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# POLYETHYLENE MULCHING EFFECTS ON SOIL PROPERTIES AND PHYSIOLOGICAL TRAITS IN TOMATO UNDER ECOLOGICAL CROP TECHNOLOGY

**Ligia ACATRINEI[1], Feodor FILIPOV [2]**

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**Abstract**

The aim of this study is to assess the influence of covering with black polyethylene mulch on soil properties and also over plant physiological behavior. Analyzed gas-exchange parameters were: soil net $CO_2$ exchange rate (NCER), soil respiration (Ce) and water humidity (W flux) as soil indicators and photosynthetic rate, transpiration, and stomatal conductance and also sugars leaf content as plant physiological indicators.

Plant material was Prekos tomato variety cultivated in protected organic system at The Vegetable Research and Development Station Bacau (SCDL Bacău). Our analysis showed that black plastic mulch on the soil surface favored soil compaction especially on the space between tomato plant rows. The strong soil compactness state was reflected by the high bulk density values and other indicators as smooth soil surface and the cracks networks. In variant with no black plastic cover, soil gas-exchange showed that net $CO_2$ exchange rate of was 7.94 µmol $m^{-2}s^{-1}$ and soil $CO_2$ flux as soil respiration was 77.4 µmol $m^{-2}s^{-1}$ both higher in comparison with black polyethylene covering variant. In variant with black plastic cover because of higher soil moisture under polyethylene the water flux between air and soil are increased. Photosynthesis registered a slight increase, having the value of 10 µmol $m^{-2}s^{-1}$ in flowering phenophase (June) and about 11 µmol $m^{-2}s^{-1}$ in ripening phenophase (July) in uncovered with polyethylene variant. During the studied period, the variant uncovered with black plastic (polyethylene) registered a small variation of the photosynthesis rate but a higher mean value than covered variant. Covered variant registered a higher value in the flowering phenophase and a smaller value in ripening stage.

**Key words**: polyethylene much, Prekos tomato variety, soil respiration, photosynthesis, sugar leaf

The use of plastics -- to cover greenhouses and high tunnels, as row covers, and for soil mulches – revaluated the horticultural practices. There is a wide variety of plastic mulch on the market that can reflect, absorb or transmit sunlight. Black plastic mulch increases soil temperatures about 5ºC at a depth of 2 inches compared to bare ground. Clear mulch is the most transparent to infrared radiation and warms the soil to the greatest extent of all plastic mulches, increasing daytime soil temperatures from about 7ºC to 13ºC at a depth of 2 inches. Infra-Red Transmitting (IRT) mulches warm the soil as intermediary between clear and black mulch. Highly reflective plastic mulches repel certain aphids. The main benefits of using plastic mulch include: increasing soil temperature, decreasing of water loss by direct evaporation, increased yield, reduced nutrient leaching and improved nutrient uptake, getting early production, ensure full control of weeds, ensure maintenance of a lower water content in soils from zone with high rainfall (Kasirajan S., Mathieu N., 2012).

Managing growth and development of an entire crop for optimum production involves the manipulation of environmental condition to obtain not only the maximum rate of photosynthesis under the given light conditions, but also the optimum balance of vegetative and generative growth of plants for sustained production and high yields (Portree J., 1996). The flux of $CO_2$ emitted from the soil surface to the atmosphere mainly originates from the respiration of roots as well as decomposition of root parts, soil organic matter and plant litter and is frequently used as an indicator of the "health" of that soil. Soil management practices, such as tillage intensity and method, the type of fertilizer used can have a great effect on $CO_2$ emissions. Some factors, which alter the resource availability, can be anticipated to influence carbohydrate partitioning in plants. The primary end products of photosynthesis are triose phosphates, which are rearranged into glucose-6-phosphate and used for the formation of starch as storage molecules or transported into the cytosol to form sucrose. In the source leaves, sucrose can be

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metabolized to its hexose products (i.e. glucosis and fructosis), it can be stored in the vacuole, or it can be transported through the phloem to the sink tissues (Osorio S. *et al*, 2014).

Sucrose as disaccharides compound is relatively a stable molecule (it is transported between different plant organs and even stored for long periods) when compared with monosaccharides, which are promptly metabolized and are seldom transported between cells or accumulated.

