-related illness) (Pickering, 2000). Moreover, consumer demand is apparent for wines with lower ethanol levels, perceived as healthier, products that ensure food security, nutritional richness and participation in quality of life. Since viticultural strategies and pre-fermentation practices for limiting sugar accumulation in grapes or lowering sugar concentration in must not always lead to high quality products, a series of fermentation processes (changing the sugars consumed/alcohol produced ratio, early interruption of fermentation, use of low-alcohol producing yeast) and post-fermentation practices (physical removal of alcohol) to produce LAW from well-ripened grapes need to be considered.

This work presents currently known possibilities to produce low or reduced alcohol wines, providing a brief overview for producers and consumers concerning the technological aspects and factors that influence the quality and acceptance of LAW.

MATERIAL AND METHOD

The study summarizes recent data from international literature on microbiological and post-fermentation practices for producing dealcoholised, low or reduced alcohol wines, for a better understanding of the concept and easier implementation of the technologies by winemakers.

RESULTS AND DISCUSSIONS

a. Microbiological practices

1. Low-alcohol producing yeast

Saccharomyces cerevisiae is the principal yeast selected for wine fermentation. Recent studies have shown that the use of different *S. cerevisiae* strains induced small differences (0.4% v/v) in ethanol yielded in wine following fermentation (Bucher *et al.*, 2019). Selection of yeasts used in winemaking was made until recent years in order to obtain a high alcohol concentration. Currently, along with the ability to amplify the aromatic profile, it is necessary to isolate yeasts that consume more sugar and produce less ethanol. Also, several non-conventional yeasts were used to obtain lower levels of alcohol in wines. *S.*

uvarum and *S. cerevisiae* × *S. uvarum* hybrids produced 0.30% (v/v) less ethanol than *S. cerevisiae* yeasts (Tilloy *et al*., 2013). Moreover, some experiments confirmed the low volatile acidity and glycerol production of *Torulaspora delbrueckii* with lower ethanol production (Herraiz *et al*., 1990). *Candida zemplinina* strains possessed a poor alcohol/sugar yield, with 12% less compared to *S. cerevisiae* strains. No significant differences in ethanol production were observed when *C. zemplinina* and *S. cerevisiae* co-cultures were used. In contrast, sequential fermentations (*S. cerevisiae* added after 24 h) lead to a lower ethanol production up to 0.90% (v/v) (Tilloy *et al*., 2013).

Worldwide investigations are focused on generating by genetic engineering new *S. cerevisiae* and non-*Saccharomyces* strains to produce less ethanol by diverting sugar metabolism to other end-points (*e.g.* glycerol), while maintaining wine quality (Varela *et al*., 2015). In normally functioning yeast, most of the NADH produced during glycolysis is subsequently oxidized during ethanol formation, but yeast can utilize other pathways for oxidising NADH, including cytosolic production of glycerol (Kutyna *et al*., 2010). These yeasts usually show a higher content of fermentation by-products. Moreover, the use of genetically modified organisms is often seen as a negative aspect by most consumers. Transgenic incorporation of cytosolic oxygen-dependant NADH-oxidase enzymes showed promising results in lowering ethanol production (Schmidtke *et al*., 2012). Also, expression in wine yeast of lactate dehydrogenase gene (LDH) from *Lactobacillus casei* has resulted in reduced ethanol concentration (0.25% v/v) by diverting carbon metabolism to lactic acid production (Dequin *et al*. 1999).

2. Other microbiological approaches

A tested alternative to producing LAW was to exploit the *oxidative metabolism of yeasts*. In the fermentation process there is first a considerable increase in yeast biomass through aerobic metabolism (cca. 2% of total sugar amount). Then, due to the lack of oxygen, the anaerobic metabolism is triggered. Future studies will have to find solutions to prolong the aerobic phase of yeast growth, without altering the organoleptic characteristics of obtained wines (Varela *et al*., 2015). Strong *aeration* for the first 48 h before the anaerobic process enabled the production of LAW by *Metschnikowia pulcherrima* (Morales *et al.,* 2015).

Several *metabolites* can influence yeast metabolism by altering redox balance, like: furfural, vanillin, glycolaldehyde, organic acids (cinnamic, benzoic, formic and propionic acids), sodium or potassium chloride, sulphur dioxide and sodium carbonate (Kutyna *et al*., 2010). Some of these metabolites can be added to the fermenting must, but might affect wine sensory profile.

Increasing *fermentation temperature*, can also alter yeast metabolism and divert carbon away from ethanol production, but such conditions may affect dramatically wine sensory profile. Also, *early arrest of fermentation* is often restrictive in terms of nutritional and microbiological stability of the sweet wine obtained (high residual sugar content) (Pickering, 2000).

b. Post-fermentation practices

1. Wine blending

In order to reduce excessive alcohol concentration of wines a strategy can be represented by blending high alcohol wines with wines containing less alcohol. Wine obtained from early harvested grapes contains a lower level of alcohol, but does not have the aromatic or phenolic complexity of the ripe grape wine and may present excessive acidity or bitterness (Varela *et al*., 2015).

2. Reverse osmosis

Reverse osmosis is the most used procedure for lowering wine alcohol (Gil *et al*., 2013). Varying the pore size and pressure applied on the membrane result in a series of membrane filtration processes (reverse osmosis, nanofiltration, ultrafiltration and microfiltration). Reverse osmosis membranes can be made of cellulose acetate, regenerated cellulose, synthetic polymers and ceramics (Schmidtke *et al*., 2012). Water and ethanol, being small molecules, pass through the membrane into the permeate, which has to be reduced in alcohol in a second step, usually by osmotic distillation. This alcohol reduced fraction is finally blended with the concentrate (Schmitt and Christmann, 2019). Wine can be aslo restored to the original water content by the *addition of low sugar grape must* or by water (*diafiltration)*, but in the most countries the water dilution is not legally allowed.

3. Vacuum distillation

The boiling point of pure ethanol is around 78 °C, this temperature being too high for performing a wine treatment. The vacuum distillation achieves lower boiling points by applying a vacuum in the column. This process is performed at reduced pressure (0.07 to 1 bar) and a lower temperature (30 to 60 °C), in order to keep aromatic losses as low as possible. At the end of the treatment, the alcohol content of the wine can achieve 0.5% (v/v) (Varela *et al*., 2015). Aguera *et al*. (2010) separated 135 L of pure ethanol from 1000 L wine with 14% (v/v) alcohol. However, lowering alcohol by 2% (v/v) has been found to reduce the concentration of higher alcohols by 25% and esters by 45%. For lower volumes of wine a rotary evaporator can be used for vacuum distillation. In industrial *vacuum rectification* the condensate is passed to an aroma leaching and some of the flavours are returned to the final LAW (Schmitt and Christmann, 2019).

4. Osmotic distillation and pervaporation

Osmotic distillation (evaporative perstraction or membrane distillation) and pervaporation share similar processes. Ethanol removal occurs as a process of evaporation at the membrane interface, diffusion of the vapor across the membrane and condensation into a stripping phase (Schmidtke *et al*., 2012). Most processing can be conducted at low temperatures (cca. 30°C), without applying high pressure (Saha *et al*., 2013). In pervaporation, the wine is separated by partial vaporization through a nonporous selectively permeable membrane. Pervaporation uses an inert gas or vacuum to remove the permeate. Ethanol migrates through the membrane in a gaseous phase and recondenses as permeate. Unfortunately, significant aroma losses may arise when pervaporation is applied.

At low rates of ethanol removal (<2 % v/v), osmotic distillation is reported to have a modest impact on aliphatic acids, monoterpenes and some wine alcohols. However, ethyl esters were substantially reduced in wine (Saha *et al*., 2013).

5. Spinning cone

Spinning cone column (SCC) is a gas-liquid contacting device consisting of a vertical counter-current flow system that contains a succession of rotating and stationary metal cones (Pickering, 2000). The liquid flows down on the stationary cones under the influence of gravity and moves up in a thin film by the action of applied centrifugal force. Vapour flows up the column, traversing the spaces between the successive fixed and rotating cones. Minerals and other non-volatile components in the original wine are preserved. In the first stage, delicate aroma components are removed at moderate vacuum (0.04 atm) and low temperature (26-28 °C) (1% of wine). The second stage is conducted at higher temperature (38 °C) and results in an alcohol concentrate above 50% (v/v) (Saha *et al*., 2013).

6. Other approaches

In *freeze concentration* method water of wine can be removed by freezing and the alcohol in the residual liquid can be removed by vacuum distillation. LAW can be adjusted to various alcohol concentrations with the alcohol fraction.

In *dialysis*, water is used to provide the concentration gradient, allowing the movement of ethanol out of the wine into the water. As the concentration gradient exists only for alcohol, previous dealcoholised wine can be used instead of water.

Alcohol and aroma-containing condensate resulting from wine evaporation can be extracted with *organic solvents* such as pentane and hexane (Pickering, 2000). Disadvantages of solvent extraction of wine include thermal damage and the potential presence of solvent residuals in the extract.

CO_2 is one of the most commonly solvent used for *liquid-liquid extraction*. Alcohol may be extracted from wine using liquid CO_2, which, under specific pressure and temperature conditions, has properties similar to those of solvents. Carnacini *et al*. (1989) concluded that extraction with supercritical CO_2 is a promising process. Unlike organic solvents, supercritical CO_2 is not toxic.

Alcohol can be also *adsorbed* onto porous resins such as styrol/ divinylbenzol copolymers or silica gels. These processes are more suitable at laboratory level rather than large-scale production.

CONCLUSIONS

1. The use of *Saccharomyces* and non-*Saccharomyces* yeast strains in co-cultures or sequential cultures, has proven to be an effective strategy for reducing ethanol production, especially by redirecting yeast carbon metabolism to the production of other compounds like glycerol or lactic acid by genetic engineering.

2. Reduction of ethanol concentration following alcoholic fermentation of mature-grape must remains the main approach currently used, reverse osmosis-vacuum distilation and spinning cone columns best preserving the sensory features of low-alcohol wines.

3. For reasons associated with health, economics and high quality, currently exists a need for the development of effective, fast and less expensive technologies to reduce the alcoholic concentration of wines. However, the most efficient strategies involves a compromise between ethanol removal, energy consumption and potential impact on wine composition and sensory attributes.

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REFERENCES

1. Aguera E., Bes M., Roy A., Camarasa C., Sablayrolles J.-M., 2010 - *Partial removal of ethanol during fermentation to obtain reduced-alcohol wines*. American Journal of Enology and Viticulture, 61(1), pp. 53-60.

2. Bucher T., Deroover K., Stockley C., 2019 - *Production and marketing of low-alcohol wine.* In Morata A., Loira I. (eds.), Advances in Grape and Wine Biotechnology, Edit. IntechOpen, pp. 1-16. DOI: 10.5772/intechopen.87025.

3. Carnacini A., Marignetti N., Antonelli A., Natali N., Migazzi S., 1989 - *Alcohol removal and aroma recovery from wine by permoseparation, dialysis, and extraction with CO2*. Industrie delle Bevande, 18, pp. 257-264.

4. Dequin S., Baptista E., Barre P., 1999 - *Acidification of grape musts by Saccharomyces cerevisiae wine yeast strains genetically engineered to produce lactic acid*. American Journal of Enology and Viticulture, 50, pp. 45–50.

5. Gil M., Kontoudakis N., Estévez S., González-Royo E., Esteruelas M., 2013 - Non microbiological strategies to reduce alcohol in wines. In 1st International Symposium: Alcohol Level Reduction in Wine, pp. 25-29.

6. Herraiz T., Reglero G., Herraiz M., Martin-Alvarez P.J., Cabezudo M., 1990 - *The influence of yeast and type of culture on the volatile composition of wines.* American Journal of Enology and Viticulture, 41, pp. 313-318.

7. Kutyna D.R., Varela C., Henschke P.A., Chambers P.J., Stanley G.A., 2010 - *Microbiological approaches to lowering ethanol concentration in wine.* Trends in Food Science & Technology, 21 (6), pp. 293-302.

8. Morales P., Rojas V., Quiros M., Gonzalez R., 2015 - *The impact of oxygen on the final alcohol content of wine fermented by a mixed started culture*. Applied Microbiology and Biotechnology, 99, pp. 3993–4003.

9. Pickering G.J., 2000 - *Low and reduced-alcohol wine: a review*. Journal of Wine Research, 11 (2), pp. 129–144.

10. Saha B., Torley P., Blackman J., Schmidtke L., 2013 - *Review of technological strategies to reduce alcohol levels in wines.* In 1st International Symposium: Alcohol Level Reduction in Wine, pp. 78-86.

11. Schmidtke L.M., Blackman J.W., Agboola S.O., 2012 - *Production technologies for reduced alcoholic wines*. Journal of Food Science, 71 (1), pp. R25-R41.

12. Schmitt M., Christmann M., 2019 - *Alcohol reduction by physical methods.* In Morata A., Loira I. (eds.), Advances in Grape and Wine Biotechnology, Edit. IntechOpen, pp. 1-18. DOI: 10.5772/intechopen.85989.

13. Tilloy V., Cadière A., Ehsani M., Dequin S., 2013 - *Microbiological strategies to reduce alcohol levels in wines.* In 1st International Symposium: Alcohol level reduction in wine, pp. 29-32.

14. Varela C., Dry P.R., Kutyna D.R., Francis I.L., Henschke P.A., Curtin C.D., Chambers P.J., 2015 - *Strategies for reducing alcohol concentration in wine*. Aust. J. Grape Wine Res., 21, pp. 670–679.

ANTIRADICAL CAPACITY OF SOME RED WINES PRODUCED IN THE IASI VINEYARD IN RELATION TO THEIR PHENOLIC CONTENT

CAPACITATEA ANTIRADICALICĂ A UNOR VINURI ROŞII PRODUSE ÎN PODGORIA IAŞI ÎN RELAȚIE CU CONȚINUTUL FENOLIC AL ACESTORA

ZAIȚ Monica[1*], FILIMON V. R.[1], NECHITA Ancuța[1], DAMIAN Doina[1]
*Corresponding author e-mail: monica.zait95@gmail.com

Abstract: *In recent years great attention has been paid to food antioxidants and their association with multiple health benefits. Free radical scavenging activity is currently considered to be one of the most important characteristics of wine and is often associated with its polyphenolic content. The aim of this paper was the assessment of total phenolic compounds, anthocyanin and tannin contents of five wines (Cabernet Sauvignon, Merlot, Pinot gris, Arcaş and Busuioacă de Bohotin) produced in the NE of Romania - Iasi vineyard, from 2018 and 2019 harvests, in relation to their free radical scavenging activity (DPPH). High content of phenolic compounds (flavonoids and non-flavonoids) and their positive correlation with the free radical scavenging activity of the analysed samples suggests that rose and red wines are excellent source of compounds with antiradical capacity.*
Key words: free radical, scavenging activity, antioxidants, DPPH, phenolic compounds

Rezumat. *În ultimii ani a fost acordată o atenție deosebită antioxidanților alimentari şi asocierii acestora cu multiple beneficii pentru sănătate. În prezent, activitatea antiradicalică este considerată a fi una dintre cele mai importante caracteristici ale vinului şi este adesea asociată cu conținutul său polifenolic. Scopul acestei lucrări a fost evaluarea conținutului total de compuşi fenolici, antociani şi taninuri din cinci probe de vin (Cabernet Sauvignon, Merlot, Pinot Gris, Arcaş şi Busuioacă de Bohotin), produse în zona de NE a României - podgoria Iaşi, din recoltele anilor 2018 şi 2019, în raport cu capacitatea antiradicalică (DPPH) a acestora. Conținutul ridicat de compuşi fenolici (flavonoizi şi non flavonoizi) şi corelația pozitivă a acestora cu activitatea antiradicalică a probelor analizate sugerează faptul că vinurile rose şi roşii reprezintă o sursă excelentă de compuşi cu capacitate antiradicalică.*
Cuvinte cheie: radicali liberi, activitate antiradicalică, antioxidanți, DPPH, compuşi fenolici

INTRODUCTION

The overproduction of reactive oxygen species (ROS) has been reported to result in oxidative stress and is involved in the damage of cell structures that

[1]Research and Development Station for Viticulture and Winemaking Iasi, Romania

causes various disease states (Sanaa *et al.*, 2018). This can be largely counteracted by antioxidant defence systems.

In recent years, increasing attention has been paid to food antioxidants and their association with multiple health benefits. In general, it has been described that phenolic compounds are secondary antioxidants included in the category of free radical scavengers. Consumption of red wine has been proven to increase plasma/serum antioxidant activity and to protect LDL from oxidation. Consequently, the potent antioxidant activity of phenolic compounds in red wine has been proposed as an explanation for the French paradox (Davalos and Lasuncion, 2009). For these reasons free radical scavenging activity is currently considered to be one of the most important characteristics of wine and is often associated with its polyphenolic content. The aim of this paper was the assessment of total phenolic compounds, anthocyanin and tannin contents of five wines (Pinot gris, Busuioacă de Bohotin, Cabernet Sauvignon, Merlot and Arcaş) produced in NE of Romania - Iasi vineyard, in relation to their free radical scavenging activity.

MATERIAL AND METHOD

For conducting the study were used the wines obtained from grapes of five *Vitis vinifera* L. varieties: Cabernet-Sauvignon, Merlot, Arcaș (Cabernet Sauvignon × Babească neagră), Busuioacă de Bohotin and Pinot gris, in the years 2018 and 2019, growing in the experimental field of the Research-Development Station for Viticulture and Winemaking Iasi, Romania. Grapes were harvested at technological maturity, destemmed, mechanically crushed, macerated (5 days) and pressed. The wine was fermented using *Saccharomyces cerevisiae ssp. bayanus* yeast strain *(*Fermactive CB, Sodinal, France*)* and fining was done with bentonite (Spherobent super, 0.9 g/L). The wines were filtered and stabilized with SO_2. Physical and chemical features of wines were analysed according to the Compendium of international methods of wine and must analysis (OIV, 2012). Colour parameters (proportion of red, yellow, blue, colour intensity, colour hue, and brilliance of red wines) were calculated according to the method described by Glories (1984), measuring the absorbance at 420, 520 and 620 nm using an Analytik Jena Specord 200 plus spectrophotometer. Total phenolic, flavonoid and non-flavonoid fractions were determined by the colorimetric method using the Folin-Ciocâlteu reagent (Merck, Germany) (Singleton and Rossi, 1965) and expressed as galic acid equivalent (GAE)/L ($x = 1.1317 \times DO - 0.0451$). Flavonoids were precipitated using an acidic formaldehyde solution (pH<0.8) (Tibiri, 2010). Anthocyanins were determined by pH variation method (AOAC, 2005).

The free radical scavenging activity of the wine samples was determined using 2,2-diphenyl-1-picrylhydrazyl free radical (DPPH) (Alfa Aesar, Germany), according to the protocol presented by Brand-Williams (1995). Sulphur dioxide, used as preservative, could influence the antiradical activity by locking anthocyanins. In order to free anthocyanin from their combinations an acetaldehyde 10 % solution was used.

Pearson's correlation coefficient (r) was used to measure the strength of the association between the antiradical activity and phenolic content.

RESULTS AND DISCUSSIONS

Wine physico-chemical parameters of wines have complied with the values mentioned by the current legislation (***, 2016). The alcohol concentration ranged between 10.6 % vol. (Arcaş, 2018) to 14.9 % vol. (Pinot gris) (tab. 1). All wines were dry (1.2 - 3.8 g/L sugars), so the sugar content was too low to affect the antiradical activity of the analysed samples.

Table 1

Physico-chemical features of wines

Variety	Arcaş		Busuioacă de Bohotin		Cabernet Sauvignon		Merlot		Pinot gris	
Year	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
pH	3.58	0.30	3.42	0.28	3.43	0.30	3.54	0.29	3.64	0.31
ρ 20°C (g/cm^3)	0.9933	0.9922	0.9927	0.9915	0.9935	0.9918	0.9922	0.9930	0.9916	0.9918
Alc. (% vol)	10.6	12.1	14.7	13.1	12.4	12.1	11.8	12.7	14.5	14.9
Total acidity (g TA /L)	5.62	6.3	6.38	6.52	5.39	6.75	5.92	4.57	5.25	5.4
Volatile acidity (g Ac.ac./L)	0.43	0.3	0.39	0.28	0.36	0.30	0.45	0.29	0.43	0.31
Free SO_2 (mg/L)	53	28	47	48	37	33	50	37	36	35
Total SO_2 (mg/L)	105	75	105	130	87	83	104	100	82	93
Sugars (g/L)	1.40	1.20	3.80	1.90	1.20	1.20	1.20	1.90	1.40	1.20
Dry extract (g/L)	22.40	19.60	28.60	22.20	22.40	19.60	22.70	21.60	25.50	21.90
N.rd. extract (g/L)	21.00	18.40	21.80	20.30	21.20	18.40	21.50	19.70	21.90	20.00

Note: TA - tartaric acid; Alc – Alcohol; Ac.ac - acetic acid; N.rd. - Non-reducing.

Red wines (Arcaş, Cabernet Sauvignon and Merlot) showed a higher free radical scavenging activity (54.52 - 88.87 %), comparing to rose wines (fig. 1).

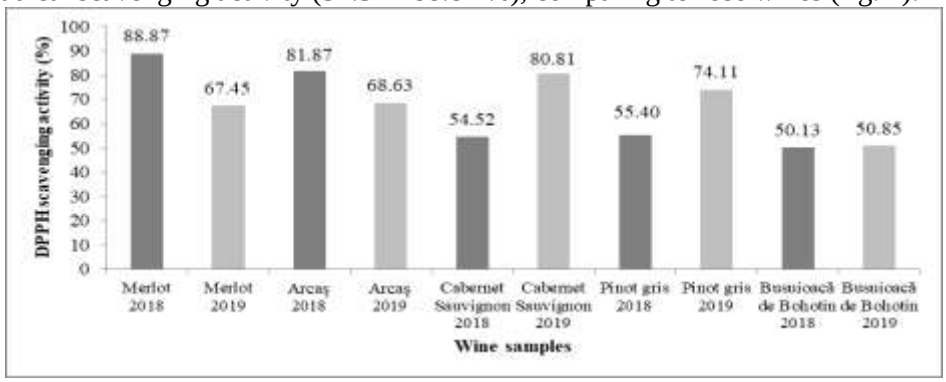


Fig. 1 DPPH scavenging activity (%) of wines made in Copou Iasi wine center

Colour is an attribute connected with many parameters, directly linked to wine quality, giving information on possible defects or poor storage conditions and also has a direct effect on consumer acceptability (Valentin *et al*., 2016). Colour composition of the analysed wines showed predominantly red and yellow hues.

The wines with the highest colour intensity were Merlot (2.21) and Arcaş (2.76). Rose wines presented higher values of colour brightness, ranging from 97.74 to 99.44 (tab. 2).

Table 2

Chromatic parameters of analysed wine samples

Variety	Year	Red (R%)	Blue (B%)	Yellow (Y%)	Colour intensity	Hue	Colour brightness
Arcaş	2018	42.09	5.56	52.34	1.74	1.24	62.99
	2019	56.05	3.45	40.50	2.76	0.72	65,00
Busuioacă de Bohotin	2018	27.44	12.17	60.39	0.48	2.20	97.74
	2019	39.08	3.43	57.49	0.29	1.47	98.99
Cabernet Sauvignon	2018	46.35	4.22	49.43	1.85	1.07	57.49
	2019	51.69	4.39	43.91	1.43	0.85	74.32
Merlot	2018	38.79	3.80	57.41	2.21	1.48	42.05
	2019	52.71	3.45	43.84	1.16	0.83	83.24
Pinot gris	2018	17.28	21.06	61.66	0.28	3.57	99.44
	2019	40.79	3.88	55.33	0.31	1.36	98.84

Red wines were rich in phenolic compounds (TPC), with higher values for Arcaş (2018), up to 2.42 g/L GAE, while rose wines showed values around 1.4 g/L GAE (tab. 3).

This paper explores the relationship between phenolic compounds, chromatic parameters and DPPH scavenging activity, using Pearson's correlation coefficient *r*. Thus, TPC showed a very strong correlation with flavonoid content (r=0.9754), a strong positive correlation with the tannin (r=0.8779), cathechin (r=0.8119) and anthocyanin (r=0.7493) content of wines. A moderate positive correlation of TPC with DPPH scavenging activity (r=0.5807) might imply that antiradical activity increases along with the concentration of phenolic compounds.

Although non-coloured, the non-flavonoid constituents are known to enhance and stabilize the colour of rosé/red wines by intra- and intermolecular reactions (Davalos and Lasuncion, 2009). This is reflected in the strong positive correlation with red colour percentage (R%) (r=0.7711) and moderate positive correlation with colour intensity, anthocyanin and catechin contents.

Flavonoids presented a very strong positive correlation with tannins (r=0.9205), a strong correlation with catechin (0.7219) and moderate positive correlation with anthocyanins (r=0.6622). Also, a moderate positive correlation of flavonoids with free radical scavenging activity was observed (r=0.5287).

Catechins showed a negative moderate correlation with the analysed parameters, excepting a positive moderate correlation with colour intensity (r=0.6804) and antiradical activity (r=0.6832). Also, tannins showed a weak correlation with chromatic parameters of wines and a positive moderate correlation with their DPPH scavenging activity (r=0.6108).

Anthocyanins showed the highest correlation with DPPH scavenging activity (r = 0.7486), a strong positive correlation with colour intensity (r=0.7075) and a moderate positive correlation with R% (tab. 4).

Table 3

Phenolic content of wines produced in Copou - Iasi wine centre

Variety	Arcaş		Busuioacă de Bohotin		Cabernet Sauvignon		Merlot		Pinot gris	
Feature / Year	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
DO 280	29.46	18.02	13.28	12.83	18.78	18.4	18.56	22.46	10.50	14.23
TPC (g/L GAE)	2.42	1.55	1.44	1.40	1.38	1.40	1.73	1.58	1.40	1.56
Non-FL. (g/L GAE)	0.40	0.41	0.31	0.35	0.37	0.33	0.39	0.36	0.14	0.30
FL. (g/L GAE)	2.02	1.14	1.13	1.05	1.01	1.07	1.35	1.22	1.24	1.25
Ant. (mg/L)	596.30	495.71	214.35	217.67	563.77	525.10	519.70	529.06	138.40	120.45
Cat. (mg/L)	21.8	9.82	2.51	2.59	10.11	11.49	11.14	9.18	1.87	4.35
Tan. (mg/L)	39.53	14.02	6.04	5.08	11.48	11.00	19.34	16.8	18.86	23.57

Note: GAE –galic acid equivalent; TPC – Total phenolic compounds; Non-FL – Non-Flavonoids; FL – Flavonoids; Ant – anthocyanins; Cat – Catechin; Tan –tannins.

Table 4

Correlation between phenolic content of wine, chromatic parameters and antioxidant activity

	TPC	*Non-FL*	*FL*	*Ant*	*Cat*	*Tan*	*R%*	*B%*	*Y%*	*C.I.*	*Hue*	*C.B.*	*AA %*
TPC	1												
Non-FL	0.4160	1											
FL	0.9754	0.2052	1										
Ant	0.7493	0.5947	0.6622	1									
Cat	0.8119	0.6267	0.7219	0.9397	1								
Tan	0.8779	0.1006	0.9205	0.5907	0.6836	1							
R%	0.1115	0.7711	-0.0670	0.4316	0.5082	0.0052	1						
B%	-0.1927	-0.8730	0.0043	-0.3939	-0.4386	-0.0156	-0.8614	1					
Y%	-0.0289	-0.5501	0.1023	-0.3809	-0.4678	0.0035	-0.9210	0.5956	1				
C.I.	0.3300	0.6993	0.1857	0.7075	0.6805	0.2035	0.6376	-0.4811	-0.6395	1			
Hue	-0.1929	-0.8711	0.0036	-0.4659	-0.5347	-0.0215	-0.9646	0.9464	0.7998	-0.5881	1		
C.B.	-0.2479	-0.6393	-0.1118	-0.5995	-0.5392	-0.1415	-0.5835	0.4257	0.5963	-0.9686	0.5168	1	
AA%	0.5807	0.3968	0.5287	0.7486	0.6832	0.6108	0.4081	-0.4318	-0.3145	0.5200	-0.4249	-0.4316	1

Note: CA – catechin; Ant – anthocyanin; Non-FL - non-flavonoids; FL – Flavonoids; TPC - Total phenolic compounds; Tan – Tannins; AA% - Antiradical activity (%); Y – Yellow; B – Blue; R – Red; CB – colour brightness; CI - colour intensity.

CONCLUSIONS

1. Merlot and Arcaş wines showed the highest colour intensity, due to a high polyphenolic content, especially anthocyanins, that presented a high correlation with DPPH free radical scavenging activity (r=0.7486) and positive correlation with red colour percentage (R%).

2. High content of phenolic compounds of the analysed samples and their positive correlation with the free radical scavenging activity suggests that red wine is an excellent source of compounds with important benefits for human health.

3. Experimental data showed that intense red-coloured wines might be healthier due to their rich phenolic compounds composition which helps the body fight against damage caused by reactive oxygen species.

REFERENCES

1. **AOAC, 2005** - *Total monomeric anthocyanin pigment content of fruit juices, beverages, natural colorants, and wines ph differential method*. Association of Analytical Communities.
2. **Bardaweel S., Gul M., Alzweiri M., Ishaqat A., Alsalamat H., Bashatwah R., 2018 -** *Reactive Oxygen Species: the Dual Role in Physiological and Pathological Conditions of the Human Body*, Eurasian J Med., vol. 50(3), p. 193-201.
3. **Brand-Williams W., Cuvelier M.E., Berset C**., **1995** - *Use of a free radical method to evaluate antioxidant activity*. LWT - Food Science and Technology Volume 28, Issue 1, p 25-30.
4. **Davalos A., Lasuncion M.A.**, **2009 -** *Health-Promoting Effects of Wine Phenolics,* Chapter 9E. In Moreno-Aribas V., Polo M. C. (eds.). *Wine chemistry and biochemistry*. Ed. Springer, New York. p. 573-575.
5. **Glories Y., 1984** - La *couleur des vins rouges. 2^{e} partie. Mesure, origine et interpretation. Connaiss. Vigne Vin* 18 (4), p. **253**-271.
6. **Goldstein J. L., Swain T., 1963**. *Methods for determining the degree of polymerization of flavans,* Nature, 198, p 587-588.
7. **OIV, 2012** - *Compendium of international methods of wine and must analysis, Vol. International Organisation of Vine and Wine (OIV)*.
8. **Ribéreau-Gayon, Glories P., Y., Maujean A., and Dubourdieu D.. 2006.** *Handbook of enology Vol 2: The chemistry of wine stabilization and treatments***.** Chichester, UK: John Wiley and Sons, p. 172-78.
9. **Singleton V. L., Rossi J. A.,** 1965 - *Colorimetry of total phenolics with phosphomolybdic-phosphotungstic acid reagents*. Am. J. Enol. Vitic. vol.16, p.144 - 158.
10. **Tibiri A., Sawadogo W. R., Ouedraogo N., 2010** -*Evaluation of antioxidant activity, total phenolic and flavonoid contents of Entada africana Guill. Et Perr. (Mimosaceae) organ extracts* Research Journal of Medical Sciences, 4(2), p. 81-87.
11. **Valentin D., Parr W. V, Peyron D., Grose C., and Ballester J. 2016**. *Colour as a driver of Pinot noir wine quality judgments: An investigation involving French and New Zealand wine professionals.* Food Quality and Preference 48, p.:251–61.
12. *****, 2016** – *H.G. 512 din 20 iulie 2016 pentru aprobarea Normelor metodologice de aplicare a Legii viei şi vinului în sistemul organizării comune a pieței vitivinicole nr. 164/2015.* The Official Journal of Romania, no. 585 / 2 august 2016.

ASPECTS REGARDING THE EPIGEE ENTOMOFAUNA EXISTING IN SOME AGRICULTURAL CROPS IN 2019

ASPECTE PRIVIND ENTOMOFAUNA EPIGEE EXISTENTĂ ÎN UNELE CULTURI AGRICOLE ÎN 2019

HEREA Monica[1]*, TĂLMACIU M.[1], TĂLMACIU Nela[1]
*Corresponding author e-mail: monica28is@yahoo.com

Abstract. *Observations were made in 2019 in apple tree plantations, corn crops and cabbage crops belonging to the Vasile Adamachi farm, Iasi, Iasi County. The purpose of the paper was to compare the entomofauna by a number of 3 different crops as well as agroecosystem technology and conditions. The material was harvested using Barber soil traps from June until September inclusive. The collected material was cleaned of vegetal remains and was then prepared for identification at insect level. The analysis of the collected material shows that the specimens collected belong to the Hexapoda Class, with several orders of insects and the Arachnida Class, the Aranea order. Most of them belong to the Insecta class. The orders to which the species are collected are: Coleoptera, Heteroptera, Hymenoptera, Diptera, all of the Hexapoda class. Regarding the abundance of entomofauna on crops, it is found that most of the catches belonged to the cabbage crop where they were collected (126) followed by the apple orchard (123) and then the maize crop (107).*
Key words: entomofauna; epigenous; Agricultural crops; dynamics

Rezumat. *Observaţiile au fost făcute în anul 2019 într-o livada de mări, o cultură de porumb şi o cultură de varză aparţinând fermei Vasile Adamachi, Iaşi, judeţul Iaşi. Scopul lucrării a fost de a compara entomofauna unui număr de 3 culturi diferite, precum şi tehnologia şi condiţiile agroecosistemelor. Materialul a fost recoltat folosind capcane de sol Barber din iunie până în septembrie inclusiv. Materialul colectat a fost curăţat de resturi vegetale şi a fost apoi pregătit pentru identificare la nivelul insectelor. Analiza materialului colectat arată că exemplarele colectate aparţin clasei Hexapoda, cu mai multe ordine de insecte şi clasa Arachnida, ordinul Aranea. Majoritatea aparţin clasei Insecta. Ordinele la care sunt colectate speciile sunt: Coleoptera, Heteroptera, Hymenoptera, Diptera, toate din clasa Hexapoda. În ceea ce priveşte abundenţa entomofaunei pe culturi, se constată că majoritatea capturilor aaparţinut culturii de varză unde au fost colectate (126) urmate de livada de măr (123) şi apoi de cultura de porumb (107).*
Cuvinte cheie: entomofauna epigee, culturi agricole, dinamică.

INTRODUCTION

Apple tree plantations, corn crops and cabbage crops occupy important areas in the country but also in the eastern part of the country, namely eastern Moldova.

[1]University of Agricultural Sciences and Veterinary Medicine Iasi, Romania

These agricultural species under study have an extremely high number of plant organisms and adverse animal species that cause them damage (Amzăr, 2000; Cârdei, 2006).

Percher has compiled a list of 80 diseases, caused by viruses, mycoplasmas, bacteria, fungi and physiological imbalances; 64 insect and mite species, as well as 8 nematode species and at least 2 rodent species are added. In this last situation, culture is impossible without sustained concerns about preventing and combating them, in order to reduce the losses, to obtain high, constant and quality crops.

Fighting must be in line with the new ecological concept of integrated combat, which consists of a system of regulation of pest populations, taking into account the specific flight and the dynamics of pests and zoophytes, using harmoniously all methods Combating (agrofitotechnical, physico-mechanical, biological and chemical) to keep pest density or attack at a level that does not produce harvest losses.

This paper presents the results of researches on the epigeon entomofauna existing in the apple, corn and cabbage crops of the Vasile Adamachi farm in Iasi, Iasi County.

MATERIAL AND METHOD

The material was harvested using Barber soil traps from 3 crops, as follows: apple, corn and cabbage crops. Five traps were used in each crop, and samples were harvested from June to September inclusive, at intervals between the date of trapping on 30.05.2016, and the first collection was done on 03.06.2019. The distance between traps per row was about 5 m. There were 5 traps for each crop: apple, corn, cabbage, so a total of 15 traps. 15 collections were made on the following dates: 03.06; 07.06.; 13.06; 20.06; 30.06; 05.07; 09.07; 14.07; 20.07; 25.07; 01.08; 07.08; 14.08; 07.09; 13.0.

The soil traps type Barber are plastic boxes with a volume of 500 ml which are placed in the ground. The barking of the boxes has been done with care so that the edge of the trap is perfectly level at the ground and the insects easily to enter (Andrici, 2015; Tălmaciu, 2016).

In the Barber soil traps, water and liquid detergent for dishes were used as a fixative liquid. The fixative fluid has a great influence on the effectiveness of the traps and must possess good preservative qualities to prevent the maceration of the captured individuals.

By locating at least 5 traps, it is possible to collect all species of species to establish the biotope dominance.

At each collection, the contents of each box were placed on a sieve doubled by a gauze bead to separate the insects from the fixative liquid.

The gauze with each sample was placed in labeled jars. The label contains the following information: stationary, culture, collection date and trap number. In order to preserve insect elasticity and to anesthetize the living ones, medicinal spirits have been used. After each collection, the trap was reintroduced into the soil and the fixative liquid was replaced (Perju, 2004; Tălmaciu, 2016)

The collected material was brought to the laboratory, and the insects were determined and inventoried.

RESULTS AND DISCUSSIONS

The situation of the collections in 2019 was the following:

In the apple plantations (tab. 1), the 15 collections were harvested 123 samples belonging to a number of six orders, namely: *Coleoptera, Lepidoptera, Diptera, Hymenoptera* and *Heteroptera*, all belonging to the Hexapoda class, and *Arachnida* beloning to class Aranea. The best represented were the *Coleoptera* orders, with 72 samples and *the Diptera*, with 38 samples. The orders *Aranea* and *Heteroptera* had one sample.

The situation of the collections in 2019 was the following:

For the corn crop (tab. 2), the 126 samples belonging to the 8 orders were harvested: *Coleoptera, Lepidoptera, Diptera, Hymenoptera, Heteroptera* and *Orthoptera*, all belonging to the *Hexapoda* class and the orders *Aranea* and *Acari* belonging to the Arachnida class. The best represented were *Coleoptera* orders, with 45 samples, *Hymenoptera,* with 381 samples and *Diptera*, with 29 samples. The *Aranea* and *Acari* orders had 2 samples collected, and the *Heteroptera* order had one sample.

The situation of the collections in 2020 was the following:

In the cabbage crops (tab. 3), 107 samples were collected from 7 orders, as follows *Coleoptera, Lepidoptera, Diptera, Hymenoptera, Heteroptera and Orthoptera*, all belonging to the *Hexapoda* class and the *Aranea* order of the *Arachnida* class . The best represented were *Coleoptera* orders, with 43 samples and *Hymenoptera*, with 38 samples. The *Aranea* orders had one sample.

Table 1

The collected entomofauna from apple culture by the Barber soil trap method in the Adamachi stationary in 2019

No.	Order	Harvesting number															Total of samples
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	VIII	XIV	XV	
1	Coleoptera	8	10	2	4	4	3	5	8	7	3	-	4	10	2	2	72
2	Lepidoptera	1	1	-	-	-	-	1	-	-	-	-	1	-	1	-	5
3	Diptera	1	2	1	1	-	-	-	1	2	8	5	6	5	2	4	38
4	Aranea	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1
5	Hymenoptera	-	1	1	-	-	-	-	-	-	-	1	-	-	3	-	6
6	Heteroptera	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1
Total order and samples		10	14	4	5	4	3	6	10	9	12	6	11	15	8	6	**123**

Table 2

The collected entomofauna from corn crop by the Barber soil trap method in the Adamachi stationary in 2019

No.	Order	Harvesting number															Total of samples
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	
1	Coleptera	3	-	3	-	4	4	7	3	4	3	2	5	2	2	3	45
2	Lepidoptera	1	-	1	-	1	1	-	2	1	-	-	-	1	-	1	9
3	Diptera	-	2	-	-	5	10	-	-	4	-	1	1	2	1	3	29
4	Aranea	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
5	Hymenoptera	-	1	-	-	-	-	1	8	-	8	5	2	1	1	4	31
6	Heteroptera	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1
7	Orthoptera	-	-	-	-	-	-	-	-	-	-	-	-	6	1	-	7
8	Acari										1	-	-	1	-	-	2
Total order and samples		3	4	-	10	15	8	13	10	12	8	8	13	5	11	**126**	

Table 3

The collected entomofauna from cabbage crops by the Barber soil trap method in the Adamachi stationary in 2019

No.	Order	Harvesting number															Total of samples
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	VIII	XIV	XV	
1	Coleoptera	5	1	4	-	-	-	2	3	4	2	3	6	8	1	4	43
2	Lepidoptera	1	-	-	-	-	-	1	2	-	1	2	-	-	-	-	7
3	Diptera	1	2	1	2	-	-	2	-	3	-	1	1	-	1	2	16
4	Aranea	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1
5	Hymenoptera	-	5	-	14	-	-	-	6	-	-	-	1	-	3	3	32
6	Heteroptera	-	-	-	1	-	-	-	1	-	1	-	1	-		-	4
7	Orthoptera								3	-	-	-	1	-	-	-	4
Total order and samples		7	8	5	17	-	-	5	15	7	5	6	10	8	5	9	107

Table 4

The collected entomofauna through the period of research

No.	Order	Culture/no. of samples			Total	% of total
		apple	corn	cabbage		
1	Coleoptera	72	45	43	**160**	**44.94**
2	Diptera	38	29	16	**83**	**23.31**
3	Lepidoptera	5	9	7	**21**	**5.89**
4	Ortoptera	-	7	4	**11**	**3.08**
5	Araneae	-	2	1	**3**	**0.85**
6	Hymenoptera	6	31	32	**69**	**19.38**
7	Heteroptera	1	1	4	**6**	**1.70**
8	Acari	1	2	-	**3**	**0.85**
TOTAL		**123**	**126**	**107**	**356**	**100.0**

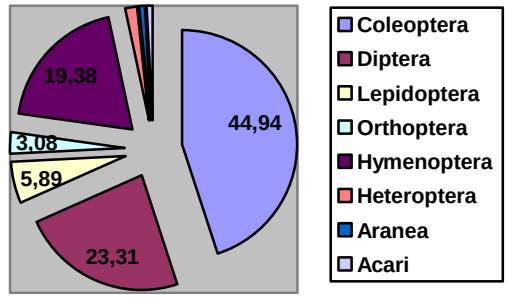


Fig. 1 Graphical representation of the weight of each order in the collected entomofauna

CONCLUSIONS

The researches were carried out in two stations in Iasi county on the entomofauna of the fruit tree, ecological, corn and white cabbage crops ecosystems.

The study tracked the abundance of the epigee fauna belonging to the orders *Coleoptera, Heteroptera, Hymenoptera, Diptera*, all of the Hexapoda class.

Regarding the abundance of entomofauna on crops, it is found that most of the cabbage crops were collected (107) followed by apple crops (123) and then corn cultures (126).

REFERENCES

1. Amzăr Valentina, Branişte N., 2000 – *Cultura mărului*. Editura Geea, Bucureşti.

2. Andrici C., Tălmaciu M., Tălmaciu Nela, Herea Monica, 2015 - *Aspects to knowledge of existing invertebrates fauna in corn cultures*, Analele Universității din Craiova, Ed. Universitaria Craiova, vol. XX (LVI), pag. 329-332,

3. Cârdei E., Corneanu G., Humă Ramona, 2007 – *Rezultate tehnologice şi economice în cultura mărului.* Lucrări ştiințifice, vol , seria Horticultură, Editura „Ion Ionescu de la Brad", Iaşi.

4. Perju T., 2004 – *Dăunătorii din principalele agroecosisteme şi combaterea lor integrată* – Editura Pereş Cluj Napoca

5. Tălmaciu M., Mocanu Ionela, Herea Monica, Tălmaciu Nela, Manole Liliana, 2016- *Observation on invertebrate fauna encountered in some agricultural crops*, Global Illuminators, Full Paper Proceeding NDMRP, vol. 2, 2016 p 119-129.

OBSERVATIONS ON THE EPIGEOUS FAUNA IN SOME FRUIT APPLE ORCHARDS IN THE PERIOD 2018-2019

OBSERVAȚII CU PRIVIRE LA FAUNA EPIGEE DIN UNELE PLANTAȚII POMICOLE DE MĂR ÎN PERIOADA 2018-2019

TĂLMACIU M. [1]***, HEREA Monica***[1]**, ***TĂLMACIU Nela***[1]
*Corresponding author e-mail:monica28is@yahoo.com

Abstract. *During the research period at the Vasile Adamachi station in Iaşi, an apple orchard was studied during two years of research. In order to draw up the structure and ecological parameters representative of the invertebrate entomofauna in the plantation, six Barber-type soil traps were set, and during the research species belonging to the orders Coleoptera (Dermestes laniarius, Polydrosus amoenus, Tomoxia biguttata, Anisodacty) were collected. Harpalus distinguendus, Armadillidium vulgare, Galeruca pomonae, Pseudophonus rufipes), Hymenoptera (bees, wasps, ants), Arahnida, Heteroptera (Pyrhocorris sp.), Lepidoptera, Gastropoda (snails) and Isoptera. Following the centralization of the number of specimens and the species collected, it could be observed that the values obtained were significantly close in the two years of research, in the plantation under study.*
Key words: Barber soil traps, entomophagous, apple orchard

Rezumat. *În perioada de cercetare la staționarul Delesti Vaslui a fost luată în studiu o plantatie pomicola de măr pe parcursul a doi ani de cercetare. Pentru intocmirea structurii şi a parametrilor ecologici reprezentativi entomofaunei de nevertebrate din plantație, au fost fixate şase capcane de sol de tip Barber, iar pe parcursul cercetărilor au fost colectate specii apartinând ordinelor: Coleoptera (Dermestes laniarius, Polydrosus amoenus, Tomoxia biguttata, Anisodactylus binotatus, Harpalus distinguendus, Armadillidium vulgare, Galeruca pomonae, Pseudophonus rufipes), Hymenoptera (albine, viespi, furnici), Arahnida, Heteroptera (Pyrhocorris sp.), Lepidoptera, Gastropoda (melci) şi Isoptera. În urma centralizării numărului de exemplare şi a speciilor colectate s-a putut observa faptul că valorile obținute au fost sensibil apropiate în cei doi ani de cercetare, in plantația luata in studiu.*
Cuvinte cheie: capcane de tip Barber, entomofagi, livezi de măr.

INTRODUCTION

The orchards as a type of agroecosystem, comprise complex biocenoses, with a high degree of organization, with multiple intra- and interspecific relationships, due primarily to the permanence of crop plants and secondly to the large volume of vegetative mass, thus approaching ecosystems. represented by forests. However, they are artificial ecosystems, which include unsaturated biocenoses, so they are susceptible to attack by pests and phytopathogens, and the

[1]University of Agricultural Sciences and Veterinary Medicine Iasi, Romania

technological link of phytosanitary protection has an important role in achieving high and constant production (Minoiu *et al* 1987).

Thus, it is known that the production potential of these horticultural systems can be reduced by 20-30% or sometimes totally compromised due to the attack of diseases and pests (Lăcătuşu *et al*.1980).

The control of diseases and pests in apple and hair orchards only with the help of pesticides in order to keep them below the economic threshold of damage, requires the application of a number of 10-12 simple or combined treatments during a calendar year.

MATERIAL AND METHOD

For the collection of the biological material were used soil traps type Barber. This consisted of placing in the soil of 6 recipients has been placed a solution of formalin (40%) diluted with water to a concentration of 5% (fig.1 and fig. 2) (Minoiu and Lefter, 1987).

Fig. 1 Soil trap type Barber (original)

Fig. 2 Entomofauna collected with the Barber soil trap

The location of traps was made on two rows at a distance of 12 meters between the rows and 6 meters between traps by 3 traps per row.

The sampling procedure was done in each of the three years of observation (2018 and 2019) in the period from May to August, at intervals of about 10-20 days. At each harvest the collected insects were placed in gauze cloth, each sample separately and replaced or supplemented then the liquid in the trap. The material was then tagged, of the label specifying: data collection, the number of traps, the stationary and variety (Herea M. 2019). In laboratory the material was cleaned of plant debris and then washed under running water, it is selected the order or species.

RESULTS AND DISCUSSIONS

In 2018, following the ten harvests, a number of 2858 beetle specimens resulted, in the seven experimental variants (tab. 1): V1 - existing vegetal carpet (control), totaled a number of 511 beetle specimens; V2 - vegetal carpet overseeded with guinea fowl (*Lotus corniculatus*), totaled a number of 412 beetles; V3 - vegetated carpet overgrown with white clover (*Trifolium repens*) totaled a number of 451 beetles; V4 - overgrown vegetable carpet with red clover (*Trifolium pretense*) totaled a number of 229 beetles; V5 - overgrown seedbed with alfalfa (*Medicago sativa*) totaled a number of 618 beetles; V6 - overseeded vegetable carpet with a mixture of the four legume species,

totaled a number of 414 beetle specimens; V7 - black field, totaled a number of 223 beetles.

Table 1

Number of samples of harmful and useful species collected in 2018 from the 7 experimental variants

Data of harvesting	V 1	V2	V3	V4	V5	V6	V7	TOTAL
I 25.05.2018	0	0	26	7	39	28	17	117
II 07.06.2018	154	99	99	65	111	76	0	604
III 20.06.2018	68	65	79	33	90	97	31	463
IV 04.07.2018	49	45	64	37	91	58	80	424
V 16.07.2018	24	5	24	10	46	0	0	109
VI 31.07.2018	58	68	34	28	87	75	73	423
VII 12.08.2018	44	34	43	23	48	48	3	243
VIII 23.08.2018	95	84	66	19	51	0	0	315
IX 12.09.2018	6	5	0	3	11	3	0	28
X 26.09.2018	13	7	16	4	44	29	19	132
TOTAL	**511**	**412**	**451**	**229**	**618**	**414**	**223**	**2858**
Average per variant	**408**							

It is observed that the largest number of specimens collected in 2018, were registered by the variants V 5 with 618 copies, V1 with 511 copies and V 3 with 451 copies. The lowest number of specimens collected were V 2, V4, V 6 and V 7, which recorded between 223 and 414 specimens of beetles (fig. 1)

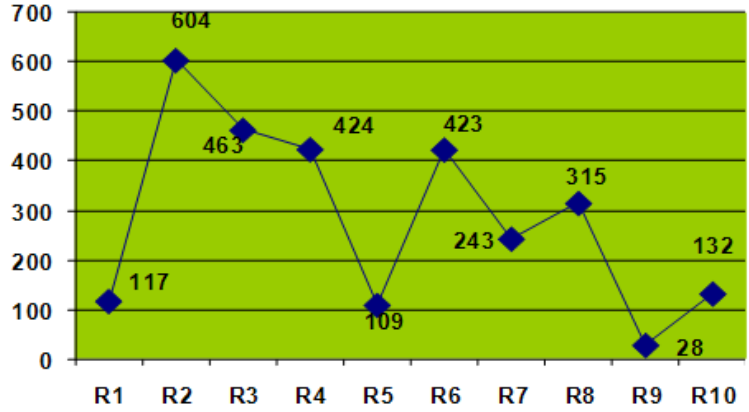


Fig. 1 Graphical representation of the beetles collected at the 10 harvests

The control variant V1, existing vegetal carpet, had 511 specimens collected, representing 125.24% compared to the average number of specimens collected in the 7 experimental variants which was 408.

In 2018, for all 7 experimental variants and all 10 harvests, a number of 2826 specimens belonging to 138 species were collected.

These had a variable number of specimens being between 1 and 566. The species with the highest number of specimens collected, over 100, were: *Anysodactilus binotatus* (566 specimens), *Harpalus distinguendus* (417 specimens), *Dermestes laniarius* (325 specimens), *Otiorrhynchus pinastri* (325 specimens) and *Harpalus tenebrosus* (141 specimens). A number of 44 species had only one specimen.

In 2019, in all 7 experimental variants and in all 10 harvests, a number of 2616 specimens of epigeous fauna of beetles belonging to 51 species were collected (tab. 2)

These had a variable number of specimens being between 1 and 636. The species with the highest number of specimens collected, over 100, were: *Harpalus calceatus* (636 specimens), *Anysodactilus binotatus* (434 specimens), *Harpalus tenebrosus* (412 specimens), *Harpalus distinguendus* (315 specimens), *Harpalus pubescens* (300 specimens) and *Harpalus griseus* (173 specimens). A number of 12 species had only one specimen.

Table 2

Structure, dynamics and abundance of beetle species collected from apple orchards in 2019

No.	Species	Harvesting										To tal
		I	II	II	IV	V	VI	VII	VIII	IX	X	
1.	Harpalus calceatus	57	165	24	96	96	51	99	15	24	9	636
2.	Anysodactilus binotatus	59	150	49	63	87		9		10	7	434
3.	Harpalus tenebrosus			21		126	36	87	87	45	10	412
4.	Harpalus distinguendus	42	30	52	39	60	33	20	8	18	13	315
5.	Harpalus pubescens	33	42	13	75	6	54	51	21	5		300
6.	Harpalus griseus	14	78	24	30	6		8			13	173
7.	Otiorrhynchus pinastri		9		25	30	10	10	12			96
8.	Harpalus tardus		12	17						18	6	53
9.	Harpalus aenesus	24						3	3			30
10.	Hister purpurascens	9		9								18
11.	Metabletus truncatelus	3			3	3		9				18
12.	Oxypora vittata										8	8
13.	Rinomias forticornis							8				8
14.	Scymnus auritus		3					3			2	8
15.	Dermestes laniarius					7						7
16.	Longitarsus tabidus							7				7
17.	Amara aenea					3			3			6
18.	Aphthona euforbiae				1				5			6

19.	Harpalus azureus	3	3									6
20.	Acylophorus glaberrinus					5						5
21.	Cianirys cianea						3		2			5
22.	Coccinella 7 punctata								3	2		5
23.	Tachyporus hypnorum					5						5
24.	Pentodom idiota				1	3						4
25.	Aleochara ruficornis							3				3
26.	Amara crenata									3		3
27.	Apion apricans								3			3
28.	Chysomela marginata								1	2		3
29.	Malachius bipustulatus		3									3
30.	Otiorrhynchus porcatus	3										3
31.	Tachyusa constricta				3							3
32.	Agriotes ustulatus								2			2
33.	Anthicus floralis				2							2
34.	Apion virens								2			2
35.	Blaps letifera									2		2
36.	Carabus coriaceus							2				2
37.	Elater nigrinus					2						2
38.	Meligetes subrugosus	1	1									2
39.	Pteryngium crenatum						2					2
40.	Acrulia inflata					1						1
41.	Anthicus humeralis				1							1
42.	Bembidion ruficolle				1							1
43.	Ceuthorynchus obsoletus								1			1
44.	Ceuthorynchus troglodytes					1						1
45.	Gymnetron pascuorum							1				1
46.	Meligetes maurus			1								1
47.	Mordela aculeata										1	1
48.	Othius punctulatus							1				1
49.	Oxypora alternans										1	1
50.	Tanymechus dilaticollis		1									1
TOTAL		**248**	**497**	**210**	**340**	**441**	**189**	**321**	**168**	**129**	**70**	**2616**

In the two years of research, in all 7 experimental variants and in all 10 harvests, a number of 5441 specimens of beetles belonging to 152 species were collected.

These had a variable number of specimens being between 1 and 1000. The species with the highest number of specimens collected, over 100, were: *Anysodactilus binotatus* (1000 specimens), *Harpalus distinguendus* (732 specimens), *Harpalus calceatus* (730 specimens).), *Harpalus tenebrosus* (553 specimens), *Dermestes laniarius* (332 specimens), *Harpalus pubescens* (324 specimens), *Otiorrhynchus pinastri* (281 specimens) and *Harpalus griseus* (213 specimens). A number of 115 species had few specimens, being between 1 specimen and 10 specimens collected.

CONCLUSIONS

1. During the research period 2018-2019, 7 variants of soil maintenance in the apple orchard were experimented as follows

- V1- existing vegetal carpet (control);
- V2- vegetal carpet overseeded with guinea fowl (*Lotus corniculatus*);
- V3- vegetated carpet overgrown with white clover (*Trifolium repens*);
- V4- overgrown vegetable carpet with red clover (*Trifolium pretense*);
- V5- overgrown seedbed with alfalfa (*Medicago sativa)*;
- V6- overseeded vegetable carpet with a mixture of the four legume species;
- V7- black field;

2. In 2018, for all 7 experimental variants and all 10 harvests, were collected a number of 2826 specimens of beetles belonging to 138 species.

3. In 2019, in all 7 experimental variants and in all 10 harvests, were collected a number of 2616 specimens of beetles belonging to 51 species.

4. In the two years of research, in all 7 experimental variants and in all 10 harvests, a number of 5441 specimens of beetles belonging to 152 species were collected.

REFERENCES

1. **Chatened du Gaetan, 1990** - *Guide des Coleopteres d'Europe. Délacrois et Niestlé*, Paris.
2. **Herea Monica, Tălmaciu Nela, Mocanu Ionela Tălmaciu M., 2019**- *Contributions to the knowlwdge of the structure of coleopters species collected from the apple tree fruit orchards,* 19th International Multidisciplinary Scientific GeoConference SGEM 2019 ,www.sgem.org, SGEM2019 Conference Proceedings, ISBN 978-619-7408-84-3 / ISSN 1314-2704, Vol. 19, Issue 5.1, 125-133 pp.
3. **Lăcătuşu Matilda, Pisică C., 1980** – *Biologia dăunătorilor animali*, Editura Didactică şi Pedagogică, Bucureşti;
4. **Minoiu N., Lefter Gh., 1987** –*Bolile şi dăunătorii speciilor sâmburoase,* Ed. Ceres, Bucureşti;
5. **Panin S., 1951-***Determinatorul coleopterelor dăunătoare şi folositoare din R.S.R*., Ed. de Stat.
6. **Rogojanu V., Perju T., 1979** - *Determinator pentru recunoasterea daunatorilor plantelor cultivate*. Editura Ceres, Bucuresti.