Our investigations concern to the influence of black plastic mulch on soil properties and on the physiological parameters in Prekos tomato variety cultivated in protected spaces under organic technology.

## MATERIAL AND METHOD

The experimental design deployed soil chambers connected to an infra-red $CO_2$ gas analyzer. Physiological features analyzed by portable photosynthesis system (LCi, ADC Bioscientific) were such as: photosynthetic rate (µmol $CO_2$ $m^{-2}$ $s^{-1}$), transpiration (mmol $H_2O$ $m^{-2}$ $s^{-1}$), and stomatal conductance (mmol $m^{-2}$ $s^{-1}$). The representative soil type is Cambic Cernozem after Romanian System of Soil Taxonomy or Haplic Chernozems after WRBS. The physio-chemical properties of investigated soil were represented in tables below (*table 1, table 2*).

Table 1

**Soil size particle of the Cambic Cernozems**

| Depth cm | Size particle (%) | | | | Texture |
|---|---|---|---|---|---|
| | 0.2÷2 mm | 0.02÷ 0.2mm | 0.02÷ 0.002mm | <0.002 mm | |
| 0-25 | 0.5 | 44.6 | 27.2 | 27.7 | Medium loam |
| 20-33 | 0.8 | 43.1 | 30.6 | 25.5 | |
| 33-56 | 0.7 | 45.6 | 29.5 | 24.2 | |
| 56-90 | 1.0 | 50.8 | 26.9 | 21.3 | |

Table 2

**The characteristics of analyzed soils**

| Depth cm | $BD_r$[1)] g/cm$^3$ | $BD_{pr}$[2)] g/cm$^3$ | $BD_{ipr}$[3)] g/cm$^3$ | $PD_{ipr}$[4)] g/cm$^3$ | $PD_{ipr}$[5)] g/cm$^3$ |
|---|---|---|---|---|---|
| 0-5 | 1.34 | 1.23 | 1.44 | 1.48 | 1.69 |
| 10-15 | 1.34 | 1.21 | 1.42 | 1.46 | 1.67 |
| 20-25 | 1.34 | 1.49 | 1.52 | 1.74 | 1.77 |
| 30-35 | 1.36 | 1.53 | 1.55 | 1.76 | 1.79 |
| 40-45 | 1.36 | 1.48 | 1.50 | 1.71 | 1.73 |

[1)]Bulk density of restricting rooting; [2)] Bulk density the plants rows areal;[3)] Bulk density on the interval between plants rows; [4)] Packing density on the plant rows [5)] Packing density of soil from middle interval between plants rows

Plant material consists by young leaf, exposed in sun. It was analysed two variants: soil covered with black plastic polyethylene and un uncovered variant at the experimental design placed in The Vegetable Research and Development Station Bacau. Samples from Prekos tomato variety cultivated in protected organic system, were collected on June (in flowering phenophase) and July (in ripening phenophase) 2008.

Sugars leaf analysis of dried plant material was extracted by Bertrand method combined with method Borel. Results were expressed as g % of dry matter. Measurements of soil gas-exchange parameters regarding soil respiration (Ce), water flux (W flux) and net $CO_2$ exchange rate (NCER) were undertaken with a soil chamber of portable photosynthesis system.

## RESULTS AND DISCUSSIONS

Soil gas-exchange showed that net $CO_2$ exchange rate (NCER) of 7.94 µmol $m^{-2}s^{-1}$ and soil respiration (Ce) of 77.4 µmol $m^{-2}s^{-1}$ are both higher in variant of which are not covered with black plastic mulch in comparison with values obtained at variant covered with black plastic mulch. Black plastic polyethylene variant registered a light smaller value of 73.85 µmol $m^{-2}s^{-1}$ for soil respiration and a value of 7.58 µmol $m^{-2}s^{-1}$ for net $CO_2$ exchange rate (NCER) (*figure 1*).