OBSERVATIONS ON THE STRUCTURE, DYNAMICS AND ABUNDANCE OF EXISTING ARTHROPOD FAUNA IN THE APPLE ORCHARDS FROM SC LOTURI SERVICE SRL IN 2018

OBSERVAȚII PRIVIND STRUCTURA, DINAMICA ŞI ABUNDENȚA FAUNEI DE ARTROPODE EXISTENTE ÎN PLANTAȚIILE POMICOLE DE MĂR DE LA SC LOTURI SERVICE SRL ÎN ANUL 2018

TALMACIU Nela[1]*, TALMACIU M.[1], HEREA Monica [1]
*Corresponding author e-mail:ntalmaciu@yahoo.com

Abstract. *Observations were made on the apple fruit tree orchards belonging to S.A. Loturi Service S.R.L. Delesti, Vaslui County, during the year 2018 from May to August. For this, observations were made periodically on the field, and samples were also collected using soil traps type Barber, which were then analyzed in the laboratory. Barber traps were represented by 6 pots with a total volume of 600 mL, in which we used as a preservative liquid a salt solution with 25% concentration and these traps were placed at ground level to collect efficiently specimens belonging to the Coleoptera order. After collection, each sample was labeled and then brought to the laboratory where the impurities were removed in the first phase and only coleopteran species were selected. The species of coleopters in the observation period were: Anisodactilus binotatus, Pseudophonus rufipes, Pterostichus cupreus, Ophonus obscurus, Dermestes laniarius, Coccinella 7 punctate, Epicometis hirta, Opatrum sabulosum, Amara crenata, Dorcadion pedestre, Tachyusa coarctata, Monotoma picipes, Metabletus truncatelus , Brachynus crepitans, Meloe proscarabeus etc.*
Key words: Coleopters, apple orchards, Barber traps

Rezumat. *Observațiile s-au făcut într-o livadă de măr aparținând S.A. Loturi Service S.R.L. Delesti, judetul Vaslui, pe parcursul anului 2018 din luna mai până în luna august. Pentru aceasta, s-au făcut periodic observații pe teren, iar probele ce au fost colectate folosind capcane de sol de tip Barber, au fost prelevate apoi au fost analizate în laborator. Capcanele Barber au fost reprezentate de 6 boluri din material plastic cu un volum total de 600 mL, în care am folosit ca lichid conservant o soluție de sare cu concentrație de 25% și aceste capcane au fost amplasate la nivelul solului pentru a colecta eficient exemplare aparținând ordinului Coleoptera. După colectare, fiecare probă a fost etichetată şi apoi adusă la laborator unde impuritățile au fost îndepărtate în prima fază şi au fost selectate doar speciile de coleoptere. Speciile de artropode colectate în perioada de observație au fost: Anisodactilus binotatus, Pseudophonus rufipes, Pterostichus cupreus, Ophonus obscurus, Dermestes laniarius, Coccinella 7 punctate, Epicometis hirta, Opatrum sabulosum, Amara*

[1]University of Agricultural Sciences and Veterinary Medicine Iasi, Romania

crenata, Dorcadion pedestre, Tachyusa coarctata, Monotoma picipes, Metabletus truncatelus , Brachynus crepitans, Meloe proscarabeus etc.
Cuvinte cheie: Coleoptera, plantaţie pomicolă de măr, capcane de tip Barber.

INTRODUCTION

From an ecological point of view, the main goal in recovery is to create sustainable biogeocenosis on the territory of disadvantaged agricultural ecosystems that have a strong environmental transformation effect. The main biogeocentic component in the circulation of substances is played by a complex of invertebrates in soil that includes different functional groups that differ according to their type of nutrition (phytophagus, zoophagus, saprophage) and in the form of their activity (Luzyanin *et al* 2018). Ground beetles are a major component of zooscenotic soil ecosystems. They play an important role in the functioning of terrestrial biocenoses, they serve as model objects for eco-faunistic studies aimed at studying the processes of formation of disturbed anthropogenic communities.

Information on species composition and diversity of beetles belonging to the Coleoptera order is reflected in the more works (Panin, 1951)

The aim of these researches is to study the ecological and faunistic structure of the soil coleoptera population from fruit tree apple belonging to SC Loturi Service SRL Delesti, Vaslui country.

MATERIAL AND METHOD

The following summer (2018), we installed the pitfall traps in this place we had installed 42 traps in total. In the stationary, were placed 6 traps per row of trees from the edge to the inside in a straight line at a distance of 20 m from the edge and 6 to 8 m between traps per row (Cozma *et al* 2006; Luzyanin *et al* 2018) at each of the 7 variants V-1, existing vegetal carpet, V-2 , Vegetable carpet thickened with Lotus corniculatus, V-3, Vegetable carpet thickened with *Tifolium repens*, V-4, Vegetable carpet thickened with *Trifolium pratense*, V- Vegetable carpet thickened with *Medicago sativa*, V-6, Vegetable carpet thickened with mixture of the 4 leguminous species and V-7 black field. Pitfall traps were a plastic cup (8 cm diameter), containing a plastic inner collecting cup and covered by a plywood supported over the trap by two nails. Traps were operated during the frost-free season (from early May until the end of August), providing a potential total of 100 trapping days.

Fig. 1 Soil traps type Barber

Hence, we collected beetle data during the two years of research. All beetles from the order Coleotera were identified to the species level using the book of determination (Gaëtan du Chatenet, 1990; Panin, 1951; Reitter, 1916).

RESULTS AND DISCUSSIONS

The research from SC Loturi Service SRL Delesti Vaslui, in 2018 (tab. 1), in the apple orchards the largest number of samples were collected was belonging at: *Anysodactilus binotatus* (640samples), *Harpalus distinguendus* (477 samples), *Dermestes laniarius* (323 samples), Otiorrhynchus pinastri (179 samples), Harpalus calceatus (115 samples), *Harpalus tenebrosus* (93 samples), *Metabletus truncatelus* (62 samples), *Tachyusa coarctata* (60 samples), *Oxypora vittata* (58 samples), *Epicometis hirta* (36 samples), *Amara crenata* (35 samples), *Paramalus paralelipipedus* (35 samples), *Colodera aethiops* (34 samples).

Table 1

The structure and abundance species of epigeous entomofauna collecting from the apple orchard belonging to SC Loturi Service SRL Delesti, Vaslui district in 2018

No	Species	25.04.	No	Species	04.05.
1	Anysodactilus binotatus	**89**	1	Anysodactilus binotatus	**187**
2	Harpalus distinguendus	**74**	2	Harpalus distinguendus	**172**
3	Dermestes laniarius	**33**	3	Dermestes laniarius	**76**
4	Otiorrhynchus pinastri	**51**	4	Harpalus calceatus	**11**
5	Harpalus calceatus	**1**	5	Tachyusa coarctata	**16**
6	Harpalus tenebrosus	**48**	6	Oxypora vittata	**8**
7	Metabletus truncatelus	**7**	7	Amara crenata	**5**
8	Epicometis hirta	**17**	8	Paramalus paralelipipedus	**10**
9	Amara crenata	**8**	9	Colodera aethiop	**11**
10	Aphtona euphorbiae	**4**	10	Aphtona euphorbiae	**10**
11	Monotoma picipes	**9**	11	Harpalus aeneus	**5**
12	Harpalus aeneus	**2**	**Total**		**511**
13	Epurea obsoleta	**12**			
Total		**355**			
No	**Species**	**15.05.**	**No**	**Species**	**25.05.**
1	Anysodactilus binotat.	**229**	1	Anysodactilus binotat	**49**
2	Harpalus distinguend	**115**	2	Harpalus distinguendus	**54**
3	Dermestes laniarius	**111**	3	Dermestes laniarius	**22**

4	Otiorrhynchus pinastri	**5**	4	Otiorrhynchus pinastri	**11**
5	Harpalus calceatus	**39**	5	Harpalus calceatus	**6**
6	Harpalus tenebrosus	**4**	6	Harpalus tenebrosus	**20**
7	Metabletus truncatelus	**7**	7	Metabletus truncatelus	**11**
8	Tachyusa coarctata	**8**	8	Oxypora vittata	**7**
9	Epicometis hirta	**14**	9	Amara crenata	**4**
10	Harpalus griseus	**9**	10	Paramalus paralelipip	**18**
11	Harpalus pubescens	**5**	11	Harpalus griseus	**6**
12	Aphtona euphorbiae	**5**	12	Harpalus pubescens	**5**
Total		**551**	13	Monotoma picipes	**6**
			Total		**219**
No	**Species**	**08.06.**	**No**	**Species**	**15.06.**
1	Anysodactilus binotatus	**2**	1	Anysodactilus binotatus	**27**
2	Harpalus distinguendus	**2**	2	Harpalus distinguendus	**19**
3	Dermestes laniarius	**52**	3	Dermestes laniarius	**14**
4	Otiorrhynchus pinastri	**42**	4	Otiorrhynchus pinastri	**46**
5	Harpalus calceatus	**2**	5	Harpalus calceatus	**25**
6	Metabletus truncatelus	**6**	6	Metabletus truncatelus	**16**
7	Tachyusa coarctata	**14**	7	Oxypora vittata	**6**
8	Oxypora vittata	**14**	8	Epicometis hirta	**5**
9	Amara crenata	**18**	9	Harpalus tardus	**3**
10	Paramalus paralelipipedus	**7**	**Total**		**161**
11	Harpalus tardus	**14**			
Total		**173**			
No	**Species**	**04.07.**	**No**	**Species**	**28. 07.**
1	Anysodactilus binotatus	**13**	1	Anysodactilus binotatus	**44**
2	Harpalus distinguendus	**41**	2	Dermestes laniarius	**15**
3	Otiorrhynchus pinastri	**13**	3	Otiorrhynchus pinastri	**11**
4	Harpalus calceatus	**5**	4	Harpalus calceatus	**26**
5	Harpalus tenebrosus	**21**	5	Colodera aethiops	**23**
6	Metabletus truncatelus	**4**	6	Harpalus griseus	**10**
7	Tachyusa coarctata	**22**	7	Harpalus aeneus	**4**
8	Oxypora vittata	**23**	**Total**		**133**

9	Harpalus pubescens	**10**		
10	Harpalus aeneus	**2**		
11	Sipalia circelaris	**13**		
12	Phylotreta atra	**11**		
Total		**178**		

Table 2

Structure and abundance of common species of coleopter collected by Barber traps during the two years of research

No	Name of species	Total 2018
1	Harpalus calceatus	115
2	Anysodactilus binotatus	640
3	Harpalus tenebrosus	93
4	Harpalus distinguendus	477
5	Harpalus pubescens	20
6	Harpalus griseus	25
7	Otiorrhynchus pinastri	179
8	Harpalus tardus	17
9	Oxypora vittata	58
10	Metabletus truncatelus	51
11	Harpalus aeneus	13
Total		**1688 = 74%**

In the fruit-growing plantation as a stationary experience during one years of study using the soil traps type Barber were collected in total 2281 samples (tab. 2), a total of 11 beetle species recorded the highest number of specimens, as follows: *Anysodactilus binotatus, Harpalus distinguendus, Otiorrhynchus pinastri, Harpalus calceatus, Harpalus tenebrosus, Oxypora vittata, Metabletus truncatelus, Harpalus griseus, Harpalus pubescens, Harpalus tardus* and *Harpalus aeneus.*

CONCLUSIONS

The research carried out within the fruit tree statue of SC Loruri Service SRL Delesti, Vaslui county, focused mainly on the identification of the useful and harmful coleopter species that are part of the integrated ecosystem.

In 2018, applying the Barber method were collect in total 2281 samples that were captured in the 8 collections during the observation period. Of the most common species we recall: *Paramalus paralelipipedus, Tachyusa coarctata, Sipalia circelaris, Harpalus calceatus, Anysodactilus binotatus, Harpalus tenebrosus, Harpalus distinguendus, Otiorrhynchus pinastri, Harpalus tardus, Oxypora vittata and Metabletus truncatelus.*

REFERENCES

1. **Cozma V., Diaconu A., Grecu M., Tălmaciu M., Pareza M., Vasiliu G., 2006** - *Observaţii privind abundenţa şi diversitatea coleopterelor din coronamentul unor livezi de măr cu management diferit de exploatare.* Lucr.şt, Seria Horticultură, Iaşi, vol I, issue 49; pp.1093-1096.
2. **Gaëtan du Chatenet, 1990** - *Guide des Coléopterés d'Europe*. Délacrois et Niestlé, Paris.
3. **Luzyanin S., Eremeeva Natalya, 2018** - *Ecological-and-Faunistic overview (Coleoptera, Carabidae) on Reclaimed Coal Open Pit Dumps*, IIIrd International Innovative Mining Symposium E3S Web of Conferences, Kemerovo, Russian Federation, 41, 02022, https://www.researchgate.net/publication/325990126_Ecological-and-faunistic_overview_Coleoptera_Carabidae_on_Reclaime_Coal_Open_Pit_Dumps
4. **Panin S., 1951** - *Identification manualof harmful and useful beetles in R. P. R* ., Publisher of State for scientific and didactic literature, Bucuresti.
5. **Reitter E., 1916** - *Fauna Germanica. Die Kafer des Deutschland Reichs Lutz*., Edit. Stuttgardt, Stuttgardt.

EVIDENCE OF THE MAIN PATHOGENIC AGENTS AND PESTS OF THE VINE AND ITS PHYTOSANITARY CONTROL IN THE CLIMATE CONDITIONS OF 2019

EVIDENȚA PRINCIPALILOR AGENȚI PATOGENI ŞI DĂUNĂTORI AI VIȚEI DE VIE ŞI CONTROLUL FITOSANITAR AL ACESTORA ÎN CONDIȚIILE CLIMATICE ALE ANULUI 2019

PISTICIUC I.[1]*, ZALDEA Gabi[1], NECHITA Ancuța[1]
*Corresponding author e-mail:pisticiuc.i@gmail.com

Abstract. *The careful monitoring of vineyards plays a particularly important role in creating forecasts and warnings to help combat the main pathogens and pests. Main vine diseases such as downy mildew, powdery mildew and gray rot can cause significant production losses if not combated according to well-established phytosanitary programs. On the other hand, their irrational control can lead to the emergence of phytotoxicity phenomena, or forms of resistance to pests. The present paper aims to present the evolution of the main viticultural diseases that appeared in the SCDVV Iaşi vineyards, in the climatic conditions of 2019.*
Key words: pathogens, pests, phytosanitary control

Rezumat. *Ținerea sub atenta observație a plantațiilor viticole joacă un rol deosebit de important în crearea prognozelor şi avertizărilor cu ajutorul cărora se vor combate principalii agenți patogeni şi dăunători. Bolile cheie ale viței de vie precum mana, făinarea şi putregaiul cenuşiu pot produce pierderi semnificative de producție dacă nu sunt combătute după programe fitosanitare bine stabilite. Pe de altă parte, combaterea nerațională a acestora poate conduce la apariția fenomenelor de fitotoxicitate, sau a formelor de rezistență în ceea ce priveşte dăunătorii. În lucrare este prezentată evoluția principalelor boli şi dăunători din plantațiile viticole ale SCDVV Iaşi, în condițiile climatice ale anului 2019.*
Cuvinte cheie: agenți patogeni, dăunători, control-fitosanitar

INTRODUCTION

Pathogen and pest control technologies are a major element in ensuring sustainable viticulture, leading to homogeneous and cost-effective production. The success of the control of diseases and pests on the vine is ensured when the control scheme is drawn up at plantation or farm level, in depending with microclimate conditions, the biological reserve of the pathogens, the sensitivity of the variety to their attack and last but not least. of pesticide choice (Tomoiagă, 2003; 2006; Severin *et al*, 1994)

[1]Research and Development Station for Viticulture and Winemaking Iasi, Romania

Pests together with vine pathogens show different forms of resistance, from one year to another, and climatic conditions, constantly changing, determine an adaptation of problematic individuals, an atypical evolution of diseases, hence the need for permanent monitoring in order to develop adequate control systems (Irimia *et al*., 2009; Stoica *et al*., 2007).

MATERIAL AND METHOD

The phytosanitary control of the vine within the Research-Development Station for Viticulture and Vinification in Iaşi was carried out in the plots with mainly cultivated varieties: Fetească alba, Fetească regală, Aligoté, Chardonnay and Aromat de Iaşi, located on flat land and on land with slopes, this having a direct involvement on the development of pathogens by creating microclimates.

The evaluation of the numerical density of the pathogens (*Plasmopara viticola, Uncinula necator and Botrytis cinerea*) and their evidence was performed by periodic field observations, sampling of plant materials and laboratory determinations. In order to assess the phytosanitary condition of the vineyards in the phenological stage BBCH 85-87, the frequency (F%), intensity (I%) and degree of attack (AD%) of each agent were determined by value. Pest monitoring (*Lobesia botrana and Eupoecilia ambiguella*) was performed using pheromone traps and vine observations. In order to establish the economic damage threshold (PED) of the pests, their record was kept by counting twice a week the captured moths, drawing graphs representing the flight curves for the two generations.

RESULTS AND DISCUSSIONS

The viticultural climate of the vegetation period was analyzed from April to September inclusive (tab. 1). During this period, average monthly temperatures were higher than the multiannual values, increasing from 10.4°C in April to 22.5°C in August.

Table 1

The viticultural climate of the vegetation period from 2019

Month	Air temperature			Rainfall (mm)	Days with rainfall > 10 mm	Hygroscopicity %	Duration of sunlight (hours)	Σ °t useful (°C)
	T med. (°C)	Media T min (°C)	Media T max (°C)					
IV	10.4	5.4	15.8	46.0	2	60	199.9	51.8
V	16.0	11.2	21.4	98.6	4	74	198.4	191.3
VI	22.4	16.5	28.8	63.0	2	72	276.5	371.8
VII	21.5	15.6	27.6	33.8	0	62	282.8	355.1
VIII	22.5	15.9	29.5	43.2	2	58	285.5	386.0
IX	17.4	11.4	24.9	38.8	2	57	239.2	223.5
Sum	-	-	-	**323.4**	**12**	-	**1482.3**	**1579.5**

The months of June, July and August were the warmest, the average maximum temperatures being 28.8°C, 27.6°C and 29.5°C respectively. Due to the high temperatures, the atmospheric drought started from June, the number of days with precipitations higher than 10 mm was very small, two days each in April, June, August and September, no day in July and four days in May. Thus, the volume of precipitation during the vegetation period was 323.4 mm compared to 398.1 mm as normal in the Copou Iaşi wine center. The relative humidity of the air had lower values than normal, being between 57% in September and 74% in May. The hours of sunshine were enough to shorten the duration of leaf wetting, the average for 2019 in the vegetation period being 1482.3 hours, compared to 1448.2 hours per year. The useful thermal balance during the vegetation period registered a value of 1579.5°C, compared to the normal value of 1386.0°C, a thermal increase of 193.5°C.

Table 2

Phytosanitary treatments program - 2019

Crt. No.	Time of application of phenophase treatment / date	Pathogen or pest	The product used	Dose (kg,L/ha)
1.	Sprout 3 – 5 cm / 06.05.2019	Mites + Mildew	Sulfocalcic gravy	12 L/ha
2.	Sprout 10 – 25 cm / 20.05.2019	Powdery mildew + Downy mildew + Mites	Profiler + Topas + Envidor	2,5 kg/ha + 0,25 l/ha + 0,4 l/ha
3.	Before flowering / 02.06.2019	Powdery mildew + Downy mildew + Moths	Forum Gold + Vivando + Envidor	1,5 kg/ha + 0,2 L/ha + 0,4 L/ha
4.	End of flowering / 13.06.2019	Powdery mildew + Downy mildew	Forum Gold + Vivando	1,5 kg/ha + 0,2 L/ha
5.	Growing grains / 20.06.2019	Powdery mildew + Downy mildew	Folpan 80 WG + Kumulus	1,5 kg/ha + 3,0 kg/ha
6.	Compaction of bunches / 01.07.2019	Powdery mildew + Downy mildew + Gray rot	Ridomil + Kumulus + Cantus	2,5 kg/ha + 3,0 kg/ha + 1,2 kg/ha
7.	Entering in ripening / 16.07.2019	Powdery mildew + Downy mildew + Gray rot	Ridomil + Kumulus + Cantus	2,5 kg/ha + 3,0 kg/ha + 1,2 kg/ha
8.	Ripening / 29.07.2019	Powdery mildew	Bouillie bordelaise	5,0 kg/ha

When developing control programs, the sensitivity to attack of pathogens of cultivated varieties, the economic threshold of damage, as well as the effectiveness of treatments performed in the previous year were taken into account. Phytosanitary interventions with contact and systemic products aimed to limit or even stop the outbreaks of infection. Thus, the 8 phytosanitary treatments were carried out according to the warnings and the climatic conditions of the year, aiming at maintaining a healthy foliar apparatus that would support the production and ensure in addition a good differentiation of the buds for next year's harvest (tab. 2).

The attack of pathogens manifested itself differently depending on the variety and the location of the plot in the plantation. By daily monitoring the climatic factors responsible for the downy mildew attack (*Plasmopara viticola*), respectively the minimum daily temperature and humidity (rain, dew, fog), corroborated with the vegetation phenophase, it was estimated that the primary infection occurred on May 15, the first oil spots being identified on May 29. The variety Fetească albă was the most affected, being located in a microclimate area favorable to the pathogen, with an intensity of 32.5% on grapes, a frequency of 66.4% and a degree of attack of 21,6% . The lowest degree of attack was reported on grapes in variety Fetească regală, respectively 2,2%.

Regarding the pathogen that produces powdery mildew, *Uncinula necator*, it can be seen that its appearance and evolution was influenced by very high temperatures in June, July and August, which conditioned its development especially in susceptible varieties. Thus, in the conditions of 2019, the powdery mildew attack manifested itself in a moderate proportion, being reported in the Fetească regală variety, only on grapes, with an intensity of 7.5% and a frequency of 7.9%.

Observations made on the gray rot of grapes, produced by the fungus *Botrytis cinerea*, showed that the attack occurred only in the Aromat de Iaşi variety, an early variety, after the cracking of the skin of the berries, with an intensity of 32.1%, a frequency of 33,0% and an attack rate of 10,6% (tab. 3).

Table 3

Manifestation of the attack of the main pathogens - 2019

The pathogen	Variety	The attacked organs	I, %	F, %	A.G. %
Plasmopara viticola	Aligoté	Leafs	21.0	46.5	**9.8**
		Grapes	34.5	35.3	**12.9**
	Fetească regală	Leafs	6.9	9.5	**0.7**
		Grapes	17.7	12.2	**2.2**
	Fetească albă	Leafs	18.0	16.25	**3.0**
		Grapes	32.5	66.4	**21.6**
	Chardonnay	Leafs	18.6	38.5	**7.16**
		Grapes	34.4	37.2	**12.8**
Uncinula necator	Fetească regală	Grapes	7.5	7.9	**0.6**
Botrytis cinerea	Aromat de Iaşi	Grapes	32.1	33.0	**10.6**

Among the dangerous pests found in the experimental plantations in the Copou Iasi wine center, we mention the grape moths (*Lobesia botrana den et Schiff, Eupoecilia ambiguella Hb. Sparganatispillereana Den et Schiff*), the eriofizi and tetranichizi mites (Gallic mite of the calf - Eriophyes vitis Nal and the common calf mite - *Tetranychus urticae Koch*). The climatic conditions in the vegetation period of 2019 had a significant influence on the evolution of the vine pest populations. The observations made on the binocular magnifying glass

during the budding phenophase as well as those during the vegetation period did not report any symptoms of mite and spider attack. Under these conditions, the only treatment that was applied was the one with sulfocalcic gravy from the bud to control the powdery mildew, with secondary action on these pests as well.

The evidence of the *Lobesia botrana* and *Eupoecilia ambiguella* moth generations was kept with the help of pheromone traps (atraAMBIG and atraBOT), strategically placing a number of 3 traps/ha, both for the first and for the second generation.

For the species *Lobesia botran*a for the first generation, the flight took place over a period of 21 days, from the end of April to the middle of May, the maximum of the flight curve reaching on 01.05.2019 with an average number of 154.7 moths on the trap (fig. 1).

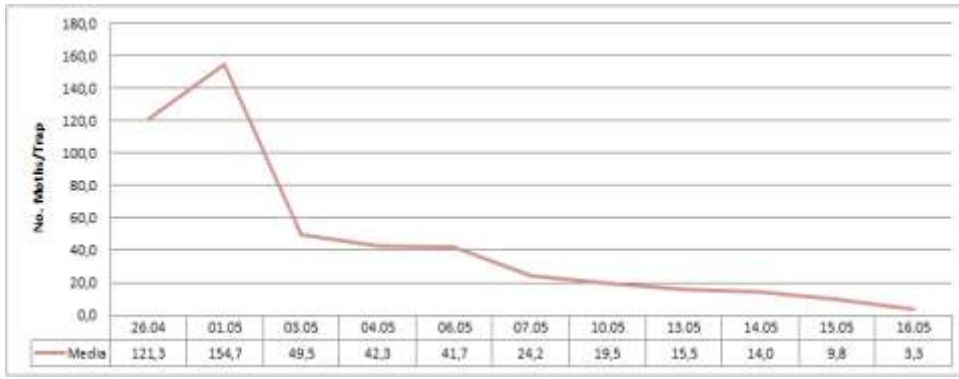


Fig. 1 Flight curve of the species *Lobesia botrana*

In the second generation, the economic damage threshold was not reached, the flight taking place over a period of 4 weeks, starting from 27.06.2019 to 01.08.2019. The maximum flight curve for the second generation was reached on 15.07.2019 when an average number of 23.5 moths / trap was recorded (fig. 2).

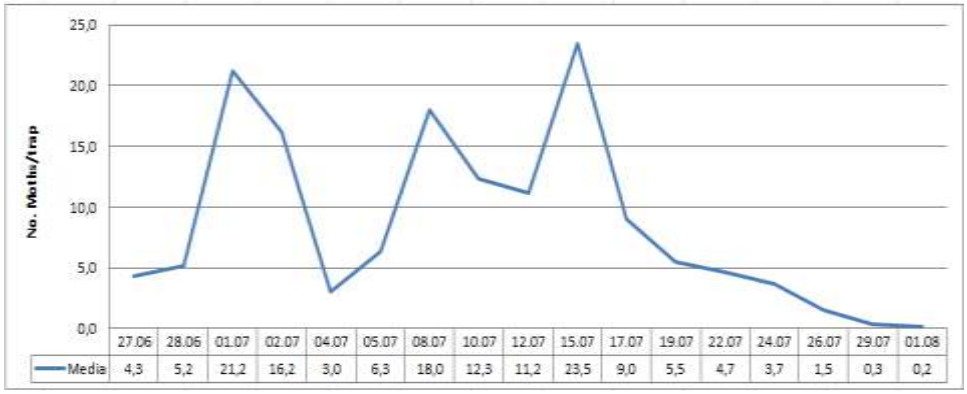


Fig. 2 Flight curve of the species *Lobesia botrana*

It should be noted that, for both the first generation (G1) and the second generation (G2) of moths, only adults of *Lobesia botrana* were caught in a number that exceeded the PED in the Fetească albă variety in G1, on May 1, under these conditions, two control treatments were warned and applied.

Another pest reported in 2019 in the vineyards of SCDVV Iasi was the frosted moth-bug (Metcalfa pruinosa), which has not been found before.

CONCLUSIONS

The analysis of the values of the climatic elements in the vegetation period of 2019 shows that it was warmer than normal, with little rainfall, and the distribution of quantities was not uniform, this leading to difficulties in combating of downy mildew.

Plasmopara viticola attacking with a fairly high frequency the varieties located in areas of favorable microclimate. The pathogens *Uncinula necator* and *Botrytis cinerea* did not cause vine problems. Of the pests reported, only *Lobesia botrana* exceeded the PED, which required two treatments.

During the vegetation period, eight treatments were carried out to control diseases and pests in correlation with the evolution of climatic factors and according to the economic damage threshold (PED), which contributed to maintaining a healthy foliar apparatus and obtaining normal quantitative productions and qualitatively.

***Acknowledgments**: The work was developed under the Sectorial Plan the ADER 2022, PS 7.1.4 „Assessment of the vulnerability of the wine ecosystem to the harmful impact of competing and antagonistic organisms, in order to develop and implement new phytosanitary control technologies adapted to biotic and abiotic stressors, with low impact on the environment"*

REFERENCES

1. Irimia Nicoleta, Ulea E., Bălău Andreea, 2009 - *Grapevine varieties behavior on maine pathogens attack in 2008 from the ampelographical collection of U.S.A.M.V. Iasi,* Research Journal of Agricultural Science USAMV Timişoara, Vol.41(1).

2. Severin V., Dejeu L., 1994 – *Bolile şi dăunători viței de vie – prevenire şi combatere,* Ed. Ceres, Bucureşti.

3. Tomoiagă Liliana, 2003 – *Combaterea rațională a bolilor şi dăunătorilor viței de vie,* Protecția plantelor VII, nr.26.

4. Tomoiaga Liliana, 2006 – *Bolile viței de vie*, Ed. Mediamira, Cluj-Napoca.

METRIC PROBLEMS FOR DETERMINING DISTANCES: DESCRIPTIVE GEOMETRY VS. AUTOCAD

PROBLEME METRICE PRIVITOARE LA DETERMINAREA DISTANŢELOR: GEOMETRIA DESCRIPTIVĂ VS. AUTOCAD

SLONOVSCHI A.[1]*, PRUNĂ L.[1]
*Corresponding author e-mail: andreislonovschi@yahoo.com

Abstract. *In this paper the authors present a comparative study on how to determine distances using the classic variant (Descriptive Geometry) but also the modern one, using the AutoCAD software, presenting for each mode the steps necessary to determine the respective distances but also the advantages and disadvantages of each way of working.*
Key words: Descriptive Geometry, AutoCAD, lengths, distances

Rezumat. *În această lucrare autorii prezintă un studiu comparativ privitor la modurile de determinare a unor distanţe utilizând varianta clasică (Geometria Descriptivă) dar şi cea modernă, utilizând programul AutoCAD, prezentând pentru fiecare mod paşii necesari determinării distanţelor respective dar şi avantajele şi dezavantajele fiecărui mod de lucru.*
Cuvinte cheie: Geometrie Dessriptivă, AutoCAD, lungimi, distanţe

INTRODUCTION

In design engineering activities, there is often a need to determine the size of distances, angles or plane contours.The speciality books present the steps of determining these dimensions using the Descriptive Geometry Methods.

Taking into account the fact that AutoCAD is a program that allows the realization of 2D, 2.5D and 3D representations but also contains a series of commands that offer the possibility to determine the sizes of distances, angles and surfaces, the authors made a comparative study regarding the ways of work listed above for different situations, in which is necessary to determine some distances, analyzing the advantages, disadvantages and difficulties involved each of two work methods.

MATERIAL AND METHOD

In the specialized literature are presented multiple theoretical cases of obtaining distances using Descriptive Geometry (Tănăsescu, 1965; Prună *et al*., 2006), obviously, in all situations the representations being made in the draught (two-dimensional plane representations). Thus, are presented a series of situations that allow the determination of the following distances:

- between two points;
- from a point to a straight line;

[1]"Gheorghe Asachi" Technical University of Iaşi, Romania

- from a point to a plane;
- between two parallel straight lines.

In engineering practice, it is useful to determine the distance between two points, since:

- the distance between two points can be assimilated with the need to determine the length of a rafter (valley rafter or not) (fig. 1) or ramps (fig. 2);

Fig. 1 The representation of a rafter in a residential building

Fig. 2 The representation of a ramp

In Descriptive Geometry, the value of the distance between two points, that determines a line segment that is not parallel to any of the projection planes [H] or [V], is determined using:

1. The method of replacing the projection planes (Marin *et al*, 1998; Precupeţu and Dale, 1987):
   - of the vertical plane; at the end a line segment($a'_1b'_1$)is obtained which shows the real distance between points A and B (fig. 3);
   - of the horizontal plane; at the end a line segment (a_1b_1) is obtained which shows the real distance between points A and B (fig. 4);

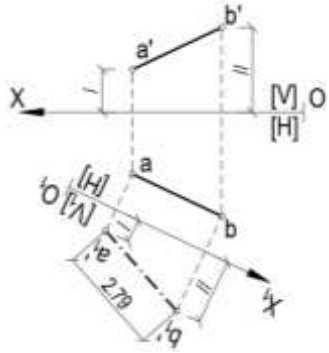


Fig. 3 ($a'_1b'_1$) is the actual distance between A and B

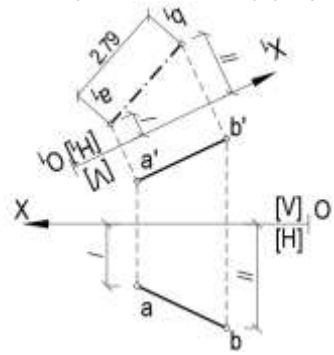


Fig. 4 (a_1b_1) is the actual distance between A and B

2. The method of revolution, using (Marin *et al*, 1998; Precupeţu and Dale, 1987):
   - the level revolution, in the end, a straight-line segment ($a'_1b'_1$) is obtained which shows the real distance between points A and B (fig. 5);
   - the frontal revolution, in the end, a straight-line segment (a_1b_1) is obtained which shows the real distance between points A and B (fig. 6);

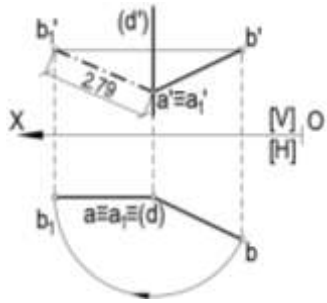


Fig. 5 ($a'_1b'_1$) is the real distance between A and B

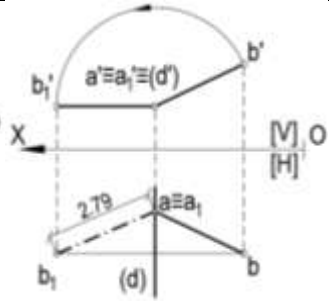


Fig. 6 (a_1b_1) is the real distance betweenA and B

As a result of the study conducted in AutoCAD, the authors observed the following:

- the commands for determining lengths, angles or areas (fig. 7) can only be used on objects that are represented in the XOY plane;

Fig. 7 Commands that allow the determination of distances, angles or surfaces

- as the vast majority of these objects are not lying in this plan (fig. 8) the respective commands cannot be used as they provide erroneous information.

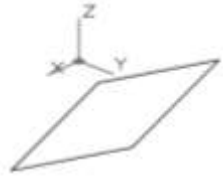


Fig. 8 The plane of the rectangle is not aligned with the XOY plane (visual style:*2D Wireframe*)

The simplest way to solve this problem is to align the plane determined by the two axes with the plane of the object (fig. 9).

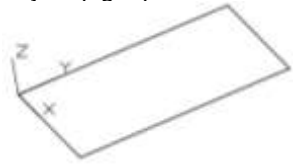


Fig. 9 The plane of the rectangle is aligned with the XOY plane (visual style:*2D Wireframe*)

To determine, using the AutoCAD software, the distance between the same points (A and B), the following steps must be taken:

- the direction of view of the X, Y and Z axes is changing so that, they be positioned as in Descriptive Geometry (fig. 10);

Fig. 10 The directions of the axes correspond to those in Descriptive Geometry

- the two points are represented, by the POINT command, taking into account their coordinates relative to the origin of the system (point O) (Slonovschi and Prună, 2016) (fig. 11);
- the represented points are joined with the help of the LINE command (Slonovschi and Prună, 2016) (fig. 12);

Fig. 11 The points are represented

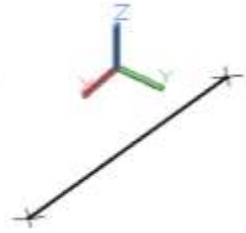


Fig. 12 The points are joined

- using the UCS command, the X-axis is aligned with the current UCS of the straight-line segment (fig. 13);

Fig. 13 The X-axis aligns with the current UCS of the straight line segment

- the LIST command is launched (Prună and Slonovschi, 2014);
- the drawn straight-line segment is selected, then the key ENTER <E> is pressed;
- the software displays the properties of the selected object (fig. 14);
- as only the length of the segment is of interest, its value is read next to the word Length, which is currently displayed with 4 decimals (their number can be from 0 to 8).

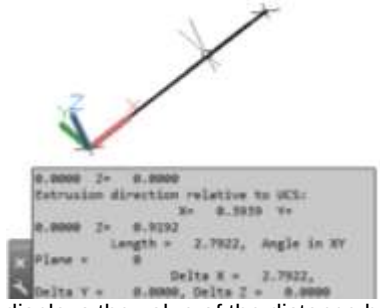


Fig. 14 The software displays the value of the distance between the two points

RESULTS AND DISCUSSIONS

Figures 3… 6 and 14 show that regardless of the method used to determine the distance between two points the result is the same.

It is also observed that each of the two working methods analyzed differ completely, neither of the working modes having common elements.

Although it is the first type of distance presented in the literature, each of the two working modes requires a deep knowledge of Descriptive Geometry or AutoCAD, because:

- using Descriptive Geometry Methods, a user must:
  - determine according to a common landmark the coordinates along the X, Y and Z axes of the two points in space;
  - represents in the draught, the horizontal and vertical projections of the points;
  - to go through the stages of changing the vertical [V] or horizontal [H} projection plane;
  - to go through the stages of the level or front replacing planes method.
- using the AutoCAD program, a user must:
  - to has advanced knowledge of working in 2D and 3D;
  - to know the commands for representing a point (POINT) and a straight-line segment (LINE);
  - to know how to work with the UCS command;
  - to know the command to display the properties of a selected object (LIST) and know how to interpret those results.

From the study it can be seen that both working variants allow obtaining identical results, with the observation that solving the topic using the AutoCAD program offers the possibility to adjust the number of decimals (from 0 to 8), so a higher accuracy in displaying results.

To see practically how to determine the distance between two points, the length of the valley rafter, shown in figures 15 and 16, is determined in both variants, using both Descriptive Geometry Methods (Changing Projection Plans and Rotation Method) and AutoCAD.

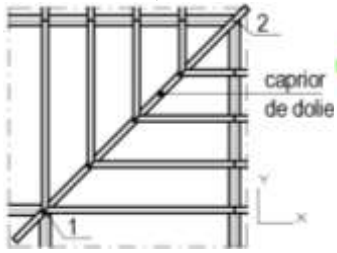


Fig. 15 The valleyrafter (top view)

Fig. 16 The valley rafter (three-dimensional view)

Are known:

- the dimensions of the cross-section of the valley rafter;
- the bearing areas on the wall plate (marked with 1 in figure 15) and on the hip jack rafter (marked with 2);
- level quotas for hip jack rafter and wall plate.
- coordinates along the X and Y axes of the rafter support points (1 and 2).

With these elements, one can easily determine the coordinates along the X, Y and Z axes of point 2 relative to 1. Having these coordinates, the two points are represented and the steps listed above are resumed, noting that and this time the same result was obtained regardless of the method used for solving.

For the other types of distances listed at the beginning of the paper, each of them requires a much deeper knowledge of both Descriptive Geometry and AutoCAD, because:

- using Descriptive Geometry Methods, solving problems requires successive changes of projection planes;
- using the AutoCAD software, solving the problems can only be done if the user knows very well the 3D part of the program and obviously the specific commands.

Finally, it can be stated that both working variants are equally good, the user being the one who opts on one working mode or the other.

CONCLUSIONS

1. Determining the different types of distances (between two points, from a point to a straight line, from a point to a plane or between two parallel straight lines) is particularly important in both the design and execution part.

2. Obtaining these distances can be done both in the classic version (using Descriptive Geometry Methods) and in the modern version (using the AutoCAD software).

3. Regardless of the working method used (classic or modern) problem solving requires in-depth knowledge in the working variant chosen by the user.

4. Both working methods are equally good, the user establishing the working variant that suits him, with the observation that by using the AutoCAD software the accuracy of the displayed distance can be adjusted from 0 to 8.

REFERENCES

1. Marin et al, **1998** – *Geometrie Descriptivă, probleme şi aplicații,* Editura Bren Bucureș ti
2. Precupeț u P., Dale C., **1987** – *Probleme de Geometrie Descriptivă cu aplicații în tehnică*, Editura Tehnică, Bucureşti
3. Prună L., Slonovschi A., 2014 – *Infografică*, Editura PIM, Iaşi,
4. Prună L., Slonovschi A., Antonescu I., 2006 – *Geometrie Descriptivă.* Editura Societății Academice „Matei – Teiu Botez".
5. Slonovschi A., Prună L., **2016** – *Infografică. AutoCAD. Comenzi de desenare*, Editura PIM, Iaşi
6. Tănăsescu A. 1965 –*GeometrieDescriptivă*. Editura Didactică şi Pedagogică Bucureşti

THE USE OF THE MATHEMATICAL CURVES IN THE OBTAINING PROCESS OF THE SPECIFIC ORNAMENTS OF THE DECORATIVE ELEMENTS FROM A GARDEN

UTILIZAREA CURBELOR MATEMATICE ÎN PROCESUL DE OBȚINERE A ORNAMENTELOR SPECIFICE ELEMENTELOR DECORATIVE DINTR-O GRĂDINĂ

SLONOVSCHI A.[1]*, PRUNĂ L.[1]
*Corresponding author e-mail: andreislonovschi@yahoo.com

Abstract. *The decorative and non-decorative elements from a garden can have different ornaments. For getting these it may be used, various mathematical curves.Starting from this observation, the authors analyzed some mathematical curves from the perspective of used them within the Inventor computer program, with the goal of generated different ornaments using this software.Following this study, they arrived at some conclusions and recommendations, presented at the end of this paper, in the case of use mathematical curves by the Inventor software.*
Key words: ornaments, mathematical curves, Inventor

Rezumat. *Elementele decorative sau non-decorative dintr-o grădină pot avea diferite ornamente. Pentru obținerea acestora pot fi utilizate diferite curbe matematice. Pornind de la această observație, autorii au analizat mai multe curbe matematice din perspectiva utilizării lor în cadrul programului de calcul Inventor, cu scopul de a genera diferite ornamente. În urma acestui studiu ei au ajuns la câteva concluzii şi recomandări utile, prezentate la sfârşitul acestui articol, în cazul utilizării curbelor matematice de către programul de calcul Inventor.*
Cuvinte cheie: ornamente, curbe matematice, Inventor

INTRODUCTION

For the design of the decorative and non-decorative elements from a garden, the Autodesk Inventor software can be successfully used (Prună and Slonovschi, 2018). These may have, or not, ornaments inside of them.In this context, it is very important to know what is the level of precision that can be gained when comes about to be designed the ornaments within the decorative elements desired.The authors tried to find out if it is possible to be obtained a complex artistic model in case that the designer has in his mind such a thing.

It is known the fact that the shape of an ornament may be defined starting from one or more curves.So, the authors concluded that the way of representing different curves, in Inventor software, is the answer to the question mentioned above.In this software, some curves can be obtained using a command called

[1]"Gheorghe Asachi" Technical University of Iaşi, Romania

Spline Interpolation.To use this command, the positions of some points must be precisely known.These points are on the curve. In other words, the points belonging to the curve.So, the user must specify the "x" and "y" coordinates of each point used in the process of representing the desired curve.In some cases, because of the large number of dimensions that must be given, this task can be difficult to accomplish.This difficulty lies in the following two causes: the first is related to the accuracy with which the coordinates of a point can be determined and the second is related to the specification in the software of a large number of dimensions.

Thus, when the designer imagines a particular shape for an ornament, he must to imagine and draw on a sheet of paper, the curve that defines it.Then he has to attach to that curve an orthogonal system of axes.Finally, he must accurately determine the coordinates of some points belonging to the drafted curve.The more points there are, the better the accuracy.But, we must not lose sight of the fact that the operation by which the coordinates of the points are measured depends both on the accuracy of the tools used and on the skills of the designer.

Regarding the second case, it must be shaw that is difficult to dimension a large number of points. This is due to the space available in the graphics editor of the software, limited by the surface of the monitor. This fact leads to the overlapping of the dimensions and, by consequence, the correctness of them will be hard to track, figure 1 and figure 2.

Fig. 1 A shape obtained started from two free curves.

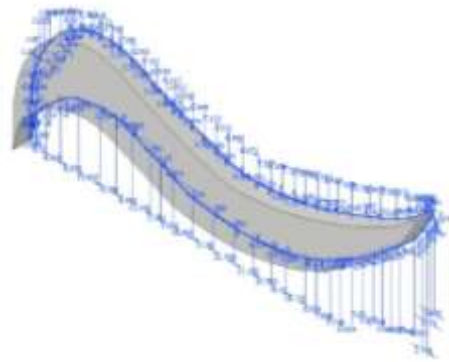


Fig. 2 The dimensions used to obtain the two free curves.

At this point, the authors wondered to what extent different mathematical curves can be used successfully, thus having the opportunity to eliminate the shortcomings listed above. So, they decided to study different mathematical curves, from the perspective of used them in the process of the ornaments' generation.

MATERIAL AND METHOD

A curve can be obtained with the command named Equation curve.Having in mind the idea that a curve it must also have an aesthetic role, the authors chose the

next mathematical curves.

The **Maltese Cross** is a well-known symbol, and cartesian parametrization for the curve is shown below (https://mathcurve.com/courbes2d.gb/croixdemalte/croixdemalte.shtml/.):

$$x = a * \cos(t)(cos^2(t) - 2) \text{ and } y = a * \sin(t) * cos(t) \quad (1)$$

This curve could be obtained in at least two ways shown in figure 3 and Figure 4. If the option presented in figure 3 is chosen, it must be immediately used the Mirror command but, finally, the extrusion operation will be not possible. So, the user has to choose the option shown in figure 4.

Fig. 3 This approach, after completing the curve, will not allow the possibility to use the Extrude command.

Fig. 4 The solution will give the possibility to use the Extrude command.

The cartesian parametrization for **Parabola** is shown below (http://www.math.md/stireal/matematica/candidat/parabola.pdf.):

$$x = \frac{t^2}{a} \text{ and } y = t \quad (2)$$

A parabola like that in figure 5 could be obtained using equations(2) for an interval -*t* to *t* where *t* is a real number.This curve must be closed, and two constraints must be established to make possible the use of the Extrude command, figure 6.

Fig. 5 The parabola

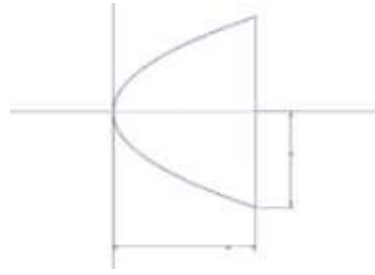


Fig. 6 The curve o parabola must be closed

The cartesian parametrization for **Hyperbola** is shown below (https://mathcurve.com/courbes2d.gb/hyperbole/hyperbole.shtml.):

$$x = 3/\cos(t) \text{ and } y = 4 * (\sin(t)/\cos(t)) \quad (3)$$

A hyperbola like that in figure 7 could be obtained using equations(4) for an interval -*t* to *t* where *t* is a real number.This curve must be closed, and two constraints

must be established to make possible the use of the Extrude command, figure 8.

Fig. 7 The hyperbola

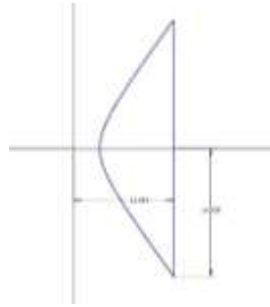


Fig. 8 The curve o hyperbola must be closed

There are several mathematical curves whose cartesian parameterization is known but which, transformed into closed curves, do not allow the extrusion of the surface defined by them.This happens even though the software displays the message "Fully constrain", which indicates that 3D modelling operations can take place. Here are some such curves: **Cissoid of Diocles** with cartesianparametrization given by equations (4), (https://mathcurve.com/courbes2d.gb/cissoiddroite/ cissoiddroite.shtml), **Piriform Quartic** (Drop fo Water) with cartesianparametrization given by equations (5), (https://mathcurve.com/courbes2d.gb/piriforme/piriforme.shtml) **Deltoid** with cartesian parametrization given by equations (6), (https://mathcurve.com/courbes2d.gb /deltoid/deltoid.shtml) and **Astroid** with cartesianparametrization given by equations (7), (https://mathcurve.com/courbes2d.gb/astroid/astroid.shtml).

$$x = 2 * a * sin^2(t) \text{ and } y = (2 * a * sin^3(t))/\cos(t) \quad (4)$$

$$x = a * cos^2(t) \text{ and } y = a^2 * cos^3(t) * \sin(t) \quad (5)$$

$$x = a * (2 * \cos(t) + \cos(2t)) \text{ and } y = a * (2 * \sin(t) - \sin(2t)) \quad (6)$$

$$x = a * cos^3(t) \text{ and } y = a * sin^3(t) \quad (7)$$

The cartesian equations and a range of values were entered, for each studied curve, figure 9. Having these data, the software automatically draws the curve for the specified range, figure 10.

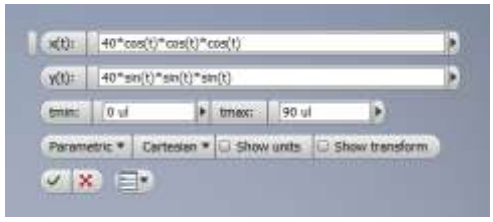


Fig. 9 The data for a branch of an astroid curve

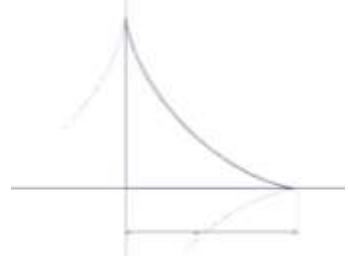


Fig. 10 The branch of an astroid curve

Then, to determine if the curve can be or not extrude, the resulting curve was transformed into a closed curve.This was done in two ways and, each time the result was tested in connection with the possibility of extruding the resulting surface.A first option was to close the obtained curve with the help of the right segments, as can be seen in figure 10.The second option consisted of the use of the Mirror command, the curves being symmetrical about one of the OX or OY axes or with both.

RESULTS AND DISCUSSIONS

Analysing the mathematical curves mentioned above, the authors found that there are curves that can be transformed into closed curves and the resulting surfaces allow the execution of the Extrude command.They are represented with maximum precision by the software and allow the ornaments to be obtained with relative ease.

Fig. 11 The Maltese Cross

The Maltese Cross, as an ornament, can be obtained starting from the curve shown in figure 4. After extrusion, the result can be multiplied by Circular Pattern and the Maltese Cross is obtained, figure 11. A model that is based on the parabola curve, figure 12, was obtained starting from the result presented in figure 6. The model from figure 13 was obtained starting from the result presented in figure 8.

Fig. 12 Parabola use

Fig. 13. Hyperbola use

For those curves that do not allow to obtain surfaces that could be extruded, the authors have found a way of working that still allows their use.Thus, the curve to be used as the basis of the model is represented, according to its equations, in the Inventor software.Then several points are chosen on the respective curve and, their coordinates are determined. To establishthe coordinates, the function that allows the placement of dimensions is used. This ensures a high accuracy of measurements. The results may or may not be retained in an Excel file. A polyline is drawn through these points. Subsequently, it allows the construction of surfaces that can be extruded. If the coordinates of the points have been saved using an Excel file, there is a command that allows plotting the points that belong to the curve by automatically reading the coordinates of those points in that file.

Figure 14 shows a model for the construction of which several cissoid curves were used. The technique mentioned above was used to obtain each curve.Once again, the technique of determining the coordinates of the points

belonging to the desired curve was used.A model for which astroid curves were used is shown in figure 15. Once again, the technique of determining the coordinates of the points belonging to the desired curve was used.

Fig. 14 At the basis of this model, there are four cissoid curves

Fig. 15 At the basis of this model, there are four astroid curves

CONCLUSIONS

1. When the Inventor software is used to build ornaments inside decorative and non-decorative elements from a garden, some mathematical curves can be used.These can be represented with high precision by the software, a fact that guarantees the user that he will obtain the geometric shapes designed by them, with the respect of the finest details.

2. The authors proposed a way of working that allows the use of even those mathematical curves that do not allow that starting from them to generate a volume model, the use of the Extrude command being not possible in this case.This way of working ensures the required accuracy by using other functions specific to this software that allow determining, with high precision, the coordinates of some points that belong to the respective curve.

3. Free curves will be obtained with low accuracy. This is due to the fact that the accuracy with which the coordinates of some points on the respective curve can be measured is low. It depends both on the accuracy of the tools used but also on the skills of the designer.

REFERENCES

1. Prună L.,Slonovschi A., 2018 – *Workflows Used in Design of the Decorative Elements from a Garden.* Lucrări ştiințifice USAMV Iaşi, seriaHorticultură, Vol 61.
2. *,** https://mathcurve.com/courbes2d.gb/croixdemalte/croixdemalte.shtml.
3. *,** http://www.math.md/stireal/matematica/candidat/parabola.pdf.
4. *,** https://mathcurve.com/courbes2d.gb/hyperbole/hyperbole.shtml.
5. *,** https://mathcurve.com/courbes2d.gb/cissoiddroite/cissoiddroite.shtml
6. *,** https://mathcurve.com/courbes2d.gb/piriforme/piriforme.shtml
7. *,** https://mathcurve.com/courbes2d.gb/deltoid/deltoid.shtml
8. *,** https://mathcurve.com/courbes2d.gb/astroid/astroid.shtml

PRACTICAL SOLUTION TO ACHIEVE A UTILITY SECTORIN A PRIVATE GARDEN

SOLUȚIE PRACTICĂ DE REALIZARE A UNUI SECTOR UTILITAR ÎN CADRUL UNEI GRĂDINI PRIVATE

SANDU Tatiana[1]*, IVAŞCU Cl.[2], TROFIN Alina -Elena[1], BERNARDIS R.[1], GRECU Codrina[1]
*Corresponding author e-mail: tatiana_sandu69@yahoo.com

Abstract. *This paper presents the solution of setting up a utility sector grown with traditional and exotic vegetables, but also aromatic and pharmaceutical utilitarian plants, necessary for the use of a household. The style of arran-gement of the utility sector is the English one, following the classic pattern of vegetable gardens, with well-defined geometric shapes, but which, in addition to the utilitarian role, also serve as a relaxation space. Thus the sector is provided with a small square in the center, with seating, a vessel of water for birds in the center and an ornamental brick wall with a waterfall in the form of a curtain. In the center of the arrangement, but also on the alley, were placed pots with flowering plants but also exotic tree species such as lemons, oranges, mandarins, etc. The utility sector will have a fence consisting of a white picket of 70 cm high that has not only an aesthetic but also a functional role, stopping the access of pets in the area. The entrance to this sector will be made through a vault with a gate, on which specimens of honeysuckle will be erected, and behind the arrangement, next to the ornamental wall with water and pool, two triads have been proposed that create an intimate but also aestheticenvironment, opting for their coverage with the help of specimens of improved ivy. The vegetal material is assumed to be planted in raised layers (cofferdams), made entirely of built bricks, as well as the pavement and the ornamental wall.The paper presents both the planning stage and the execution stages of this utility sector within a private property in Focşani, Vrancea, during May-August 2019.*
Key words*:*garden, utility sector, vegetables, aromatic and pharmaceutical herbs

Rezumat. *Această lucrare prezintă soluția înființării unui sector utilitar cultivat cu legume tradiționale şi exotice, dar şi plante utilitare aromatice şi farmaceutice, necesare pentru uzul unei familii. Stilul de amenajare al sectorului utilitar este cel englezesc, urmând tiparul clasic al grădinilor de zarzavat, cu forme geometrice bine delimitate, dar care, pe lângă rolul utilitar să deservească şi ca spațiu de relaxare. Astfel, sectorul este prevăzut cu o mică piațetă în centru, cu locuri de stat, un vas cu apă pentru păsări pe centru şi un zid ornamental din cărămizi cu un joc de apă sub formă de perdea. În centrul amenajării, dar şi pe alee, au fost poziționate vase cu plante floricole dar şi specii de pomi exotici precum lămâi, portocali, mandarini etc. Sectorul utilitar va avea o împrejmuire constituită dintr-un gard alb de 70 cm înălțime care nu are doar rol estetic ci şi funcțional, oprind accesul animalelor de companie în zonă. Intrarea în acest sector se va face printr-o boltă cu portiță, pe care se vor*

[1]University of Agricultural Sciences and Veterinary Medicine Iasi, Romania
[2]SC Doctor Green SRL Iasi, Romania

ridica exemplare de caprifoi, iar în spatele amenajării, lângă zidul ornamental cu apă şi bazin, au fost propuse două treiaje ce au rol de creare a unui mediu intim dar şi estetic, optând pentru acoperirea lor cu ajutorul unor exemplare de iederă ameliorată. Materialul vegetal este prevăzut a fi plantat în straturi înălţate (casetoane), realizate în totalitate din cărămizi zidite, la fel ca pavajul şi zidul ornamental. Lucrarea prezintă atât etapa de planificare cât şi etapele de execuţie a acestui sector utilitar în cadrul une iproprietăţi private din municipiul Focşani, Vrancea, în perioada mai÷august 2019.

Cuvinte cheie: grădină, sector utilitar, legume, plante aromatice şi farmaceutice.

INTRODUCTION

Research on the utilitarian sector in private gardens highlights the fact that, in most cases, they are considered miniature versions of old farmland, but these "vegetable" gardens differ both from a historical and a design point of view (Bentley, 1998).

For example, in France these gardens are called "Potager Jardin" and wecansee in their design the influence of the Renaissance periods by arranging these floors where there were not only vegetables but also flowers (which helped to maximize the effect), plant pots, gravelands and alleys and other period-specific compositional elements (Bartley, Jenifer, 2006).

The se small utilitarian gardens, regardless of time, period, needs, have kept their place and continue to be an important part of the arrangement.

The art of arranging utilitarian gardens, according to the rules of landscape architecture, has experienced a sharp development in recent years because, if in the past Romanians wanted a yard with many layers of vegetables, now they have changed their tastes, wanting a combination of decorative and utilitarian. Thus, decorative gardens appear more and more often in the new neighborhoods of villas where the utilitarian sector is considered special and treated as such (Sima, 2009).