These higher values of soil respiration and respectively, soil efflux exchange rate for $CO_2$ (NCER) are implying of an increases of micro-organisms activity in case of uncovered soil with plastic mulch. In covered variant with black plastic was observed the increasing of soil moisture represented by the W flux (vapors) of water between air and soil (*figure 1*). In generally, the highest $CO_2$ exchange rate was registered in organically managed fields, because of using organic amendments like manure, crop residues (Acatrinei L., Călugăr A., 2010, Feizienė *et. al*, 2008).

The analyzed soil has a medium loam texture. The content of clay ranged in depth between 21.3 to 27.7% at particle < 0.002 %. The values of bulk density of restricting rooting for soil with medium loam texture, has a low amplitude and ranged between 1.34 g/cm$^3$ and 1.36 g/cm$^3$ (Filipov F., 2013). Soil layers under ploughed layer have values of bulk density higher than density of restricting rooting. Values of packing density ranged between 1.46 g/cm$^3$ up to 1.79 g/cm$^3$. Limit packing density value of 1.4 g/cm$^3$ separate non-compacted soil and moderately compacted soil from strong compacted (1.79 g/cm$^3$). Compactness state of soil from plants rows is not uniform, small surfaces with low compact soil alternated with those in which the soil is moderately compact. Local soil compaction on plant lines is due to frequently pressure for performing agricultural work and repeated harvesting tomatoes (Filipov F. *et al*, 2001).

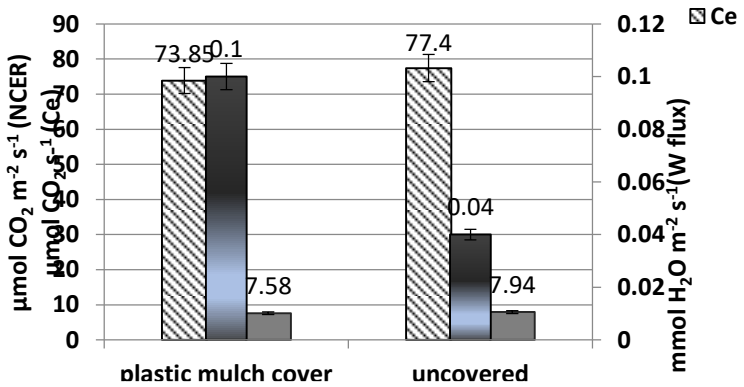



Figure 1 **Variation of soil net $CO_2$ exchange rate (NCER), soil respiration (Ce) and Water flux exchange (W flux) in analyzed variants**

Another negative effect is due to deficiency of carbon dioxide exchange from air to soil on dry and warm days, and to the soil gradually compacted among plants rows and to the moderately to strong compacted soil under ploughed horizon. The negative influence of black plastic mulch on soil quality can easily be noticed after harvesting and removing the plants debris and the black foil. Strong compaction of the soil between the plant rows is evidenced by the decrease of the surface land level after diminishing of soil porosity. Another morphological indicator of the compact soil is the smooth surface without any roughness. As a result of gradual drying of the soil between the plants rows a network of cracks is developed.

In condition which the soil was not covered with polyethylene mulch, plant gas exchange parameters have increased from flowering stage to ripening stage of Prekos tomato variety. Thus, photosynthesis rate showed the value of 10 µmol $m^{-2}s^{-1}$ in flowering phenophase (June) and about 11 µmol $m^{-2}s^{-1}$ in ripening phenophase (July). Transpiration registered a smaller variation during analyzed period, the value was 2.82 mmol $m^{-2}s^{-1}$ in June and 3.2 mmol $m^{-2}s^{-1}$ in July. Stomatal conductance with a value of 1 mmol $m^{-2}s^{-1}$ in June which was 5 times higher than that registered in June of 0.2 mmol $m^{-2}s^{-1}$ was increased at once with transpiration (*figure 2*). Stomatal behavior, generally, controls the volume of $CO_2$ entering the intercellular air spaces of the leaf for photosynthesis, playing a key role in water lost through transpiration. Some climate factors from polytunnels such as air temperature, $CO_2$ concentration, photoperiod, radiation level, relative humidity, diurnal fluctuations in water potential (moisture extremes) can affect physiological behavior of plant from protected spaces (solariums and greenhouses). Some investigations revealed that the black plastic mulch could induces in hot summer days some physiological disturbance easily seen by farmers as rolled leaves of tomatoes (Barden *et al*, 1987).