This arrangements tarted from the owner's desireto have a space where you can cultivate what you need to get food but also natural remedies in your own family.

MATERIAL AND METHOD

The purpose of this work is to present the realization, inside a landscaping in a private yard in the city of Focşani, at the request of the client, of a utilitarian sector, with aromatic and medicinal plants, but also with vegetable specimens.

The private garden covers an area of about 8,000 squaremeters, with the landscaping around the house whichis 3,000 squaremeters, with a strongemphasis on watergames.

The total area of the utility sector is approx. 70 sqm, of which approx. 70% of the total area was planned to plant species of flowering plants, aromatic and medicinal herbs, and the other 30% vegetable plants for family consumption. The design phaseis represented by the realization of the 2D utility sector plan (in .dwg format) in Autocad, after which the 3D projection was made in the RealtimeLandscaping program, to help the client to better visualize the final product. The execution phase

followed, between May and August 2019, when the projected solution for arranging the utilitarian sector was put into practice.

RESULTS AND DISCUSSIONS

From the initial analysis of the site to be arranged it is found that on the place of the future utility sector there were initially only a few improvised layers, where vegetables were already produced for family consumption, but the space was not well organized or easy to main taingiven that there was noirrigation and no pavedalleys to facilitate access. The fencing was made only from the side with meshpanels and did not offerany thing attractive from an aesthetic point of view and to a more detailed analysis, also not from a practical point of view given that the owner had pets. (fig.1).

Fig. 1 The initial situation of the site to be arranged *(original)*

Figure 2 shows the 2D plan of theutility sector, notingthe geometric style of the arrangement solution, the central area provided with decorative vessel, along with the built elements: 4 boxes in the shape of the letter L, 8 rectangular boxes, 6 square boxes, 2 narrow-rectangular and decorative wall with falling water.

Fig. 2 Utility sector layout sketch (*original*)

The location of the utilitarian sector is in the south-eastern area of the property, a favorable situation, through exposure to maximum sunshine, for the

development of leguminous, medicinal and floricultural plants that have been proposed in the arrangement (fig. 3).

Fig. 3 General plan of the private garden and the utilitarian sector*(original)*

The arrangement project provides 3D details that illustrate the solution of arranging this sector in an obvious geometric style, in figures 4 and 5 being shown the central square, with seating and a vessel of water for birds, as well as the ornamental wall of bricks with a game of water in the form of a curtain.

Fig. 4 Central area of the sector *(original)*

Fig. 5 Trenches and water curtain *(original)*

The execution phase of the arrangement started with the picketing works of thefuture sector, delimitingthenecessaryspace. All the strings were placed with the help of the laser to be perfectly straight, after which the excavations were started and the form works were made to pour the foundation (fig. 6 and 7). This was followed by the pouring of the concrete slab on the center of the sector,

comprising the water basin, the entrance and the interior of the four cofferdams that delimit this whole area. The other layers were built on a concrete belt but at the end of the project the access to the mis made on the lawn.

Fig. 6.Land picketing *(original)*

Fig. 7.Belt formwork*(original)*

It was decided to pour a concrete slab (fig. 9) to provide strength and stability of future cofferdams, wishing to keep the raised layers in time, as intact as possible. Welded mesh was used to pour the concrete (fig. 8).

Fig. 8 Welded mesh detail*(original)*

Fig. 9 Concrete pouring *(original)*

Next, the construction works of the coffers were started, these having the edge of the width of a brick (0.12 m) being built on 6 rowstoreach the desired height (approx. 0.5 m) (fig. 10 and 11).

Fig. 10 Construction of coffers *(original)*

Fig. 11 Coffers almost completed*(original)*

After making the brick elements, which constitute ther aisedlayers of plants, the brickbase was made on whichis placed a bowl of burntclay, which serves as a drinker for birds or which can be decorated with plant species with

seasonal flowers. Next to this pool with a decorative wall, on both sides there are wooden trusses specially made tomake the area more intimate.

The final result of the arrangement (fig. 12), by arranging a drip irrigation system (fig. 13), allows the beneficiary to produce his own vegetablesand at the same timeto produce enoughplant material for the preparation of phytotherapy products, also offering a special recreational area.

Fig. 12 The completed central little plaza of the utility sector *(original)*

Fig. 13 Detail–irrigation system *(original)*

CONCLUSIONS

1. In the arrangement presented, the main elements are represented by the 20 built coffers, of variable shapes and sizes, ideal for the cultivation of vegetables and aromatic and floricultural plants..

2. This utilitarian sector is fenced with a simple wooden fence, 0.7 m high, and the entrance is made through a vault with a gate, to restrict the access of pets but, at the same time, it offers a special decoration (*Lonicera caprifolium*).

3. The cost of arrangement was approx. 10,000 euros, of which approx. 6,000 euros for materials and 4,000 euros for labor.

4. Even if the costs of making this sector are not small at all, it can be considered that it was to the liking of the beneficiary because the sector allows the family to produce their own vegetables and at the same time to produce enough plant material to prepare their own phytosanitary products, also offering a recreational area.

REFERENCES

1. **Bartley Jenifer R., 2006 -** *Designing the New Kitchen Garden: An American Potager Handbook.* Editura Portland.
2. **Bentley A., 1998 -** *Eating for Victory: food rationing and the politics of Domesticity*, Urbana, Editura University of Illinois
3. **Sima Rodica, 2009 -** *Legumicultura–sursă de hrană si potențial ornamental*, Editura AcademicPres, Cluj-Napoca.

USING FRUIT GROWING SPECIES IN PERIURBAN LANDSCAPE DESIGN

FOLOSIREA SPECIILOR POMICOLE IN DESIGNUL PEISAGER PERIURBAN

ZLATI Cristina[1], PAŞCU Roxana[1]*, BERNARDIS R.[1]
*Corresponding author e-mail: ing.dr.roxana@gmail.com

Abstract. *Present study sets out a new way of developing the green spaces, centered on the citizen, wishing to become a way for cities to cope with climate change, food and nutritional security, biodiversity management and prosperity. Our purpose was to find and implement a tool for the sustainable recovery of degraded lands, by using landscaping that includes periurban spaces dedicated to the development of agro-horticultural sector. The study was conducted between 2016-2019 and represents a multidisciplinary approach, which took into consideration as many aspects as environment, economic, social, horticultural and biological. Horticultural part of this study is characterized by a great biodiversity and is dominated by fruit growing species. As for the degraded area in which urban orchards are located, they could be the hope of having safe spaces, of improving the landscape, as well as another form of social inclusion. The most important benefits from a social point of view are the maintenance of public spaces at a low cost, the social inclusion, the economy of saving food and the short chain, while under the environmental asp*ect, the protection of biodiversity and the safety of health become important.
Key words: periurban spaces, fruit growing species, landscape

Rezumat. *Studiul actual prezintă o nouă modalitate de dezvoltare şi valorificare a spaţiilor verzi, centrată pe cetăţean, dorind să devină o modalitate prin care oraşele să facă faţă schimbărilor climatice, securităţii alimentare şi nutriţionale, gestionării biodiversităţii şi prosperităţii umane. Scopul nostru a fost să găsim şi să implementăm un instrument pentru recuperarea durabilă a terenurilor degradate, prin utilizarea amenajării teritoriului periurban care include spaţii dedicate dezvoltarii sectoarelor agro-horticole. Studiul a fost realizat în perioada 2016-2019 şi reprezintă o abordare multidisciplinară, care a luat în considerare aspecte precum mediul, economic, social, horticol şi biologic. Partea horticolă a acestui studiu este caracterizată de o mare biodiversitate şi este dominată de specii pomicole. În ceea ce priveşte zona degradată în care sunt situate livezile urbane, acestea ar putea fi speranţa de a avea spaţii sigure, de a îmbunătăţi peisajul, precum şi o altă formă de incluziune socială. Cele mai importante beneficii din punct de vedere social sunt întreţinerea spaţiilor publice la un cost redus, incluziunea socială, economisirea alimentelor, în timp ce sub* aspectul mediului, protecţia biodiversităţii şi siguranţa sănătăţii devine vitală.
Cuvinte cheie: spaţiu periurban, specii pomicole, peisager

[1]University of Agricultural Sciences and Veterinary Medicine Iasi, Romania

INTRODUCTION

Population growth and increasing consumption are placing huge demands on agriculture and natural resources. In the present, approximately 15 % of world population is chronically malnourished while our agricultural systems are degrading land, water, biodiversity and climate on a growing scale. To stand up to the world's future food security and sustainability needs, food agriculture production must grow substantially but in the same time to protect the environment (Irvine *et al*., 2013).

This is why we have to find solutions for a cultivated planet and UF could be one.

In the last decade urban farming is expanding into European cities and has recently colonized the roofs of buildings, being part of the large category of roof agriculture, especially due to constraints related to the availability of urban land (Kothencz *et al*., 2017).

This paper proposes a series of projects/arrangements, analysing solutions to this dilemma, showing that tremendous progress could be made by halting agricultural expansion, closing 'yield gaps' on underperforming lands, increasing cropping efficiency, shifting diets and reducing waste. Together, these strategies could double food production while greatly reducing the environmental impacts of agriculture (Montanaro *et al*, 2017).

MATERIAL AND METHOD

For a better understanding the ideology of including fruit growing species in periurban landscape design (Specht *et al*., 2016), we reviewed their integration in a proposal to arrange a urban orchards in the city of Iasi. In the process of identifying the areas with high potential for such territorial systematizations, we discovered different sites of a special kind of picturesque in which the built elements were harmoniously combined with the vegetal ones.

For this study, we identified the 10 most populated neighborhoods in Iasi, which comprise 56% of the total population of the city and in which green spaces account for only 20% of total green spaces. Among these neighborhoods are the Mircea cel Batran, Nicolina and CUG neighborhoods, where the lack of green spaces was intensified by uncontrolled asphalting in the perimeter of the few areas with vegetation and also did not allow the reintroduction or creation of new green spaces.

Taking into account these considerations, we propose the implementation of the concept of an urban orchard in an unused space of 6400 sqm, located between three important neighborhoods, more precisely to the right of Sofia Nădejde street in front of Arcadia Hospital (fig. 1).

The principles used in the proposal for the arrangement of the Urban Orchard not only want to offer solid arguments regarding the efficient change of the landscape on which it is based, but also describe the means by which the fusion between artistic values and the qualities of the created environments is created (Timpanaro *et al*, 2015). Thus, within the urban orchard development project, it was decided to suppress the presence of cars in the landscaped space in order to obtain a strictly pedestrian landscape.

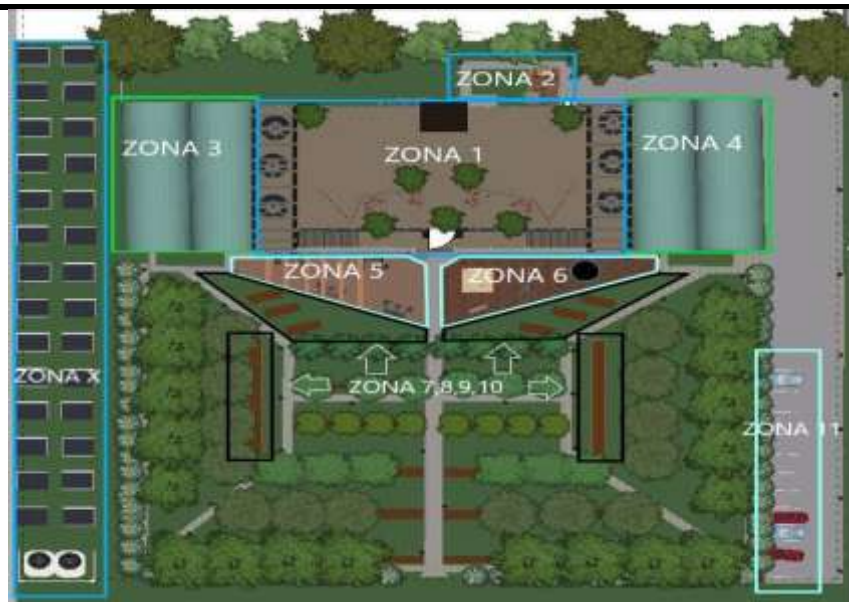


Fig. 1 The zoning of the orchard project, area at the interference of three important neighborhoods, Iasi city

The orchard is an element that ensures flavor, freshness and color to each garden. It offers a decorative spring look through flower and color, attracting pollinators and offering delicious and fragrant fruits. In addition, fruit growing can be a relaxing activity practiced with pleasure, which pleases you on all levels.

RESULTS AND DISCUSSIONS

Periurban orchards are a sustainable solution to many of the urban challenges, providing access to fresh fruit, improving the urban environment and creating habitats necessary to protect local wildlife (Zasad, 2011). The most important aspect of the project is the opportunity to facilitate connections between the inhabitants of the area, but also for them to benefit from a balanced diet rich in fresh fruits and vegetables. Connecting residents so they can create and view urban orchards as a great way to spend time in the city (most do not have their own garden). There is also a strong educational element: children, in particular, love to learn how to grow and harvest their own food, and early education creates healthy eating habits. We tried to create an orchard as varied as possible in terms of assortment, especially using qualitative varieties, low vigor dwarf type, with medium to high production, with a wide ripening season , from early May to late November.

Location of the trees in the orchard, this was done according to their size from large to small from outside to inside.

Perimeteral high-species species were used, the specimens being positioned so as to create a natural curtain of protection against proximity, but also to offer privacy to visitors.

The vigor of the planted species was taken into account, ensuring the appropriate planting distances, but also the space necessary for maintenance, the need for water, this being ensured by a well-developed irrigation system.

CONCLUSIONS

1. The concept of peri urban orchards is meant to create a space, not only with an aesthetic role, but also with an important sanogenic, economic and social role. This desire can be achieved by introducing an oasis of relaxation, as close as possible to nature for site visitors.

2. The advantage of using this type of arrangement of fruit species, initially induces visitors the feeling of modernism, but in reality, the landscape created is a rustic, natural and local, being easy to maintain.

3. The site has been designed so that each space has a well-defined role, both as an orchard, but also as a space for relaxation, trying to please all types of visitors.

4. The planting of trees and shrubs species will take into account the optimal conditions for these works to ensure the highest possible planting success.

5. Creating a research team with specialists from different fields, agriculture, landscape, biology and others will lead to diverse projects, perspectives, expertise, approaches and solutions, essential for biodiversity in food, agriculture, quality of life and for conserving food plants that will also include their use in our natural landscapes.

REFERENCES

1. **Irvine K.N., Warber S.L., Devine-Wright P., Gaston K.J., 2013** - *Understanding urban green space as a health resource: a qualitative comparison of visit motivation and derived effects among park users in Sheffield,* UK. Int J Environ Res Public Health 10, pp. 417-442.
2. **Kothencz G., Kolcsár R., Cabrera-Barona P., Szilassi P., 2017** - *Urban green space perception and its contribution to well-being.* Int J Environ Res Public Health 14.
3. **Montanaro G., Xiloyannis C., Nuzzo V., Dichio B., 2017 -** *Orchard management, soil organic carbon and ecosystem services in Mediterranean fruit tree crops.* Sci. Hortic. Amsterdam *217*, pp. 92-101 https://doi.org/10.1016/j.scienta.2017.01.012.
4. **Specht K., Weith T., Swoboda K., Siebert R., 2016 -** *Socially acceptable urban agriculture businesses.* Agron. Sustain. Dev. 36 https://doi.org/10.1007/s13593-016-0355-0.
5. **Timpanaro G., Scuderi A., Foti V.T., Lo Giudice V., 2015** - *The social relationships' effectiveness of "agrisocial" farms: a model of sustainable local development.* Rivista di Studi sulla Sostenibilità 1, pp. 99-116. https://doi.org/10.3280/RISS2015-001007.
6. **Zasada I., 2011** - *Multifunctional peri-urban agriculture - a review of societal demand and the provision of goods and services by farming.* Land Use Policy 28 (4), pp. 639–648 https://doi.org/10.1016/j.landusepol.2011.01.008.

RESEARCH ON POLLUTION OF THE GROUNDWATER CAPTURE

CERCETĂRI PRIVIND POLAREA CAPTĂRILOR DE APĂ SUBTERANĂ

LUCA M.[1*], STICEA A.S.,[1] LUCA Al.L.[2]

[*] corresponding author e-mail: mluca2015@yahoo.com

Abstract*. The research was conducted on groundwater catchments located in the hilly and mountainous area of Moldova. One of the catchments presents a complex of negative factors in the site, of which the pollutants are predominant. The interference of economic activities in the protection zone has led to changes in the quality parameters of the captured water. The activities are represented by forestry, car transport, car parks etc. Emissions from the catchment site polluted the water with biological material. The biological analyzes performed revealed the improper quality of the water captured for domestic consumption.*
Key words: protection area, quality parameters, technical expertise

Rezumat. *Cercetările au fost efectuate la captări de apă subterană amplasate în zona de deal şi montană a Moldovei. Una din captări prezintă un complex de factori negativi în amplasament, dintre care cei poluanți sunt predominanți. Interferența activităților economice în zona de protecție a dus la modificarea parametrilor de calitate ai apei captate. Activitățile sunt reprezentate de exploatarea forestieră, transportul auto, realizarea de parcuri auto, clădiri de serviciu cu grupuri sanitare etc. Noxele din amplasamentul captării au poluat apa cu material biologic. Analizele biologice efectuate au evidențiat calitatea improprie a apei captate pentru consum menajer.*
Cuvinte cheie: expertiză tehnică, parametri de calitate, zonă de protecție

INTRODUCTION

Human health parameters are primary conditions in the operation of the water supply system and implicitly of water intakes. Failure to comply with the requirements of the law causes pollution of water sources (Bica, 2000; NP 133, 2013). Environmental protection in groundwater catchment areas for water supply systems is required by law (Law 37-1995). Ensuring the sanitary quality of the captured water is a primary condition in the operation of the water supply system. Failure to comply with the requirements of current legislation will result in pollution of water sources. The presence of pollution sources requires the shutdown of the water supply system. The absence of coherent legislation in the field of environmental protection, as well as its firm application determines the pollution of water sources used to supply the population.

[1]Technical University "Gheorghe Asachi" of Iasi, Romania
[2] Polias-Instal Company of Iasi, Romania

The environment is negatively influenced by natural factors since its formation. Over time, anthropogenic factors have also emerged. From the beginning of the 20th century, anthropogenic factors began to be more influential than natural ones (Avram, 2020). A number of these factors present a high risk due to objective but also subjective causes of human society (Avram and Luca, 2017). In the last period of time, there is a coupling of natural risk factors with anthropogenic ones, a situation that determines catastrophic phenomena.

The paper aims to present the results of research on environmental degradation in the area of groundwater abstraction through the brutal intervention of anthropogenic risk factors.

MATERIAL AND METHOD

The research was carried out in the area of the water system that serves the localities of Oituz and Marginea within Oituz commune, Bacău county. Oituz locality is located in the southwest of Bacău county, on the border with Covasna county, in the area of the upper course of the Oituz river. The capture of water for domestic consumption is made from an underground source located outside the village of Oituz at the edge of a slope. The catchment is located near the confluence between the streams Leşunțul Mic and Leşunțul Mare (fig. 1) (Luca, 2020).

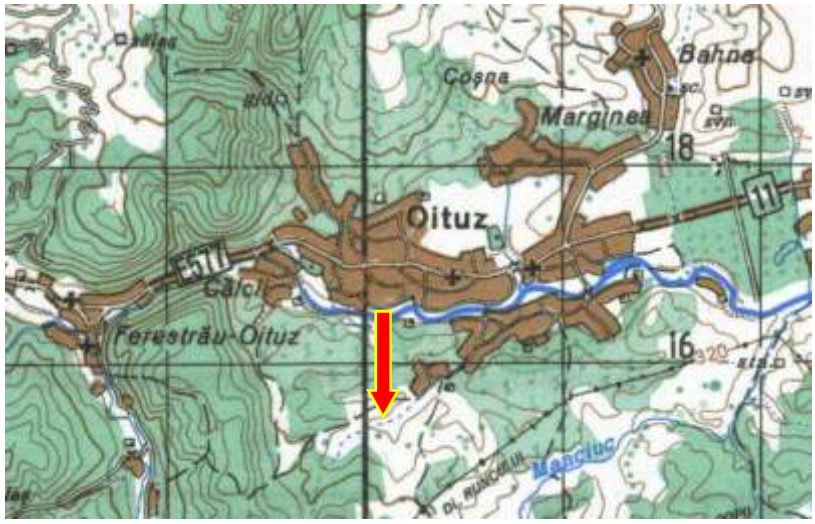


Fig. 1 Location of the research objective in the suburbs of Oituz, Bacău County

Theoretical and experimental research was conducted in the following areas:

1. Studies and research on the integration of groundwater capture in the issue of the evolution of environmental parameters in the location area in the context of land ownership changes in the last period of time.

2. Studies and experimental research on the state of quality of the environment in the area of groundwater abstraction.

3. Research of current natural and anthropogenic risk factors with influence on the evolution of the quality parameters of the captured water.

For the analysis of the situation in the field, a technical expertise was performed which highlighted the change in the structural and functional state of the catchment in the last period of time. The data collection from the field was performed through topographic measurements, specialized analyzes by fields, material samples, photo and video surveys.

The primary data were processed using statistical, hydrogeological and hydraulic calculation programs applicable to the case study.

RESULTS AND DISCUSSIONS

The location of the researched works is in the hydrographic basin of the Oituz River, the main collector of surface and groundwater in this area. Oituzul is a tributary on the right of the Trotuş River. The tributaries of the Oituz collect surface and groundwater from the mountain and hill area. The main tributaries in the studied area are Pârâul Leşunţul Mic and Pârâul Leşunţul Mare fed by a series of torrential formations.

The groundwater catchment is located at about 300 m from the confluence of the streams Leşunţul Mic and Leşunţul Mare. The captured flow is 4.8 l/s at a hydrostatic level of 1.40 - 1.70 m. The capture consists of the following components (fig. 2):

1. Two catch drains (D1, D2) located on an area at the base of a slope. The drains are 75 m long, are made of stone and gravel and are mounted at a depth of 3.50 m.

2. Two visiting homes (Cd1, Cd2) provided in the upstream section of each drain. The visiting home have an inner diameter of 1.50 m, a depth of 3.50 m. The visiting home are made of reinforced concrete.

3. A collecting visiting home (CC) to which the two catchment drains are connected. The collecting visiting home has an inner diameter of 1.50 m, a depth of 4.50 m and is made of reinforced concrete. In the collecting chamber is located the suction of the supply pipe that transports the captured water to the storage tank and the treatment station.

4. A channel located perimeter of the catchment surface with the role of supplementing the volume of water in the underground layer. The canal is fed by a diversion from a mountain stream located near the catchment front.

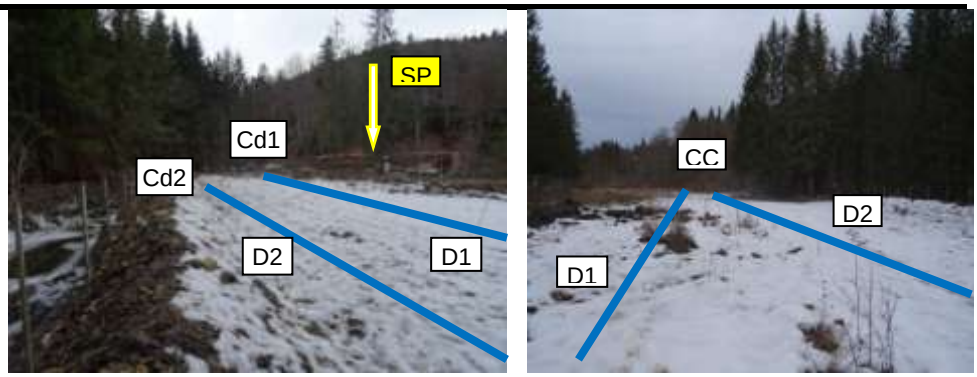
5. Sanitary protection works for groundwater abstraction consisting of: 1 - "severe sanitary protection area" protected by fencing, protection distance 72.0 m, about 2.0 ha; 2 - "restricted health protection area", protection distance 180 m, about 6.0 ha.

Fig. 2 Orthophotoplan with the location of groundwater abstraction: Cd1, Cd2 – visiting home 1, CC - collector visiting home, D1, D2 - drain, Cal - supply channel, CA - adduction pipe (Luca 2020).

The catchment was located on a land covered with large forests specific to the mountain and hill area. The phenomenon of forest retreat, but especially the intensification of wood cutting has caused a pollution of the catchment area. The field analysis highlighted the following aspects:

A. Sources of pollution:

- construction of transport roads for forestry exploitation on the sanitary protection areas (fig. 2, fig. 3);
- forest material warehouses equipped with processing and loading equipment (fig. 2, fig. 3);
- parking areas for forestry transport trucks;
- the construction of constructions for the exploitation services of the forestry activities equipped with sanitary groups.



a b

Fig. **3** General view of the groundwater emplacement site: a - view from CC to Cd1; b - view from Cd1 to CC; SP - source of pollution, noe. 2019 (Luca 2020).

B. The research carried out highlighted a number of types of pollutants:

- hydrocarbs resulting from the activity of forest transport, from the maintenance of trucks in the parking lot, from the parking of trucks during periods of inactivity;
- biological material from the sewerage installation of the constructions that serve the forest exploitation;
- biological pollutants from forest waste as a result of cutting and shaping trees;
- dust and dust from heavy traffic;
- aerosols and gases from the movement, parking and technological process of forestry equipment.

The research carried out in the field highlighted the degradation of the sanitary protection area by pollution phenomena that affected the quality of groundwater. Logging is carried out right on the "severe protection zone". Pollution is rapid, because the hydrostatic level of groundwater is only at a depth of 1.40 - 1.70 m (Luca 2020). The drains are located at a depth of 3.50 m, in which case they can be easily polluted.

The severe sanitary protection zone involves a distance of 72.0 m (Luca 2020) . Field measurements indicated a distance of 15.0 m to the road and 40-60 m to the wood depot, parking lot and buildings. The restricted sanitary protection area is about 180 m. It is not respected by the forestry activity. The perimeter of hydrogeological protection is respected due to the performance of forestry works, transport of timber, etc. The situation analyzed in the field highlights the state of environmental degradation in the area where the groundwater catchment is located.

Water quality parameters at the time of setting up the water supply system were within acceptable limits according to the standards in force. The analysis of water quality parameters performed by DSP Bacău in November 2019 highlighted the presence of biological material in water distributed to consumers. The sanitary

report indicates the presence of biological pollutants in domestic drinking water distributed in two localities.

The microbiological analysis performed revealed the following situation (Luca 2020): coliform bacteria (100/100 mL), enterococci (20/100 mL) and escherichia coli (19/100 mL). The presence of biological pollutants determined the stopping of the water distribution and the disinfection works of the system. At the same time, we started to detect the sources of pollution, analyze them and determine the remedial measures. The analyzes performed also indicated an increased turbidity above the limits of the drinking water distributed to consumers.

CONCLUSIONS

1. Anthropogenic risk factors particularly influence the state of the natural environment in the last period of time and cause disastrous situations on human society.

2. Anthropogenic risk factors have an important contribution to the degradation of drinking water sources used in the supply of the population and activities involving water with quality parameters accepted by the rules in force.

3. The partial and total degradation of the drinking water sources on the Romanian territory has recently become a permanent action and not sanctioned by the legislation in force.

4. Drinking water sources restrict their usable volume in the last period of time under the pressure of anthropogenic pollution factors, a situation that makes it difficult to supply human society with quality water.

REFERENCES

1. Bica I., 2000 - *Elemente de impact asupra mediului*. Edit. Matrixrom, Bucureşti.

2. Avram Mihaela, 2020 – *Cercetări privind impactul factorilor de risc hidroclimatic asupra lucrărilor de regularizare a râurilor. Teză de doctorat*.

3. Avram Mihaela, **Luca M., 2017** - *Analysis of phenomenon with hydrologic large risk in the hydrographic basin of the Trotuş River.* PESD, vol. 11, nr. 2, pp. 78-87, ISSN 1843-5971.

4. Luca, M., Avram Mihaela, Marcoie N., Chirica Stefania, 2017 - *Influence of hydroclimatic risk factors on the river pollution phenomenon*. Lucrări Ştiinţifice Seria Horticultură, An LXX, 60 (1)/2017, Universitatea de Ştiinţe Agricole şi Medicină Veterinară Iaşi, p. 237-242, ISSN 1454-7376.

5. Luca M., 2020 - Expertiză Tehnică: „*Extindere rețele de alimentare cu apă în satele Oituz şi Marginea, mărire capacitate sursă apă. Obiect: Captare de apă subterană*", S.C. Polias-Instal S.R.L. Iaşi

7. Ursu A., Jitariu V., Ciutea A., 2017 - *Estimating the impact of human activities on the environment in Moldavia region (HI index).* PESD, vol. 11, nr. 2, pp. 97-108.

8. *, NP 028 – 1998** - *Normativ pentru proiectarea construcțiilor de captare a apei*

9. *, NP133 – 2013** - *Normativ pentru proiectarea, execuția şi exploatarea sistemelor de alimentare cu apă şi canalizare a localităților*. Vol. 1, *Alimentări cu apă*.

10. *, Legea 137-1995** - *privind protecția mediului cu completările şi modificările ulterioare*

ENVIRONMENTAL DEGRADATION PHENOMENA IN IRRIGATION SYSTEMS

FENOMENE DE DEGRADARE A MEDIULUI ÎN SISTEME DE IRIGAȚIE

LUCA M.[1]*, STICEA A.S.[1], LUCA Al. L.[2], SION P.V.[1]
* corresponding author e-mail: mluca2015@yahoo.com

Abstract*. Irrigation systems in the eastern part of Moldova have dvanced infrastructure wear and tear.The degradation of the system's infrastructure has had a negative impact on the natural and human environment. The research carried out highlighted the negative influence of the absence of maintenance and repair works of the irrigation system on the site environment. The most active polluting factors are represented by the transport of alluvium in canals and pipes, the development of vegetation in the location of the pumping stations, the soil pollution with the noxious substances from the irrigation water, etc. The state of the environment within the irrigation system causes a human and landscape discomfort.*
Key words: canals, degradation, ecological status, impact, pipes

Rezumat. *Sistemele de irigații din zona de est a Moldovei au o uzură avansată a infrastructurii. Degradarea infrastructurii sistemului a determinat un impact negativ asupra mediului natural şi uman. Cercetarea efectuată a evidențiat influența negativă a absenței lucrărilor de întreținere şi reparații a sistemului de irigații asupra mediului din amplasament. Factorii poluanți cei mai activi sunt reprezentați de transportul de aluviuni în canale şi conducte, dezvoltarea vegetației în amplasamentul stațiilor de pompare, poluarea solului cu noxele din apa de irigație etc. Starea mediului din cadrul sistemului de irigație determină un disconfort uman şi peisagistic.*
Cuvinte cheie: canale, conducte, degradare, impact, stare ecologică

INTRODUCTION

The environment has been influenced by natural factors since its formation on Earth. Some of the natural factors have a negative influence on the environment by producing disastrous phenomena. These include climate change, earthquakes, volcanoes, floods, landslides, droughts etc. The development of human society has led to the emergence of anthropogenic factors, which began to be more influential than natural ones since the 20th century (Bica, 1998). In the last period of time, there is a coupling of natural risk factors with anthropogenic ones, a situation that determines catastrophic phenomena.

Environmental protection in the areas of irrigation systems is necessary given some negative effects of the exploitation process on watering plants (Law

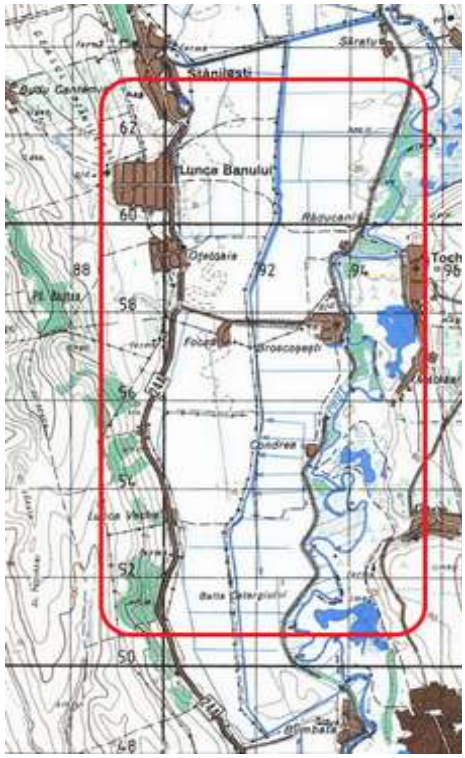
[1]Technical University "Gheorghe Asachi" of Iasi, Romania
[2] Polias-Instal Company of Iasi, Romania

137, 1995). The current way of operating some irrigation systems in Romania can produce a series of pollution phenomena with influence over a long period of time. The differentiated management of the components of the irrigation system determines an inadequate management of the maintenance, repair and rehabilitation works of the infrastructure and superstructure.

The paper aims to present the results of research on environmental degradation in the area of irrigation systems by natural and anthropogenic risk factors more active in recent times.

MATERIAL AND METHOD

The study and research material is represented by the irrigation systems located in the eastern part of Romania. The research considered the irrigation systems located in the meadow area of the Prut River and located in Vaslui County (fig. 1).



a

b

c

Fig. 1 Study and research area: a - location of irrigation systems in the Prut river meadow; b - channel CA3 and SPP 9 Oțetoaia; c - supply channel CA3, Plot SPP8 Oțetoaia (Luca, 2020)

The Albița - Fălciu Complex Irrigation and Drainage Development currently has a developed surface of 16,973 ha. Irrigation systems are located on the first terrace and in the meadow of the Prut River. Irrigation systems were designed in 1977 and were executed between 1977 and 1978. After 1990, the irrigation infrastructure (basic pumping stations, supply and distribution channels) is operated by the Territorial Branch

of Land Improvements South Moldova. Irrigation plots are managed privately by OUAI in the area. The system contains irrigation plots equipped with pressure pumping stations (SPP) and monofilament pumping stations (SPPM). The pumping stations are fed by a network of channels (Luca, 2016).

For a series of irrigation plots, technical expertise was performed to determine the current constructive and functional state. At the same time, the influence of the degradation of the irrigation system on the environment was analyzed.

The research method is the one used to carry out technical expertise for land improvement objectives and in particular for irrigation systems with water supply of pumping stations using a network of canals.

RESULTS AND DISCUSSIONS

The Albița - Fălciu Complex Irrigation and Drainage Development has been in operation for over 40 years. Irrigation and drainage systems were under state administration until 1990. After 1990, the management system was modified, being mixed, the state and farmers' associations. The mode of administration has influenced the evolution of the environment by intensifying some natural and anthropogenic risk factors.

The area considered in the study is particularly sensitive to the phenomenon of pollution on multiple levels. The site is mostly located in the meadow, has a flat surface exposed to winds, with a shallow groundwater and influenced by the Prut River. The land is intensively cultivated without adequate soil protection. All these characteristics determine a seasonal amplification of the pollution phenomenon determined by natural and anthropogenic factors.

Irrigation contributes to ensuring the conditions for the development of agricultural crops in conditions of a climate with pronounced aridity (Nicolaescu *et al.*, 2005). However, irrigation can have a direct and indirect negative impact on the environment in which it operates. The direct type impact, determined by natural and anthropogenic factors, is represented by the following phenomena:

- the introduction of water taken from a river with a certain degree of pollution on the ground negatively influences the quality of surface water and groundwater for a certain period of time (Hâncu *et al*., 2003);

- irrigation water can cause soil degradation by chemical effects, including contamination with various biological substances;

- sprinkler irrigation water (irrigation method used exclusively in the current stage by land managers) can cause erosion degradation of agricultural land;

- the presence of irrigation with the related constructions and installations substantially modifies the living conditions of the flora and fauna habitat in the area of action; irrigation alters the diversity of plant and animal species by destroying some or raising others.

The indirect impact, determined by the anthropic factor, is represented by the following phenomena:

- the application of intensive agriculture over periods of time, which reduces the amount of minerals in the soil;

- excessive fertilization of the land, with influence on the pedological characteristics of the soil;

- modification of the soil texture through the applied technological works.

For the studied area, several technical expertises were prepared in which the influence of irrigation on the environment was analyzed. The documentation analyzed the condition of the structural components of the irrigation system that interfere with the environment. The data obtained through technical expertise allowed the analysis of the impact of constructions and installations for irrigation on the habitat in the study area. The irrigation system has been in operation for about 40 years (Luca 2014; Luca 2015; Luca 2020).

a b

Fig. 2 The impact of the meadow vegetation (reed) on the hydro-mechanical and electrical installations from SPPM, Plot 7 Doniceasa-Fălciu: a - occupying the location of the pumping station with vegetation; b - the influence of vegetation on the operating conditions of the pumping unit (Luca 2016)

The field research highlighted the following aspects:

I. The sources of pollution are diverse and are represented by the following groups:

I.a - Alluvium transported by irrigation water on the route from the source to the emission from the sprinkler system. Alluvium contributes to the clogging of the supply channels of the pumping stations (fig. 1.b, fig. 1.c) and of the drainage channels (fig. 2). Alluvium influences the texture and structure of irrigated soil. Alluvium contributes to increased wear of nozzles on watering equipment. This phenomenon is mainly registered in the irrigation plot SP7 Doniceasa - Falciu, on the main supply channel CP5 for SPPM 7/4 ... 7/8. The canal is clogged at a height of about 65% (Luca, 2016).

I.b - Biological material, in particular grass, taken from the location of canals and transported in irrigation water on land occupied by agricultural crops. The absence of maintenance works on the location of the supply and distribution channels allows the development of polluting vegetation for the agricultural land. The wind picks up the seeds and introduces them into the irrigation water, after

which they are distributed with the sprinkler irrigation equipment evenly on the agricultural land (fig. 1.b, fig. 1.c). The CA3 supply channel from the SPP8 and SPP9 irrigation plots Oţetoaia has rich grass vegetation in the area adjacent to the canopy. Vegetation has become a source of soil pollution by taking seeds into irrigation water.

I.c - Biological material specific to the river meadow area, especially reed (*Phragmites australis*) excessively developed in the location of the constructions and installations of the pumping stations (fig. 2). The presence of groundwater at shallow depth favoured the development of reeds in the area of pumping stations, but especially in the drainage channels (they have water permanently (fig. 2)), but also in the irrigation channels (fig. 1.b). This situation is present in the location of the pumping stations SPPM 7/1 ... 7/8 from the irrigation plot SP7 Doniceasa - Falciu fed from the main channel CP5. The reed-like vegetation extended over the entire area adjacent to the crown of the CP5 canal. The pollution phenomenon negatively affects the structural condition of the pumping units, of the electrical installations and of the hydraulic installation (fig. 2).

a b

Fig. 3 Impact of canals on the research area: a - drainage canal filled with vegetation and inoperable; b - CP5 supply channel, Plot 7 Doniceasa – Falciu clogged on variable lengths (Luca 2016)

I.d - Chemical pollutants taken with irrigation water from the Prut River. Most of them the pollutants in the Prut River are of organic origin. They come from the discharge of untreated wastewater, but also of incompletely treated wastewater in the treatment plants of the localities along the Prut River. Among the pollutants are ammonium ions, nitrites, heavy metals, hydrocarbons, and lately pharmaceutical substances are present.

II. Pollution phenomena caused by anthropogenic factors. In the last 30 years, the pollution phenomena produced by the controlled or uncontrolled human action have intensified. In the case of the irrigation system, the following may be listed:

II.a - Absence or limitation of maintenance and repair works of the components of the irrigation system. This situation caused the flooding of the canals and pipes of the irrigation system. The effect is represented by the following:

- vegetation development in canals and on their location; the phenomenon is present in the drainage channels, as well as in / along the supply channels at the pumping stations type SPP and SPP at most irrigation plots (significant in this case are the channels CA3 and CA5);

- vegetation development in the area of the pumping stations; the phenomenon is general at the SPPM type pumping stations located on the irrigation water supply channels (significant in this case are the SPPM from the Irrigation Plot7 Doniceasa-Fălciu located on the CA5 channel);

- blocking the flow in the drainage channels and increasing the groundwater level in the soil, a situation that determines the salting of the soil and changes in the habitat of the area; some of the drainage channels are clogged and have blockages of the flow section; the high level in the drainage channels determines the increase of the groundwater level in the soil, a situation that favours the appearance and maintenance of the salting phenomenon (Marinov and Safta, 2001);

- degradation of the structure of the water supply channels of the system, a situation that caused large water losses and influenced the characteristics of the environment in the area; most of the supply channels have a degraded structure due to the exceeding of the exploitation period of the protection material due to the infiltration phenomenon (protection with large reinforced concrete slabs); the degradation of the concrete slabs led to the appearance of large water losses, a situation that influenced the stability of the canal and the constructions on it; a significant example is represented by the supply channel CA3, Plot SPP 9 Otetoaia at which the degradation phenomenon is very extensive (fig. 1.b)

- the presence of excess hydrocarbon dust, dust and aerosols in the area of the exploitation roads in the irrigation system (the roads are unmaintained and the bridges are not repaired); the pollution phenomenon is widespread throughout the irrigation system; as an example it is presented in figure 5 of the exploitation sump from the SPP8 Oțetoaia Irrigation Plot;

- aerosols and gases from the circulation, parking and technological process of agricultural machinery;

- agricultural and household waste as a result of agricultural and human activities in the area of the irrigation system; the volume of this waste has increased over time and highlights those of plastics (bags, bottles, boxes, packaging, etc.); plastic bags thrown into the supply channels cause the blockage of the suction to the pumps and implicitly the accentuated wear of the pump rotor through the cavitation phenomenon.

III. Habitat changes for existing flora and fauna at the site of the irrigation system:

III.a - Habitat modification for flora and fauna in areas of land where the parameters of the irrigation process are not properly controlled. In this category are the feeding channels degraded in proportion of 80% and with high water losses, the drainage channels clogged on about 40 - 75% of the volume.

a b

Fig. 5 State of degradation of traffic routes in the irrigation system with environmental impact in Plot SPP8 Oțetoaia: a - exploitation road along the canal; b - bridge on the drainage channel (Luca 2020).

III.b - Modification of the habitat in the area of agricultural land determined by agricultural waste from the technological process of sowing, growing and harvesting plant production.

The analysis performed in several irrigation systems in Romania shows that the current way of managing irrigated areas induces a negative impact on the environment. Both entities that work together in the management of the irrigation system (state and farmers) create major problems in ensuring the conditions of habitat stability, but also in the radical change of those present. This problem must be solved jointly by the two partners in order to solve the problems of environmental pollution.

The absence of coherent legislation in the field of environmental protection, as well as its firm application, leads to the pollution of landfills occupied by irrigation and drainage systems.

CONCLUSIONS

1. Anthropogenic risk factors have become predominant in recent decades and particularly influence the state of the natural environment in irrigation systems, affecting buildings and facilities, but also the habitat in the area of the system.

2. The supply channels of the irrigation system have become vectors for transporting biological pollutants in the network of canals and pipes of the irrigation system, a situation that favours the infestation of agricultural land.

3. Unmaintained drainage channels contribute to habitat degradation in the meadow area and cause the spread of polluting vegetation on agricultural land.

4. The absence of maintenance and repair works of the components of the irrigation system influences the transport of pollutants on the landscaped land with influences on the agricultural production, the quality of the irrigation water, as well as the living conditions for the zonal habitat.

REFERENCES

1. Bica I., 1998 – *Protecția mediului*. *Tehnici de remediere*. Edit. *H*G*A*, Bucureşti.

2. Hâncu S., Marin G., Vîrsta A., 2003 – *Transportul şi dispersia poluanților*. Edit. Bren, Bucureşti.

3. Luca M., 2015 - *Expertiză tehnică „Modernizarea si retehnologizarea sistemului de irigații la O.U.A.I. Agro Irig Prut Berezeni", jud. Vaslui*. S.C. Polias-Instal S.R.L. Iaşi.

4. Luca M., 2016 - *Expertiză tehnică „Modernizarea si retehnologizarea sistemului de irigații la O.U.A.I. Doniceasa-Fălciu", jud. Vaslui*. S.C. Polias-Instal S.R.L. Iaşi.

5. Luca M., 2020 - *Expertiză tehnică „Modernizarea si retehnologizarea sistemului de irigații la O.U.A.I. Oțetoaia", jud. Vaslui*. S.C. Polias-Instal S.R.L. Iaşi.

6. Luca M., Luca Al. L., Toma D., Tămăşanu F., 2018 - *Considerations on the modernisation of monofilament pumping stations for sprinkling irrigation*. Lucrări Ştiințifice vol. 61, nr. 2/2018, seria Agronomie, Universitatea de Ştiințe Agricole şi Medicină Veterinară Iaşi, pp. 157-162 ISSN 2069-6727.

7. Marinov A.M., Safta A., 2001 – *Influența distribuției poluanților pe suprafața solului asupra calității apelor subterane*. Lucr. Conf. „Ingineria resurselor de apă subterană", UCTB, 28-29 iunie, Bucureşti, p. 26-35.

8. Nicolaescu I., Bunociu L., et all., 2005 – Irrigation sector reform in central and eastern European country, Romanian Report, pp. 385 – 461.

9. Pleşa I., Burchiu V., 1986 - *Exploatarea sistemelor de îmbunătățiri funciare*, Edit. Ceres, Bucureşti.

10. Ursu A., Jitariu V., Ciutea A., **2017** - *Estimating the impact of human activities on the environment in Moldavia region (HI index).* PESD, vol. 11, nr. 2, pp. 97-108.

11. *, Legea 137**-1995 - *privind protecția mediului cu completările şi modificările ulterioare.*

RESEARCH ON ENVIRONMENTAL DEGRADATION IN RIVER BRANCHES AREAS

CERCETĂRI PRIVIND DEGRADAREA MEDIULUI ÎN ZONELE DE RAMIFICARE A ALBIILOR DE RÂU

SION PAUL V.[1], LUCA M.[1]*, TOMA D.[1], DOMINTE Violeta[1]

* corresponding author e-mail: mluca2015@yahoo.com

Abstract*. The conservation of the ecological system of riverbeds is a necessity for ensuring the living conditions of the aquatic and riparian habitat. A number of special problems are imposed by the riverbed branches where an island is created. The research carried out on the lower course of the Moldova River, where the riverbed was artificially branched (Cordun area, Neamț County) highlighted the need for a set of works on ecological restoration of the aquatic and riparian environment. The presence of economic disturbances in these areas (water capture) has led to significant morphological changes on the two arms of the Moldova River. The aquatic vegetation is almost completely degraded on the active arm of the river. The secondary arm of the riverbed has a variable flow over time, a situation that generates unviable living conditions for the habitat.*

Key words: aquatic environment, ecological restoration, island

Rezumat. *Conservarea sistemului ecologic al albiilor de râu este o necesitate pentru asigurarea condițiilor de viață a habitatului acvatic şi riveran. O serie de probleme speciale sunt impuse de ramificațiile de albie unde se crează un ostrov. Cercetările efectuate pe cursul inferior al râului Moldova, unde albia a fost ramificată în mod artificial (zona Cordun, județul Neamț) au evidențiat necesitatea realizării unui set de lucrări privind restaurarea ecologică a mediului acvatic şi riveran. Prezența factori perturbatori de tip economic în aceste zone (captare de apă) a determinat modificări morfologice importante pe cele două brațe a râului Moldova. Vegetația acvatică este degradată aproape în totalitate pe brațul activ al râului. Brațul secundar al albiei prezintă un debit variabil în timp, situație ce generează condiții neviabile de viață pentru habitat.*

Cuvinte cheie: mediu acvatic, ostrov, restaurare ecologică

INTRODUCTION

The environment has always been influenced by natural risk factors. Over time, anthropogenic risk factors have been added to natural factors. The cumulation of the action of the two risk factors determines negative effects on the environment.

Environmental protection in the area of hydro-urban works in the riverbed is necessary given the negative impact of the operation of buildings and facilities (Law 137, 1995). Hydro-urban constructions for capturing water from rivers

[1]Technical University "Gheorghe Asachi" of Iasi Romania

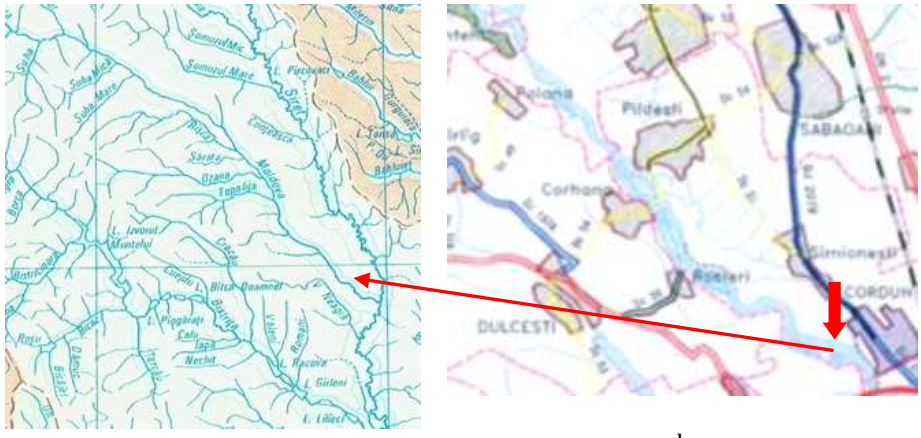
require a series of works to arrange the riverbed that disrupts the living conditions of the aquatic and riparian habitat (Bica, 2000).

The paper presents the results of research on environmental degradation in the area of works for water capture in the Moldova riverbed.

MATERIAL AND METHOD

The studies and researches were carried out on a section of the Moldova river located in the area of Cordun locality from Neamț county (fig. 1). The research material consists of the territory that includes water capture for the industrial area of Roman city. The water catchment is performed on the river bank and includes a series of constructions and installations located in the riverbed and on the shore. The execution of the catchment required the construction of a secondary arm of the river to ensure the transit of flows during the working period (Luca, 2011).

The Moldova River has a weakly meandering route in the study area. The river sector considered in the analysis presents an orientation N W - S E. The hydrological research analyzed the parameters of the maximum flow on the river section taking into account the flows registered at the Roman Hydrometric Station, Neamț County.



a b

Fig. 1 Location of the study area: a - area of the researched hydrographic basin; b - administrative map of the catchment site

Research was carried out on the river section between 2011 and 2019 in order to analyze the behaviour of the Moldova Riverbed in ensuring the optimal conditions for environmental protection in the catchment area.

Theoretical and experimental research was carried out in the following directions:

1. Research on the influence of natural factors on the morphological transformations of the riverbed and which have a negative impact on the aquatic and riparian environment.

2. The study of the influence of anthropogenic factors on the aquatic and riparian environment on the two riverbed sections resulting from the groundwater capture.

The analyzed data were taken from technical expertise performed for water abstraction from the Moldova River, as well as fine specialized documentation on the field of study. In the field, the structural and functional state of the two arms was analyzed by topographic, hydrological, geotechnical studies, etc. The field research carried out photo

surveys during the ten years of study to follow the evolution of environmental characteristics.

RESULTS AND DISCUSSIONS

The structure of the water catchment includes a series of constructions and installations located in the riverbed and on the shore. The construction of the catchment imposed the division of the river into two arms by creating an island in the area of Cordun locality (fig. 2). The flows on the secondary arm of the river were transited during the execution period. The secondary arm remained on the route of the Moldova River after the completion of the water catchment. The main water flow flows through the left arm of the river, and the right (secondary) arm is fed intermittently, especially at high flows (fig. 3) (Luca, 2011).

Fig. 2 Location of the research area on the Moldova River in the Cordun area, Neamț County; 1 - Moldova River; 2 - water capture; 3 - main riverbed (left arm); 4 - secondary bed (right arm); 5 - island (Luca 2011)

The catchment consists of constructions and installations made along the river that have the role of taking over calibrated flows over periods of time. The constructions and installations are the following: canal, capture windows, dams. The constructions executed in the riverbed consist of bottom sill, energy disipator, downstream apron and shore protections. The right arm is made in the form of a calibrated river section. The water catchment influenced the morphology of the minor riverbed of the Moldova River on a length of about 400 m.

An island with an area of 21.0 ha was formed between the two riverbeds. It is positioned at approx. 6.00 km upstream of the confluence of the Moldova river with the Siret River (fig. 3).

a b

Fig. 3 General view of the island formed by the branching of the Moldova River bed; a - upstream area of the island; b - the main riverbed and the island in the central area (photo Sion 2019)

The left arm of the river on a length of 320 m is rectilinear and has a calibrated section. The water flow occurs at high speeds (about 1.29 - 2.60 m / s, up to 4.0 m / s), a situation that strongly influences the environmental protection conditions.

a b

Fig. 4 General view of the Moldova river upstream of catchment: a - riverbed before branching; b - the entrance on the secondary riverbed with the position of the overflow; 1 - spill (photo Sion 2019).

The research highlighted the following:

- the main riverbed has a route in the form of a circular arc with a large curvature to ensure the supply of water catchment located on the river bank (fig. 4.a, fig. 5);
- the high speed of the water does not allow the formation and preservation of the living conditions of the flora and fauna;
- the calibrated riverbed is protected on a long length with rigid elements (concrete slabs, gabions, stone), a situation that does not allow the creation of an alluvial layer for the growth of aquatic flora;
- the riverbed calibrated and packed with rigid elements does not allow the fulfillment of the conditions for the growth of the aquatic fauna: in the riverbed it is not possible to create areas of rest of the fish, of reproduction and growth;

a b

Fig. 5 Constructive characteristics of the Moldova River bed in the catchment area: a - general view; b - the energy dissipation basin at the bottom threshold (photo Sion 2019)

- the canopy area is continuously degraded and polluted with dust, aerosols, hydrocarbon residues, household and industrial waste, mainly due to road transport adjacent to the canopy.

The secondary riverbed (right arm of the river) is fed only at medium and high flows. The entrance to the secondary riverbed is arranged in the form of an overflow (temporary construction). The cross section of the riverbed is variable in size and length. The riverbed consists of layers of ballast over which fine alluvium is deposited. The analysis performed in the field highlighted the following:

- the secondary riverbed has a linear sector at the entrance, followed by a sector in the shape of a circular arc, and the exit sector is slightly curved (fig. 6);
- the cross section of the right arm is variable in size and length;
- the aquatic environment on the right arm is degraded in the current stage; a negative influence is the exploitation of the ballast on the secondary riverbed;

a b

Fig. 6 The characteristics of the secondary riverbed of the Moldova River: a - the entrance section; b - the central section (photo Sion 2019)

- the morphology of the right arm is continuously modified at maximum flows, but also at the average flows that enter temporarily due to the degradation of the spillway.

- morphological changes produce areas of erosion and alluvium deposition along the length of the right arm;

- water stagnates in some sectors and creates an anaerobic environment, which influences the development of the aquatic environment;

- on the right arm there is an aquatic habitat developed in a minor stage, but affected by the water flow conditions; ensuring a stable water level can be done by running a spillway in the area where the right arm joins the left;

- the aquatic habitat in the secondary riverbed is strongly disturbed by the absence of riverbed arrangement works and the permanent impact of the maximum flow;

- the research highlighted an influx of water in the secondary riverbed produced by the underground current that crosses the ballast layer between the two riverbeds.

The presence of the island allows the creation of a habitat for protected species in the riparian area. Ecological restoration is a solution to restore the riverbed branches of an island in order to achieve adequate protection of aquatic and riparian flora and fauna (Petts anf Calow, 1996; Serban, 1999).

CONCLUSIONS

The river sectors occupied with water catchment constructions do not achieve favorable existence of the aquatic and riparian habitat, situation in which measures must be adopted for the ecological reconstruction of the riverbed-riparian zone environment.

The impact on the environment given by the rigid works of riverbeds is extremely negative and greatly disrupts the living conditions of the aquatic habitat.

The branched riverbeds of the rivers due to the location of the hydrotechnical constructions work differently in order to ensure the optimal parameters for the development of the aquatic and riparian environment.

REFERENCES

1. Bica, I., 2000 - *Elemente de impact asupra mediului*. Edit. Matrixrom, Bucureşti.

2. Luca M., 2011 - *Expertiză tehnică privind conlucrarea cu amplasamentul a obiectivului „Amenajare iaz piscicol cu utilizarea materialului excavat, comuna Horia, județul Neamț”*. S.C. Polias-Instal S.R.L. Iaşi.

3. Petts G., Calow P., 1996 - *Restoration of Rivers*, Blackwell Science Ltd., Oxford, pp. 231.

4. Şerban T., 1999 - *Reconstrucția ecologică a râurilor*. Rev. Hidrotehnica nr. 3, Bucureşti.

5. Wasson J.G., Malavoi J.R., Maridet L., Souchon Y., Paulin L., 1998 - *Impacts écologiques de la canalisation des rivières*. Éditions Cemagref, 160 pp.