In condition with black polyethylene mulch, photosynthesis rate was higher in June when registered a value of 13 µmol $m^{-2}s^{-1}$ than that registered in July which was approximative 6 µmol $m^{-2}s^{-1}$. The transpiration was registered close value in both analyzed months, around 3.5 mmol $m^{-2}m^{-1}$. Stomatal conductance registered on July a value of 0.45 mmol $m^{-2}s^{-1}$, being almost two-folded than value of 0.21 mmol $m^{-2}s^{-1}$ registered on June (*figure 3*). In previous work we observed that an increasing of internal concentration of $CO_2$ (Ci) in gas-exchange chamber and apparition of photorespiration in tomato variety due to stomatal closure.

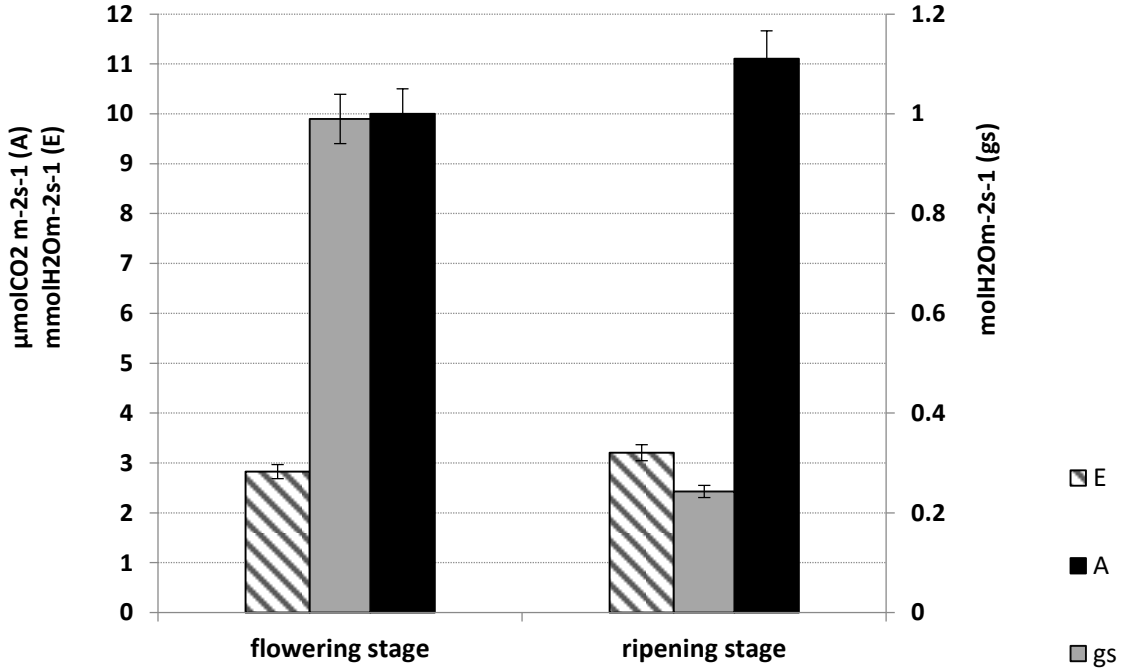



Figure 2 **Graphic representation of gas-exchange parameters (A-photosynthesis rate, E-transpiration, gs - stomatal conductance) in Prekos tomato in uncovered black polyethylene variant**

Fast rate of photosynthesis in early morning increased the accumulation of carbohydrates in tomato leaves is followed by the apparition of photorespiration process observed later in the morning (Acatrinei L., 2009, 2010). It was observed that delaying ventilation in greenhouses to conserve $CO_2$ resulted in higher temperatures over 30 °C. It well known that in higher temperatures (over 25°C), net photosynthesis begins to decline and the supplementation of $CO_2$ above this temperature is not considered rentable. Hence, the reduction of transpiration may cause insufficient cooling, and heat damage to the leaves under conditions of intense light (Nederhoff E.M., 1988).