6. *, Legea 137-1995** - *privind protecția mediului cu completările şi modificările ulterioare*

BIOREMEDIATION AND PHYTOREMEDIATION OF PESTICIDE CONTAMINATED SOIL: MICROBIOLOGICAL STUDY

BIOREMEDIAREA ŞI FITOREMEDIAREA SOLULUI CONTAMINAT CU PESTICIDE: STUDIU MICROBIOLOGIC

RASTIMESINA Inna[1]*, POSTOLACHI Olga[1], JOSAN Valentina[1]
* Corresponding author e-mail: rastimesina@gmail.com

Abstract. *The paper is focused on screening of the approaches to remediate the soil, complex contaminated by obsolete persistent organic pesticides: DDTs and trifluralin. The aim was to increase the biodegradation rates by activation of indigenous soil microflora with mineral and organic amendments. The experiment was carried out in oxic conditions, and cycled anoxic and oxic conditions, with phytoremediation applied afterwards. The effectiveness of the bioremediation procedures for soil microbiota along with degradation of pesticides was discussed. Microbiological analysis of soil at the final of experiments demonstrated the necessity of phytoremediation for soil microflora recovery.*
Key words: contaminated soil, pesticides, DDT, trifluralin, microflora

Rezumat. *Lucrarea este axată pe screening-ul procedeelor de remediere a solului, contaminat timp îndelungat cu complex de pesticide organice persistente: DDT-uri şi trifluralină. Scopul a fost creşterea ratelor de biodegradare prin activarea microflorei indigene a solului cu amendamente minerale şi organice. Experimentul a fost realizat în condiţii oxice şi în condiţii ciclice anoxice-oxice, cu aplicarea ulterioară a fitoremedierii. E fost arătată eficacitatea procedurilor de bioremediere pentru microbiota solului, paralel cu degradarea pesticidelor. Analiza microbiologică a solului, la finalul experimentelor, a demonstrat necesitatea fitoremedierii, pentru recuperarea microflorei solului.*
Cuvinte cheie: sol contaminat, pesticide, DDT, trifluralină, microfloră

INTRODUCTION

In recent decades, in Republic of Moldova, the background pollution of soil has become less significant due to the current reduction of the main sources of diffuse pollution. The quantities of fertilizers and pesticides used in agriculture were significantly reduced, and there is no current problem of pollution with nitrates and heavy metals (Anuarul IPM – 2019, 2020). Compared with previous years, Σ DDT content was significantly reduced, the content of Σ HCH and Σ PCBs remained the same. But the problem of local pollution of soils with different wastes and harmful substances is becoming more acute (Anuarul IPM –

[1] Institute of Microbiology and Biotechnology, Chişinău, Republic of Moldova

2019, 2020; State of the Environment…, 2011). A large number of locations are contaminated with several Persistent Organic Pollutants (POPs), which raises the question of potential synergistic effects of impact on the population and the natural environment, 112 locations polluted with two compounds, 43 locations – three compounds and 13 locations – four compounds (State of the Environment…, 2011). In most cases the mixture of detected pollutants includes DDT metabolites, isomers of HCH and toxaphene (Pleşca *et al.*, 2010).

Destroyed storehouse for pesticides and organic fertilizers located near Sangera village, Chisinau municipality, the Republic of Moldova, has been selected using Management of POPs (http://pops.mediu.gov.md/). The site was long-term and complex polluted by pesticides, the total content of which was 21 mg/kg dry soil; the major component of contamination was dinitroaniline herbicide trifluralin and the minor component was organochlorine insecticide DDT and its metabolites DDE and DDD (Rastimeţina *et al.*, 2016). Both compounds belong to organic halogenated pesticides, but the approaches for bioremediation of contaminated soil differed depend of ways in their transformation (Kantachote *et al*., 2004; Trifluralin, 2007; Wang and Arnold, 2003).

Dichlorodiphenyltrichloroethane (DDT) was one of the most widely used organochlorine pesticides. In 2001, the governing council of the United Nations environment program issued a treaty to eliminate or restrict the production and use of persistent organic pollutants (POPs). Although the use of DDT has been banned for wide agricultural use, part of DDT was released to environment and this trend continues, because it was still used as an anti-malaria agent or a raw and processed material for dicofol production (Guatam and Sumathi, 2006). A large amount of DDT still remains in soils. In some area, the DDT concentration found in soil markedly exceeded the level set by the national soil quality standards (Zao *et al.*, 2010).

Trifluralin is a synthetic fluorinated dinitroaniline herbicide, which is used in the control of annual grasses and broad-leaved weeds in agriculture, horticulture, viticulture, amenity and home gardens. Trifluralin can exert a phytotoxic action on some cereals, such as wheat, oats, rice, and corn. The toxic effect of this herbicide lies in the inhibition of the growth of roots, namely, in violation of the cell division processes in the roots of plants. In the plants subjected to this treatment, secondary roots are not developed, the growth of the shoot stops, and the plant died (Antonious, 2012).

Trifluralin was first registered in 1963 and is marketed in a number of names, such as Treflan, Triflurex, Triflusan and others (Trifluralin, 2007). It is currently widely registered for use throughout the world although the use within the EU was banned from 2008. In 2012, trifluralin was excluded from the State Register of plant protection products and fertilizers permitted for use in the territory of the Republic of Moldova; however, residues of the pesticide are registered in soils of Moldova to the present day (Rastimesina *et al.*, 2016).

Our goal was to estimate the effect of bioremediation and phytoremediation procedures using the stimulation of anaerobic or facultative anaerobic microflora of soil contaminated with organic halogenated pesticides.

MATERIALS AND METHODS

Samples of polluted soil were collected nearby the destroyed storehouse for pesticides and organic fertilizers, were cleaned of roots and other impurities, sieved (mesh No. 2) and air-dried at 22-23^{0}C.

The extraction of pesticide residues from soil has been performed in four repetitions per option according handbook of methods (Metode de determinare…, 2000). The determination of pesticide residues in soil was confirmed by gas chromatography with mass spectrometry GC/MS multiresidue method, at the gas chromatograph "Agilent Technologies" 6890N coupled with MSD mass selective detector "Agilent Technologies" 5973. Percentage of degradation was calculated using the expression:

% of degradation = [(PR control – PR experience) / PR control] $\times$ 100; where PR is pesticide residue (Bento *et al.,* 2003).

The bioremediation was established in the dark plastic jars, each containing 1,000 g of polluted soil. Contaminated soil without remediation was used as a control.

The experiment was designed in oxic, anoxic and cycled anoxic / oxic conditions. At the set up of the experiment in oxic conditions, the soil was amended with water, 60% of water-holding capacity (WHC) (Options 1-6), mineral fertilizer ammophoska (Option 2, 5, and 6), there were planted cucumbers *Cucumis sativus* L. (Option 3), alfalfa *Medicago sativa* L. (Option 4 and 5), and oat *Avena sativa* L. (Option 6). The duration of experiment was 112 days.

Anaerobic conditions were created by saturating the contaminated soil with water, 80% of WHC, in the plastic jars sealed with Parafilm, and stored in the dark at 22-24°C (Options 7-12). At the set up of the experiment in anoxic (Options 7, 8, and 10) and cycled anoxic / oxic conditions (Options 9, 11, and 12), the soil was amended with 0.5% peptone (Options 8-12), 1.0% mono- and dipotassium phosphates (Option 8 and 9), 1.0% mono- and disodium phosphates (Option 10 and 11), and 1.0% dipotassium and diammonium phosphates (Option 12). At the beginning of the aerobic phase, lasted for 7 days, Parafilm has been removed, and the soil mixed with a metal spatula and soil moisture was gradually brought up to 60% of WHC. At the start of each anaerobic phase, lasted for 21 days, amendments (0.2% each) were added to the soil, and soil humidity was maintained at 80% of WHC. The anoxic and cycled anoxic / oxic conditions continued for 112 days. For Options 10-12 these conditions lasted for 63 days, than it was passing to the aerobic phase by applying sawdust, and phytoremediation with oat (*Avena sativa L.*), for 72 days. Monthly plants were cut, mixed with the soil and new seeds were planted.

At the end of the experiment, the systematic groups of microorganisms (micromycetes, bacteria, actinomycetes) present in the soil were observed through inoculations on solid selective media.

RESULTS AND DISCUSSIONS

The soil was polluted by trifluralin 30.00 $\pm$ 0.34 mg/kg soil, $\sum$ DDTs (DDT, DDE, DDD) was 1.80 $\pm$ 0.07 mg/kg dry soil. The total content of

organochlorine compounds was 21.00 mg/kg dry soil, which demonstrates that the level of pollution near the storehouse exceeded the maximum residue limits (MRL) (0.1 mg/kg dry soil for trifluralin and for each metabolite of DDT) (Rastimesina *et al.*, 2016).

Natural attenuation (Option 1), or maintenance of soil moisture at 60% of WHC without tilling, any amendments, and other treatments, for 112 days, led to degradation of about 7% trifluralin and 5% DDTs (fig. 1 and 2).

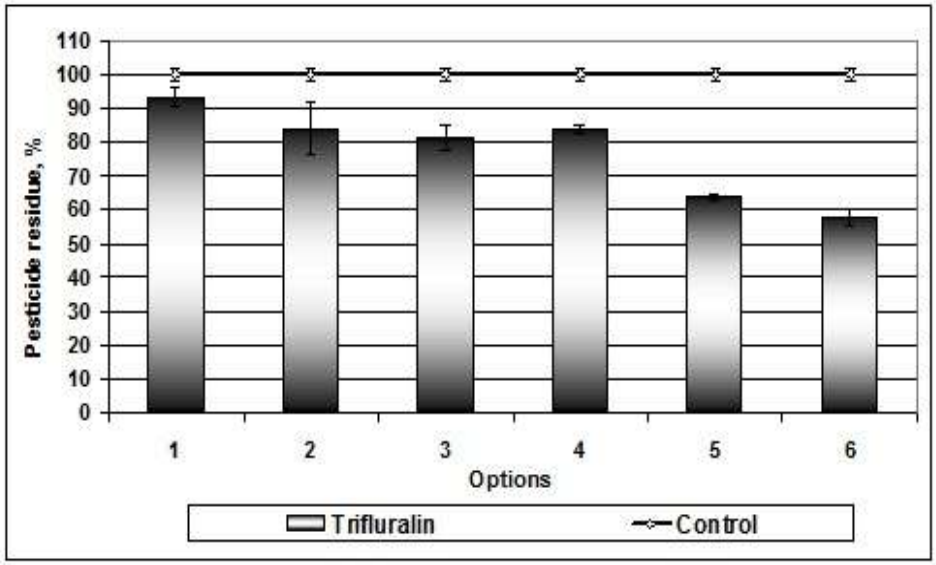


Fig. 1 The impact of bioremediation procedures in oxic conditions on trifluralin degradation in soil

Conform investigations, the biodegradation of the organofluorine herbicide – trifluralin best occurs under anaerobic conditions, and the presence of oxygen can inhibit this process (Tor *et al.*, 2000; Wang and Arnold, 2003). In our experiments on biodegradation of trifluralin in aerobic conditions the complete mineralization had not been achieved. In spite of this, the combination of bio- and phytoremediation, in experimental Options 5 and 6 led to the considerable decrease in the herbicide concentration without creating anaerobic conditions, up to 36-42% (fig. 1).

Tilling and amendments with mineral fertilizer performed in the Option 2 favored the decomposition of organochlorine pesticides by 22% compared to the control – and by 18% – compared to the Option 1. The cultivation of phytoremediation plants accompanied by the periodic tilling of the contaminated soil led to the decrease of ∑DDTs by 31-33% compared to the control (fig. 2).

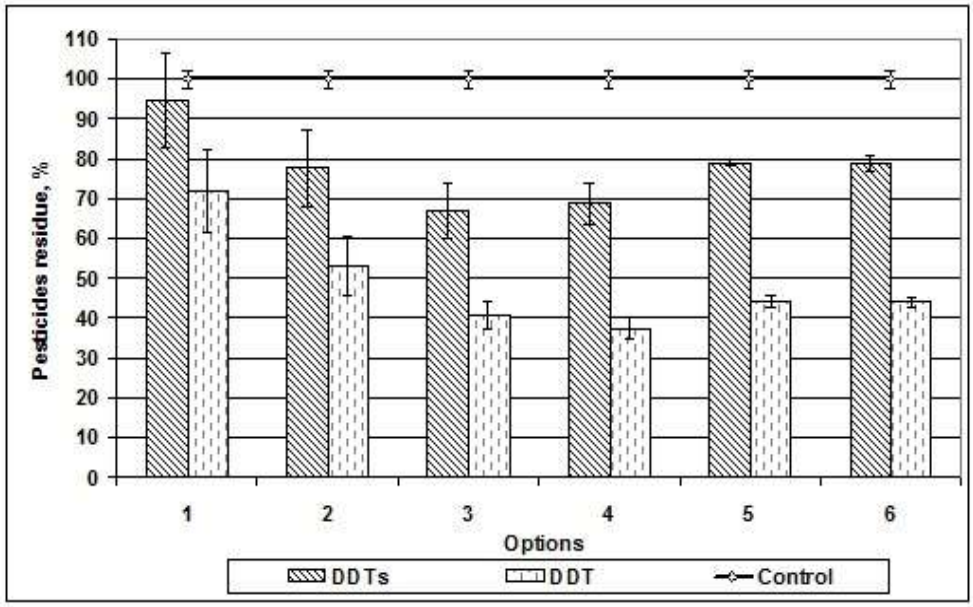


Fig. 2 The impact of bioremediation procedures in oxic conditions on DDTs and DDT degradation in soil

Creating anaerobic conditions by saturation of soil with water up to 80% of WHC allowed increasing the degradation of trifluralin to 25% and DDTs – up to 28% of the initial concentration (fig. 3 and 4).

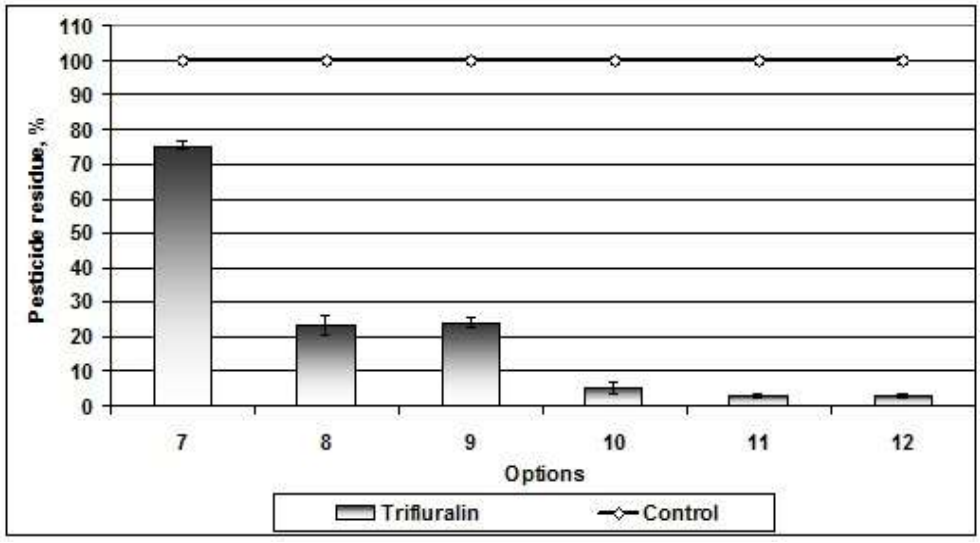


Fig. 3 The impact of bioremediation procedures in anoxic and anoxic / oxic conditions on trifluralin degradation in soil

The improving in efficiency of pesticides degradation in soil could be achieved using anoxic and cycled anoxic/oxic treatment, combined with stimulating the indigenous microflora with mineral and organic amendments (phosphates and peptone); trifluralin content in soil decreased by more than 4 times. Combination of bio- and phytoremediation techniques in the Options 11 and 12 allowed the mineralization of 98% trifluralin (fig. 3).

Amount of DDTs, decomposed in anoxic and cycled anoxic/oxic conditions without phytoremediation was not significant, degradation made less than one third of the initial concentration – 27-29.0%. Soil amendments with phosphates and peptone in cycled anoxic/oxic conditions favors the degradation of DDT (up to 0.09 mg/kg dry soil), compared with anoxic treatment. Phytoremediation provided a decrease in DDTs concentration to 69-73% (fig. 4).

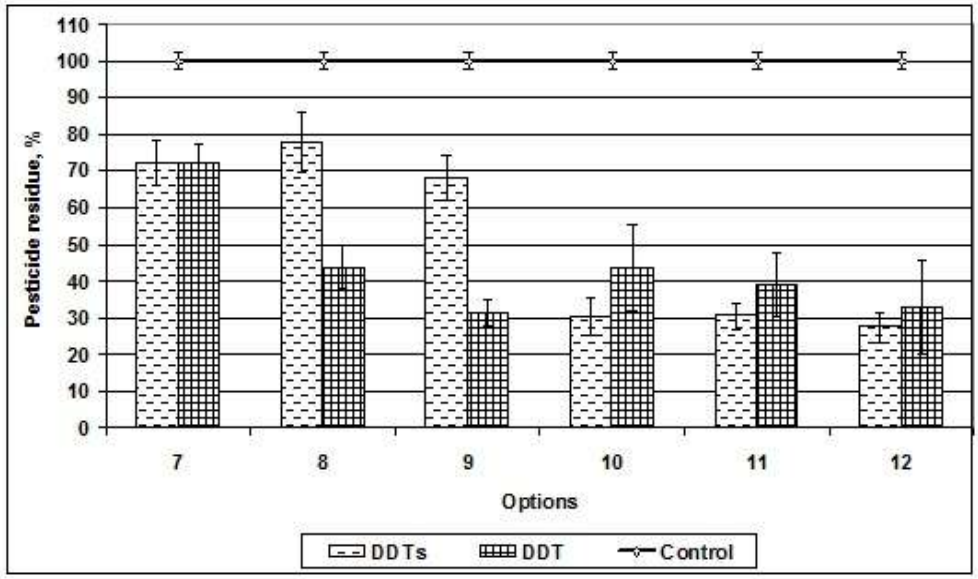


Fig. 4 The impact of bioremediation procedures in anoxic and anoxic / oxic conditions on DDTs and DDT degradation in soil

At the end of the experiment, the microbiological activity of the soil was determined depending on the bioremediation measures taken. Our experiments did not aim at characterizing all groups of microorganisms in the soil, but only at studying the indigenous soil microflora, which is involved in nitrogen transformation processes, and survived the conditions of prolonged toxic stress.

The analysis showed that in the control variant (Option 1), where the only remedial factor was maintaining sufficient soil moisture – 60% CRA, the diversity of microorganisms was low and corresponded to the carbonate chernozem. Under the long-term influence of toxicants there is a restructuring of soil microbial cenosis in the direction of reducing microbial diversity, but with the emergence of more resistant species.

Carrying out various bioremediation measures, in most cases, considerably facilitates the activation of the soil microbiota. In experimental Options 5 and 6, maintained in aerobic conditions using alfalfa and oat as phytoremediation plants, significant stimulation of bacterial growth was observed.

For the microbiological characterization we used the method of calculating the total number of microorganisms (fig. 5, fig. 6).

The ability to assimilate xenobiotic compounds in anaerobic conditions has been detected in a wide variety of microorganisms: anaerobic, facultative anaerobic, including bacteria of the genera *Pseudomonas* and *Bacillus*. In the experimental variant with alternating anaerobic-aerobic conditions, the total number of studied microorganisms decreased practically 4 times compared to the control; and the transfer of the variant in aerobic state by the introduction of the sawdust and the subsequent phytoremediation, cardinally modified the microbial cenosis and led to the increase of the number of microorganisms from all the physiological study groups (fig. 6).

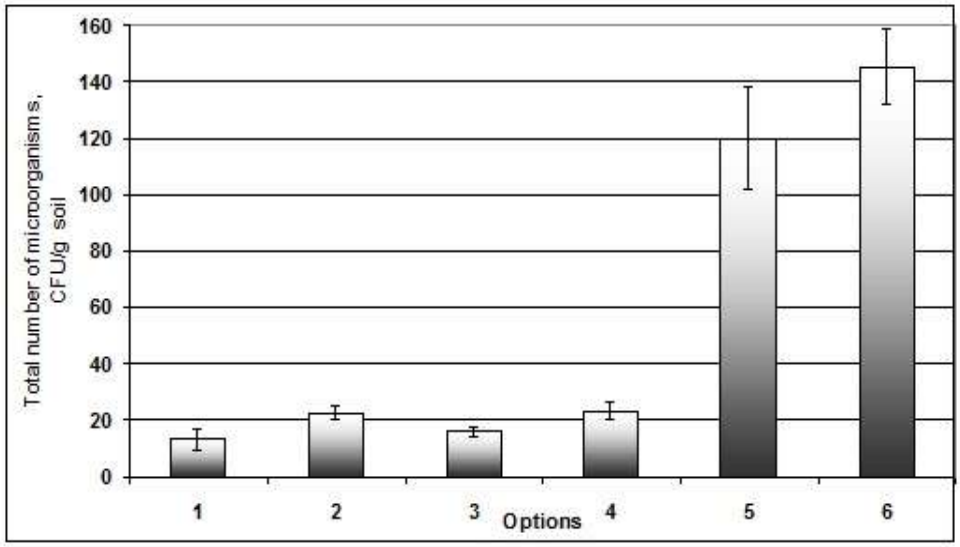


Fig. 5 Total number of microorganisms after the bioremediation procedures in oxic conditions

The increase in the number of microorganisms in all experimental variants, compared to the control, demonstrated the high effectiveness of treatments used. These include both microorganisms that have survived and / or adapted to the continuous action of pollutants, as well as forms at rest. In the control, naturally attenuated, the number of bacteria and micromycetes was much smaller and represented by microorganisms that adapted to the action of pesticides. In the experimental variants, the number of microorganisms was tens and even hundreds of times higher than in the control. The formation of a larger pool of microorganisms indicates the recovery of the soil.

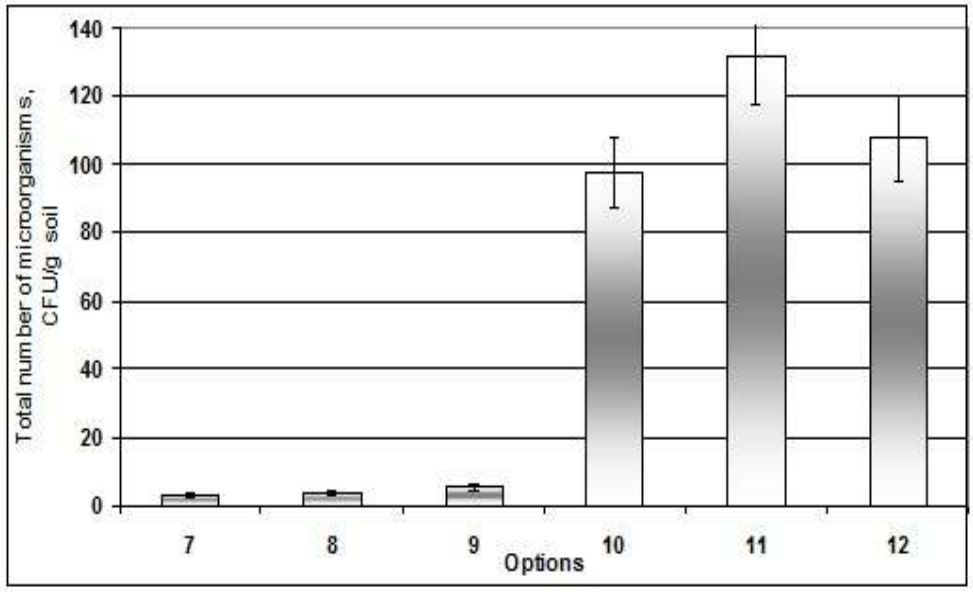


Fig. 6 Total number of microorganisms after the bioremediation procedures in anoxic and anoxic / oxic conditions

The number of microorganisms varies depending on the experimental variant. The most favorable conditions for the vital activity of microorganisms were created in the options maintained in cycled anaerobic / aerobic conditions, followed by phytoremediation.

Thus, the activation of microbial cenosis, the good growth of plants, along with the significant decrease of DDTs concentrations and practically the total elimination of trifluralin from the soil, prove the effectiveness of the bioremediation techniques used.

CONCLUSIONS

The main factor for the trifluralin decomposition in soil is anaerobic/facultative anaerobic soil microbiota, and its stimulation with nutrient supplements substantially improves trifluralin degradation.

Stimulation the indigenous microflora with phosphates and peptone in anoxic or anoxic/oxic conditions, followed by phytoremediation, can be used as a basic principle method in bioremediation of complex pollution.

In the case of integrated, complex pollution, phytoremediation, as an additional way of remediation, was important for the DDT degradation and the recovery of soil microflora.

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REFERENCES

1. **Antonious G.F., 2012 –** *On-farm Bioremediation of Dimethazone and Trifluralin Residues in Runoff Water from an Agricultural Field*. Journal of Environmental Science and Health, Part B, 47, p. 608-621.
2. **Bento F.M., Camargo F.A.O., Okeke B., Frankenberger Jr. W.T., 2003 –** *Bioremediation of Soil Contaminated by Diesel Oil.* Brazilian Journal of Microbiology, 34(1), p. 65-68.
3. **Guatam S., Sumathi S., 2006 –** *Dechlorynation of DDT, DDD and DDE in Soil (Slurry) Phase Using Magnesium / Palladium System*. Journal of Colloid and Interface Science, 304(1), p. 144-151.
4. **Kantachote D., Singleton I., Naidu R., Mcclure N., Mecharaj M., 2004 –** *Sodium Application Enhances DDT Transformation in a Long-term Contamined Soil*. Water, Air & Soil Pollution, 154, p. 115-125.
5. **Lazări I., Vasilos A., Socoliuc P. et al,. 2000 –** *Metode de determinare a reziduurilor pesticidelor în produsele alimentare, furajere şi mediul înconjurător: Îndrumar*. Vol I. Chişinău, 496 p.
6. **Matsumoto E., Kawanaka Z., Zun S., 2009 –** *Bioremediation of the Organochlorine Pesticides, Dieldrin and Endrin, and their Occurrence in the Environment.* Applied Microbiology and Biotechnology, 84, p. 205-216.
7. **Phillips T., Lee H., Trevors J.T., Seech A.G., 2004 –** *Mineralization of Hexachlorocyclohexane in Soil During Solid-phase Bioremediation.* Journal of Industrial Microbiology & Biotechnology, 31, p. 216-222.
8. **Pleşca V., Barbărasă I., Cupcea L., Marduhaeva L., 2008 –** *Poluanții organici persistenți în Republica Moldova: probleme, abordări, soluții, realizări*. Mediul Ambiant, 5(41), p. 16-19.
9. **Rastimesina I., Postolachi O., Tolocichina S., Cincilei A., 2016 –** *Procedee microbiologice de remediere a solurilor poluate cu pesticide.* Potențialul Microbiologic pentru Agricultura Durabilă. Autor-coord. S. Corcimaru. Ch.: Ştiința, p. 67-105.
10. **Sasek V., Glaser J.A., Baveye P., 2003 –** *The Utilization of Bioremediation to Reduce Soil Contamination: Problems and Solutions.* NATO Science Series IV: Earth and Environmental Sciences, 19, Springer Nature, 417 p.
11. **Schinner, F, Ohlinger, R, Kandeler, E, Margesin, R. eds., 1996 –** *Methods in Soil Biology*. Ed. Springer-Verlag, Berlin, p. 7-11.
12. **Tor J.M., Xu C., Stucki J.M., Wander M., Sims G.K., 2000 –** *Trifluralin Degradation under Microbiologically Induced Nitrate and Fe(III) Reducing Conditions*. Environmental Science & Technology, *34 (15), p. 3148–3152.*
13. **Van Liedekerke M., Prokop G., Rabl-Berger S., Kibblewhite M., Louwagie G., 2014 –** *Progress in the Management of Contaminated Sites in Europe*. JRC Reference Reports. Luxembourg: Publications Office of the European Union. 64 p.
14. **Wang S., Arnold W.A., 2003 –** *Abiotic Reduction of Dinitroaniline Herbicides*. Water Research, 37(17), p. 4191-201.
15. **Zhao Y.C., Yi X.Y., Zhang M., Liu L., Ma W.J., 2010 –** *Fundamental Study of Degradation of Dichlorodiphenyltrichloroethane in Soil by Laccase from White Rot Fungi* International Journal of Environmental Science & Technology, 7, p. 359-366.
16. *****, 2020 –** *Anuarul IPM – 2019 „Protecț ia mediului în Republica Moldova”*, Pontos, Chisinau, 500 p.

17. *, 2011 –** *State of the Environment in the Republic of Moldova, 2007-2010 (National Report – Synthesis)*. Editura "Nova Imprim" SRL, Chisinau, p. 88.

18. *, 2007 –** *Trifluralin. Dossier Prepared in Support of a Proposal of Trifluralin to be Considered as a Candidate for Inclusion in the Annex I to the Protocol to the 1979 Convention on Long Range Transboundary Air Pollution on Persistent Organic Pollutants (LRTAP Protocol on POPs)*. European Commission. DG Environment, Brussels, 29 p.

STUDY REGARDING THE APPRAISAL OF HONEY POTENTIAL FROM THE AREA OF VICTORIA COMMUNE, IAŞI COUNTY

STUDIU PRIVIND ESTIMAREA POTENȚIALULUI MELIFER DIN AREALUL COMUNEI VICTORIA, JUDEȚUL IAŞI

DOLIŞ M.G. [1]***, CHELARIU Elena Liliana***[1]***, AVARVAREI B.V.***[1]***, PÂNZARU Claudia***[1]*****

*Corresponding author e-mail: panzaruclaudia@yahoo.com

Abstract. *The current paper represents a study accomplished on the territory of Victoria commune, in Iaşi County, to estimate the honey potential of the area. The results showed that here lives a spontaneous, diversified and cultivated flora, among which exist also species of honey interest (acacia, linden, rapeseed, sunflower etc.); they can provide up to 333 tons of honey, which would ensure conditions for the maintenance of 2797 stationary bee families. The area can also assure good conditions for capitalizing on the honey potential by pastoral beekeeping, especially for acacia harvesting, where could be moved up to 15200 hives.*
Key words: potential, honey, hives, bees, plants

Rezumat. *Prezenta lucrare reprezintă un studiu efectuat pe teritoriul comunei Victoria, din județul Iaşi, cu scopul estimării potențialului melifer din zonă. Rezultatele au arătat faptul că în acest areal se găseşte o floră spontană, diversificată şi cultivată, în cadrul căreia există specii de interes melifer (salcâm, tei, rapiță, floarea soarelui etc.); acestea pot furniza până la 333 tone de miere, ceea ce ar oferi condiții pentru întreținerea unui număr de până la 2797 familii de albine staționare. De asemenea, zona poate oferi condiții bune pentru valorificarea potențialului melifer prin stupărit pastoral, în special pentru culesul de la salcâm, unde ar putea fi deplasați până la 15200 de stupi.*
Cuvinte cheie: potențial, melifer, stupi, albine, plante

INTRODUCTION

Romania benefits of an enviable honey potential, respectively a very varied honey flora, represented by species, which bloom from March to October and which ensure both maintenance and production harvests.

To capitalize on these harvests, beekeepers need detailed information about honey sources in different parts of the country, to apply the most convenient options. Thus, depending on many factors to consider (number and strength of bee families, an estimated amount of honey to be obtained, the distance of transport and cost of fuel, etc.), many beekeepers consider it profitable to move

[1]University of Agricultural Sciences and Veterinary Medicine from Iasi, Romania

beekeepers in pastoral to some massive in the country, while for others it's more profitable to capitalize on the local harvest.

Knowledge of the honey base in a given area, including the exact flowering period of plant species of apicultural interest, as well as harvesting gaps, is a very important element for the application of intensive, cost-effective beekeeping, which is why this topic made and still does, the object of studies and research. (Balana *et al.*, 1983; Cîrnu and Hociotă, 1973; Cîrnu, 1980; Doliş *et al.*, 2013; Lazăr and Doliş, 1999; Lazăr *et al.*, 2006; Mănior and Hociotă, 1978; Şonea *et al.*, 2016).

MATERIAL AND METHOD

The researches were carried out in the area of Victoria commune, Iaşi County, which proved to be a suitable place, because it presents numerous species of honey interest, both spontaneous, at the level of meadows and forests, as well as cultivated, within agricultural lands.

The forest-steppe vegetation is characteristic of the northern area of the forest-steppe from the Moldavian Plateau, where species such as elm, hornbeam, linden, oak, cherry trees predominate, and also meadows formed by fescue associations.

The steppe vegetation is a continuation of the forest-steppe vegetation towards the lower altitudes, respectively along the valleys of the Jijia and Prut rivers.

The natural forest-steppe landscape has changed recently, as many areas of land have been introduced in the arable circuit, and the forest patches have undergone changes in terms of spontaneous vegetation (tab. 1).

Table 1

The categories of land use from Victoria commune, Iaşi County

Land use	Area (hectares)	% from the entire area
Arable land	3347	51.30
Pastures and hayfields	865	13.20
Vineyard	65	1.00
Forests	1274	19.60
Others	965	14.80
TOTAL	6516	100%

Source: County Department of Statistics, Iaşi

The 1274 ha of forest are under the administration of the National Forests Authority - ROMSILVA, respectively of the Iaşi Forest District, representing two production units, respectively PU V Medeleni and PU II Jijia. In turn, the production units (PU) consist of several development units (DU). Thus PU II Jijia is composed of 40 DUs, of which only 9 are of honey interest (DU 30-39), and PU V Medeleni consists of 50 DUs, of which only 18 are of honey interest (DU 22-34, 41, 42, 48, 51). DU 22, 41, 48, 42, 51 are declared nature reserves, in which there are many secular trees and different species of plants and flowers, unique in our country. To identify the species of honey interest, the plot and pedestrian descriptions are taken after the Development of the Iaşi Forest District and the data provided by the Agricultural Department within the Victoria Local Council were used, to which are added the data collected from field trips.

Knowing the areas occupied by the species of honey interest and the honey potential of each species (from the data presented by the literature), by multiplication,

it was possible to calculate the potential honey production of the studied area, of which only one third is conventionally taken into account, knowing that during a beekeeping season, bees can't capitalize more, due to unfavourable weather and competition from other insects. (Bura *et al.*, 2005; Lazăr, 2002; Lazăr and Doliş, 2004; Mărghitaş, 1997; Pătruică, 2013).

To determine the need for bee families to make the best use of the honey potential in the area, in conditions of stationary beekeeping, the determined harvestable potential must be divided by the amount of honey harvested by each bee family within one year. In this sense, it is known that an average family accumulates about 120-130 kg of honey, of which, for own consumption, approx. 90 kg, for the development of swarms 9-12 kg, and the remaining 20-30 kg is honey for human consumption.

In a pastoral beekeeping system, for the optimal use of the entire honey potential, depending on the local conditions, rules are established for each honey species, regarding a load of hives per hectare (Doliş *et al.*, 2013).

RESULTS AND DISCUSSIONS

Using the documentation provided by the Iaşi Forest District, as well as the data collected from field trips, it was possible to estimate the honey potential of the two production units, respectively PU II Jijia and PU V Medeleni (tab. 2 and tab. 3).

The forest area of Victoria commune offers a harvestable honey potential of approximately 310.76 tons, of which 283 tons (91%) can be obtained only from acacia. Thus acacia is the most important species of honey interest in the area, having both the highest honey potential (1 t/ha), but also the highest share in the forest structure (86.6% in PU II Jijia and 30% within PU V Medeleni).

The rest of the forest species are of less importance, both in terms of weight, honey potential, but also because that's more a source of manna than nectar.

Table 2

Honey potential establishment of PU II Jijia

Species	Forest structure (%)	Area (ha)	Mean production per hectare (kg)	Potential production (kg)	Harvestable production	
					kg	%
Linden	2.8	23.3	800	18640	6213	2.52
Locust	86.6	714.3	1000	714300	238100	96.71
Field maple	0.6	5.2	300	1560	520	0.21
Maple tree	1.9	15.2	150	2280	760	0.31
Cherry tree	0.1	0.7	30	21	7	0.00
Willow	0.7	5.5	100	550	183.3	0.07
Beech	3.5	28.7	20	574	191.3	0.08
Oak tree	2.7	22.6	20	452	150.7	0.06
Hardwood	1.1	10	20	200	66.7	0.03
TOTAL	100%	825.5	-	738577	246192	100

Table 3

Honey potential establishment of PU V Medeleni

Species	Forest structure (%)	Area (ha)	Mean production/ hectare (kg)	Potential production (kg)	Harvestable production	
					kg	%
Linden	9.2	41.1	800	32880	10960	16.97
Locust	30.0	134.8	1000	134800	44933	69.59
Field maple	9.5	42.7	300	12810	4270	6.61
Maple tree	4.3	19.3	150	2895	965	1.49
Cherry tree	0.5	2.3	30	69	23	0.04
Willow	17.0	76.2	100	7620	2540	3.93
Beech	8.1	36.3	20	726	242	0.37
Oak tree	19.3	86.5	20	1730	576	0.89
Hardwood	2.1	9.3	20	186	62	0.10
TOTAL	100	448.5	-	193716	64572	100

Based on the data provided by the Agricultural Department within the Victoria Local Council and those collected from field trips, it was possible to estimate the honey potential of the agricultural area in Victoria commune (approx. 22 tons). The calculations used average values of the areas occupied by different crops over the last 10 years and also included the area related to the village's surface (tab. 4).

Table 4

Honey potential establishment of PU II Jijia

Species	Area (ha)	Mean production/ hectare (kg)	Potential production (kg)	Harvestable production	
				kg	%
Sunflower	290	60	17400	5800	26.19
Pastures and hayfields	865	30	25950	8650	39.06
Rape	304	50	15200	5066.7	22.88
Vineyard	65	5	325	108.3	0.49
Village hearth, other lands and crops	756	10	7560	2520	11.38
TOTAL	2280	-	66435	22145	100

Thus, at the level of the entire studied area (3554 ha) the estimated harvestable honey potential is about 333 tons, of which 94% is provided by the forested area.

In the conditions of practicing a stationary hive, admitting a multiplication rate of bee families of 20% and a honey production of 20 kg, in the studied area could be maintained in optimal conditions about 2797 bee families.

Under the conditions of practicing a pastoral hive, the area could provide conditions for moving hives for acacia harvesting, in particular, but also harvesting linden, sunflower, and rapeseed (tab. 5).

Table 5

The optimal number of hives for the pastoral capitalization of the honey potential of Victoria commune

Species	Area (hectares)	Hives norm/hectare	Honey bee families	
			Min.	Max.
Rapeseed	304	2-3	608	912
Sunflower	290	1-2	290	580
Acacia	849.1	14-18	11887	15283
Linden	64.4	6-11	386	708

Obviously, the number of hives moved for pastoral care in the area will depend on the weather conditions and the number of bee families reared in a stationary system in the commune.

CONCLUSIONS

In the area of Victoria commune there are valuable honey species, such as acacia (849.1 ha), linden (64.4 hectares), rapeseed (304 hectares), and sunflower (290 hectares). The estimated harvestable honey potential in Victoria commune is approx. 332.909 kg. In conditions of stationary beekeeping, at a commodity production of 20 kg/family, the area allows the growth in optimal conditions up to 2.797 bee families.

In conditions of pastoral beekeeping, for the optimal capitalization of the honey potential, up to 15.283 hives for acacia harvesting (283.033 kg), 708 hives for lime harvesting (17.173 kg), 912 hives for rapeseed harvesting (5.066 kg), and 580 hives for sunflower harvesting (5.800 kg) can be brought to the area.

REFERENCES

1. **Balana I., Grosu Elena şi col., 1983** - *Studiul resurselor melifere şi zonarea producției apicole în România*. I.C.P.A. Bucureşti.
2. **Bura M. şi col., 2005** - *Tehnologia apicolă*. Editura Solness, Timişoara.
3. **Cîrnu L., Hociotă E., 1973** - *Baza meliferă şi polenizarea culturilor entomofile*. Editura Ceres, Bucureşti.
4. **Cîrnu I., 1980** - *Flora apicolă*. Editura Ceres, Bucureşti.
5. **Doliş M.G., Lazăr Şt., Nistor C.E., Şonea C., 2013** - *Study regarding the honey bearing potential given by forestry area of Casimcea Forestry District, Tulcea County. (Studiu privind potențialul melifer oferit de arealul forestier al ocolului silvic Casimcea, județul Tulcea)*. Lucrări ştiințifice, Seria Zootehnie, Editura „Ion Ionescu de la Brad", Iaşi.
6. **Lazăr Şt., Doliş M.G., 1999** - *Investigații privind determinarea resurselor şi a potențialului melifer din arealul ocolului silvic Ciurea Iaşi*. Lucrări ştiințifice vol. 41/42, Seria Zootehnie, Editura „Ion Ionescu de la Brad", Iaşi.
7. **Lazăr Şt., 2002** - *Bioecologie şi tehnologie apicolă*. Editura Alfa, Iaşi.
8. **Lazăr Şt., Doliş M., 2004** - *Apicultură practică*. Editura Alfa, Iaşi.
9. **Lazăr Şt., Doliş M., Vornicu O.C., Voicu P.M., Gîngă V., 2006** - *Estimarea potențialului melifer al arealului forestier din județul Iaşi.* Lucrări ştiințifice vol. 49, Seria Zootehnie, Editura „Ion Ionescu de la Brad", Iaşi.

10. Lazăr Şt., Vornicu O.C., 2007 - *Apicultură*. Editura Alfa, Iaşi.
11. Mănişor Maria, Hociotă Elena, 1978 - *Baza meliferă*. A.C.A. Redacția publicațiilor apicole, Bucureşti.
12. Mărghitaş L.A., 1997 - *Albinele şi produsele lor*. Editura Ceres. Bucureşti.
13. Pătruică S., 2013 - *Apicultură şi Sericicultură*. Editura EUROBIT, Timişoara.
14. Şonea C.G., Lazăr Şt., Iacob L., Viziteu C., Doliş M.G., Nistor C.E., 2016 - *Study regarding the honey-bearing potential of Miroslava village, Iaşi County*. Lucrări ştiințifice, Seria Zootehnie, Editura „Ion Ionescu de la Brad", Iaşi.

THE INFLUENCE OF DIFFERENT TYPES OF ECOLOGICAL FERTILIZERS ON THE AGROPRODUCTIVE CAPACITY OF FIVE TOMATO CULTIVARS

INFLUENȚA DIFERITELOR TIPURI DE FERTILIZANȚI ECOLOGICI ASUPRA CAPACITĂȚII AGROPRODUCTIVE LA CINCI CULTIVARE DE TOMATE

TELIBAN G.C.[1], STOLERU V.[1], MUNTEANU N.[1], STAN T.[1], RĂDEANU Georgiana[1], AGAPIE Alina Laura[2], MATACHE M.G.[3], POPA Lorena-Diana[4], VLĂDUȚ V.[3]*

[*]corresponding author e-mail: valentin_vladut@yahoo.com

Abstract. *The purpose of this paper is to evaluate the influence of the application of fertilizers allowed in organic farming to an assortment of autumn tomatoes. The research was conducted in the didactic and experimental field of the Vegetable growing discipline, at U.S.A.M.V. Iaşi. The experiment was of a bifactorial type, testing the influence of the cultivar with five graduations (Perra D`Abruzzo, Firmus F1, Raluca; Bilbo F1 and Rio Grande) and of the fertilization with three graduations (unfertilized, organic fertilization with Humic and the application of a product based on microorganisms, namely Micoseeds MB) under the conditions of the crop year 2019. The crop was established by seedlings of 45 days, in strips of two rows, the distance between the strips being 90 cm, and between rows, of 50 cm. The distance between plants in a row was 25 cm, resulting in a density of about 57 thousand plants per hectare. The results obtained demonstrate the efficiency of the products used, the yields obtained in the case of fertilized variants being higher compared to the non-fertilized variant, for all five cultivars used.*
Key words: cultivar, fertilization, yields, chlorophyll pigments.

Rezumat. *Scopul lucrării de față este de a evalua influența aplicării unor fertilizanți admişi în agricultura ecologică la un sortiment de tomate de toamnă. Cercetările au fost efectuate în câmpul didactic şi experimental al disciplinei de Legumicultură, U.S.A.M.V. Iaşi. Experiența a fost de tip bifactorial, fiind testată influența cultivarului cu cinci graduări (Perra D`Abruzzo, Firmus F1, Raluca; Bilbo F1 and Rio Grande) şi a fertilizării cu trei graduări (nefertilizat, fertilizare organică cu Humic şi aplicarea unui produs pe bază de microorganisme, respectiv Micoseeds MB) în condițiile anului agricol 2019. Cultura a fost înființată prin răsad de 55 de zile, în benzi de câte două rânduri, distanța dintre benzi fiind de 90 cm, iar dintre rânduri de 50 cm. Distanța dintre plante pe rând a fost de 25 cm, rezultând o densitate de aproximativ 57 mii plante pe hectar. Rezultatele obținute demonstrează eficiența produselor*

[1]University of Agricultural Sciences and Veterinary Medicine of Iasi, Romania
[2]Agricultural Research and Development Station Lovrin-Timis, Romania
[3]INMA Bucharest, Romania
[4]Agricultural Research and Development Station Secuieni-Neamt, Romania

utilizate, producțiile obținute în cazul variantelor fertilizate fiind mai ridicate comparativ cu varianta nefertilizată, pentru toate cele cinci cultivare utilizate.
Cuvinte cheie: cultivar, fertilizare, producții, pigmenți clorofilieni

INTRODUCTION

The tomato crop ranks first in terms of cultivation area and yield, both in our country and in the world. Among the most important factors that ensure the productivity of a crop, the judicious choice of cultivar (variety) and fertilization play a significant role in achieving this goal.

The use of synthetic chemicals has a significant effect of increasing yield, but it has been found that these substances can endanger human health (Caruso *et al*., 2019a).

The success of a tomato crop, managed according to the principles of organic farming, depends on the adequate supply of water and nutrients (Babik and Elkner, 2002; De Oliveira *et al*., 2016), specific fertilizations applied at key moments contributing substantially to high yields. Nowadays, the range of fertilizers that can be applied is very diverse, and its choice can make it difficult for the organic vegetable farmer, especially since some products contain different amino acids or different microorganisms useful for organic farming.

Under these circumstances, the purpose of this research is to evaluate the influence of fertilization on five autumn tomato crops, managed according to the rules of organic farming.

MATERIALS AND METHOD

The research was carried out under the experimental conditions of the year 2019, at the Didactic Station of U.S.A.M.V. Iaşi, the V. Adamachi Horticultural Farm, "Ion Ionescu de la Brad" University of Agricultural Sciences and Veterinary Medicine of Iaşi. The experiment was organized on a medium leached chernozem soil type, with a medium supply of nutrients, with 3% organic matter (Teliban *et al*., 2020) and pH = 6.5. The meteorological conditions in the experimental period were moderately favorable for this species.

The experimental protocol dictated the organization of a bifactorial experiment organized in the form of subdivided plots, with three repetitions, in which the influence of two experimental factors, the cultivar and fertilization, was studied, on an autumn tomato crop:

Factor A – the Cultivar, with five graduations: a_1 = Perra D`Abruzzo, a_2 = Firmus F1, a_3 = Raluca; a_4 = Bilbo F1 and a_5 = Rio Grande F1;

Factor B – the fertilization of the crop with three graduations: b_1 = unfertilized variant, b_2 = fertilization with Humic (12 l/ha) and b_3 = application of microorganisms, where Micoseeds MB was used (80 kg/ha).

The tomato crop was established using seedlings of 45 days, on June 1st, in strips of 2 rows, the distance between the strips being 90 cm, and between rows, of 50 cm. The distance between plants in a row was 25 cm, resulting in a density of about 57 thousand plants / hectare. The works carried out during the vegetation period were those recommended by the literature (Munteanu, 2003) and consisted mainly of drip irrigation, weed control and fertilization carried out in two installments, in

the doses appropriate for each type of fertilizer. The first fertilization was carried out 15 days after planting, and the second one in the phase of formation of the first fruits.

In order to determine the influence of fertilization on the five tomato crops studied, the determinations performed were focused on evaluating the yield resulted from each experimental plot and on determining the total chlorophyll pigment content, which was done before harvest, using the CCM-200 plus (Chlorophyll Content Meter).

The experimental data was processed by appropriate statistical-mathematical methods (Jitareanu, 1999; Leonte and Simioniuc, 2018). The least significant differences (LSD) test was used for the yields, and the Tukey test for chlorophyll content (Caruso *et al*., 2019b).

RESULTS AND DISCUSSIONS

The yields obtained according to the first factor studied – the cultivar - are presented in table 1. They varied from 38.0 t/ha, yield obtained by the Perra D'Abruzzo cultivar, up to 50.0 t/ha in the case of the Firmus F1 cultivar.

In the case of the Firmus F1 cultivar, distinctly significant positive differences were obtained compared to the Rio Grande cultivar taken as a control, namely a difference of 10.13%. The Bilbo variety also recorded a 5.07% yield increase, which is considered to be statistically significant.

Very significant negative differences compared to the control were obtained in the case of the Perra D'Abruzzo cultivar. The Raluca cultivar registered distinctly significant negative differences.

Table 1

Results obtained regarding the influence of cultivar on the tomato yield

No.	Cultivar	Yield			Difference significance
		t/ha	% compared to the Control	Difference compared to the Control	
1.	Perra D`Abruzzo	38.0	83.70	-7.14	ooo
2.	Firmus F1	50.0	110.13	4.6	**
3.	Raluca	40.6	89.43	-4.8	oo
4.	Bilbo F1	47.7	105.07	2.3	**
5.	Rio Grande F1	45.4	100	0.0	C

LSD 5% = 2.3 t/ha; LSD 1% = 3.4 t/ha; LSD 0.1% = 5.1 t/ha

The yields obtained in the case of the fertilization regime varied from 39.2 t/ha in the unfertilized graduation, to 47.9 t/ha, at the Micoseeds MB graduation. There was a yield difference of 2.0 t/ha between Micoseeds MB and Humic graduations (tab. 2).

For the Humic and Micoseeds MB variants, the yield increases recorded were very significantly positive compared to the unfertilized control. These exceeded the control of the experiment by 17.9% in the case of the variant

fertilized with Humic, respectively by 22.19%, in the case of the application of microorganisms, namely Micoseeds MB. This demonstrates that fertilization has had a positive influence on yield.

Table 2

Results obtained regarding the influence of fertilization on the tomato yield

No.	Treatment	Yield			Difference significance
		t/ha	% compared to the Control	Difference compared to the Control	
1.	Unfertilized	39.2	100	0.0	C
2.	Humic	45.9	117.09	6.7	***
3.	Micoseeds MB	47.9	122.19	8.7	***

LSD 5% = 3.1 t/ha; LSD 1% = 4.2 t/ha; LSD 0.1% = 5.6 t/ha

The fertilization carried out with Micoseeds MB had a strong influence on the yield, registering a difference of 8.7 t/ha compared to the control. Also, in the case of the fertilization with Humic, the difference compared to the control was of 6.7 t/ha.

The yield results determined by the graduations between the combinations of the two factors, cultivar and fertilization regime, are presented in table 3.

Table 3

Results regarding the influence of the cultivar x fertilization combination on the tomato yield

No.	Variant	Yield			Difference significance
		t/ha	% compared to the Ct	Difference compared to the Ct	
1.	Perra D`Abruzzo x unfertilized	32.8	84.32	-6.1	-
2.	Perra D`Abruzzo x Humic	38.9	100	0.0	-
3.	Perra D`Abruzzo x Micoseeds MB	42.4	109.00	3.5	-
4.	Firmus F1 x unfertilized	45.7	117.48	6.8	-
5.	Firmus F1 x Humic	51.7	132.90	12.8	***
6.	Firmus F1 x Micoseeds MB	52.7	135.48	13.8	***
7.	Raluca x unfertilized	34.6	88.95	-4.3	-
8.	Raluca x Humic	43.2	111.05	4.3	-
9.	Raluca x Micoseeds MB	44.1	113.37	5.2	-
10.	Bilbo F1 x unfertilized	44.0	113.1	5.1	-
11.	Bilbo F1 x Humic	48.6	124.94	9.7	**
12.	Bilbo F1 x Micoseeds MB	50.4	129.56	11.5	**
13.	Rio Grande F1 x unfertilized	38.9	100	0.0	C
14.	Rio Grande F1 x Humic	47.2	121.34	8.3	*
15.	Rio Grande F1 x Micoseeds MB	50.0	128.53	11.1	**

LSD 5% = 6.8 t/ha; LSD 1% = 9.3 t/ha; LSD 0.1% = 12.6 t/ha

The yields resulted in this case ranged from 32.8 t/ha (Perra D'Abruzzo x unfertilized) to 52.7 t/ha (Firmus F1 x Micoseeds MB), while the control of the experiment recorded a yield of 38.9 t/ha.

Following the combination of the two factors, cultivar and fertilization, very significant positive differences were highlighted in the case of the combination: Firmus F1 x Humic and Firmus F1 x Micoseeds MB with an increase compared to the control of 32.9% and 35.48%, respectively. There were also distinctly significant positive differences in the case of Bilbo F1 x Micoseeds MB, Rio Grande x Micoseeds MB and Bilbo F1 x Humic, thus resulting in increases of 29.56%, 28.53% and 24.94%, respectively. The Rio Grande x Humic variant obtained a significant positive difference compared to the control, with an increase of 21.34%. Results with values below the control of the experiment were recorded by the variants Perra D'Abruzzo x unfertilized and Raluca x unfertilized with 15.68% and 11.05%, respectively.

Following the combination of the two factors, cultivar and fertilization regime, the best results were obtained with the Firmus F1 hybrid fertilized with Micoseeds MB and with Humic, and the lowest yield was obtained with the Perra D'Abruzzo x unfertilized cultivar.

The chlorophyll pigments content, determined with the portable device CCM 200 plus, varied within quite large limits, from 9.1 CCI (Raluca x Humic) to 24.6 CCI (Bilbo F1 x Micoseeds MB).

In the case of the Bilbo and Firmus cultivars, the content of chlorophyll pigments was the highest for all the graduations of the fertilization factor, this correlating positively with the high yields obtained in the case of these two combinations. A low content of assimilating pigments was recorded by the Raluca variety and in this case the yields obtained were relatively small (fig. 1).

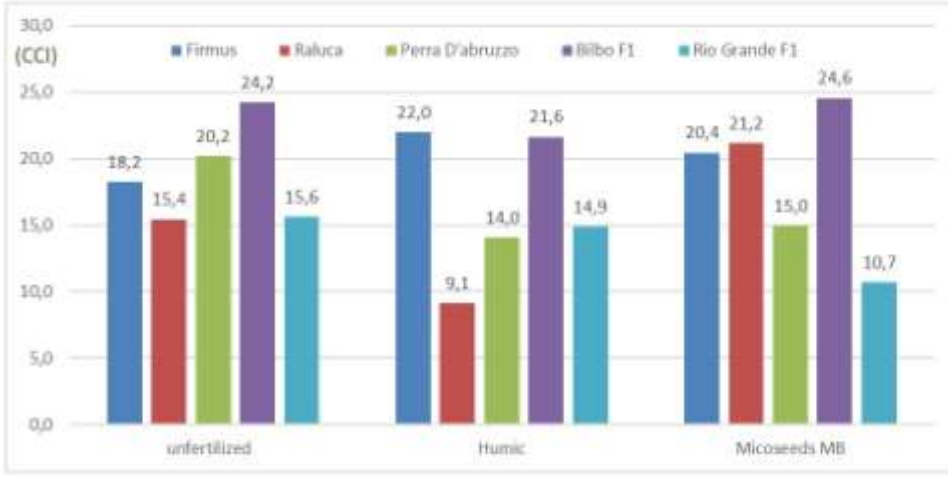

Fig. 1 The content of assimilating pigments
for the combination of variety x fertilization factors

CONCLUSIONS

1. The highest yields for the autumn tomato crop were registered by the hybrids Bilbo F1 and Firmus F1, which recorded distinctly significant yield increases compared to the control of the experiment, namely Rio Grande.

2. The results obtained demonstrate the efficiency of the products used, the yields obtained in the case of fertilized variants being higher compared to the unfertilized variant, for all five cultivars used.

REFERENCES

1. **Babik I., Elkner K., 2002 –** *The effect of nitrogen fertilization and irrigation on yield and quality of broccoli*. Acta Horticulturae, Issue 571, pp. 33-43. Doi: 10.17660/ActaHortic.2002.571.2
2. **Caruso G., Stoleru V., Munteanu N., Sellitto V.M., Teliban G.C., Burducea M., Ţenu I., Morano G., Butnariu M., 2019a** – *Quality Performances of Sweet Pepper under Farming Management*. Notulae Botanicae Horti Agrobotanici, Cluj-Napoca, vol. 47, No: 2, pp. 458-464. DOI:10.15835/nbha47111351.
3. **Caruso G., De Pascale Stefania, Cozzolino E., Cuciniello A., Cenvinzo V., Bonini P., Colla G., Rouphael Y., 2019b** – *Yield and Nutritional Quality of Vesuvian Piennolo Tomato PDO as Affected by Farming System and Biostimulant Application*. Agronomy, 9, 505; doi:10.3390/agronomy9090505.
4. **De Oliveira F.C., Geisenhoff L.O., Almeida A.C.D., De Lima J.A., Lavanholi R., 2016 –** *Economic feasibility of irrigation systems in broccoli crop*. Engenharia Agricola, vol. 36, Issue 3, pp. 460-468. https://doi.org/10.1590/1809-4430-Eng.Agric.v36n3p460-468/2016.
5. **Jităreanu G., 1999 –** *Agricultural experimental technique*. Ed. „Ion Ionescu de la Brad", Iasi.
6. **Leonte C., Simioniuc Violeta, 2018 –** *Metode şi tehnici utilizate în cercetarea agronomică (Methods and techniques used in agronomic research).* Ed. „Ion Ionescu de la Brad", Iaşi.
7. **Munteanu N.**, **2003** – *Tomatele, ardeii şi pătlăgelele vinete (Tomatoes, peppers and eggplants)*. Ed. „Ion Ionescu de la Brad" Iasi.
8. **Stan N., Munteanu N., 2003 –** *Legumicultură (Vegetable growing), vol. II*. Ed. „Ion Ionescu de la Brad" Iasi.
9. **Teliban G.C., Stoleru V., Burducea M., Lobiuc A., Munteanu N., Popa Lorena-Diana, Caruso G., 2020** – *Biochemical, physiological and yield characteristics of red basil as affected by cultivar and fertilization*. Agriculture, 10(2), 48. https://doi.org/10.3390/agriculture10020048.

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