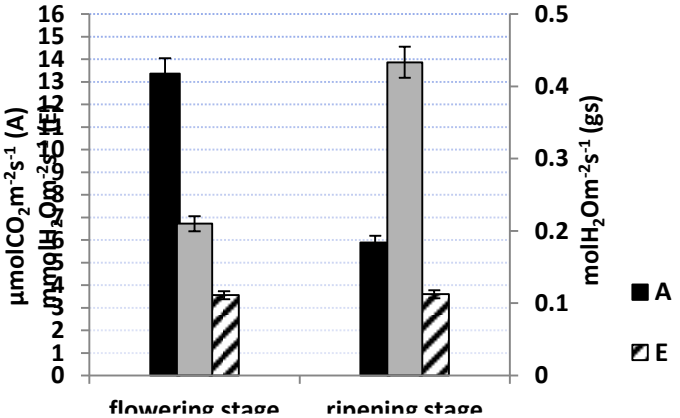



Figure 3 **Graphic representation of gas-exchange parameters (A-photosynthesis rate, E-transpiration, gs - stomatal conductance) in tomato varieties in condition with black polyethylene mulch**

In young plants, carbon dioxide may increase sugar translocation in the roots and movement of nitrogen towards the development of new roots. Carbohydrates are accumulated in the vegetative or early reproductive phase (Osorio S. *et al*, 2014). Sugars leaf registered different accumulation in analyzed plots. During studied vegetation stage, the accumulation of carbohydrates increased and thus, on July was registered higher amount of mono-, di- and polysaccharides on each analyzed variant (with black polyethylene mulch and without black polyethylene mulch) (*figure 4*). In variant with black polyethylene mulch, were observed a reduced the accumulation of monosaccharides in June and respectively, in polysaccharides on July than in variant without black polyethylene mulch. Increased disaccharides in ripening stage were almost 1.16 higher in variant with black polyethylene cover being correlated with increasing photosynthesis rate observed at this variant. Polysaccharides which have a structural role for plants increased two times higher in variant without black polyethylene mulch in comparison with uncovered variant. Covering with black polyethylene were increased the photosynthesis rate, accumulation of monosaccharides and also disaccharides in a fast manner from flowering stage to the ripening stage of tomatoes. In some cases, sugar metabolism can be used as an indicator of the photosynthetic activity. The production of sugars in the mesophyll cells and their transport to guard cells may present a central role in the tight regulation of A-gs. Some researchers found correlation for sugars with A and also, with gs and provides further evidence for a role of sucrose (disaccharide) and its derivatives, glucose and fructose (monosaccharides), in connecting mesophyll and guard cells. There is evidence showing that disaccharide (sucrose) can act as an osmolyte and its accumulation in leaves inhibiting the uptake of monosaccharides from photosynthesis and also decreasing starch levels (Gago J. *et al*, 2016)

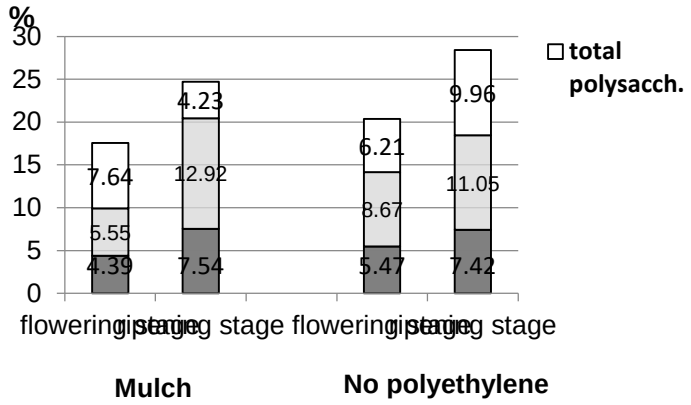



Figure 4 **Sugars leaf variation of tomato organic crop in different soil condition**

This observation is confirmed also by our results that shows in variant with black cover polyethylene on soil surface, the increasing stomatal conductance is linked with reduced photosynthesis rate and respectively, a higher disaccharides amount observed in ripening stage of Prekos variety. In that case, tomato plant registered an increased development and shortening the vegetation period due an increasing photosynthetic rate and a variable accumulation of sugars leaf. In uncovered variant, the photosynthesis rate is higher during the vegetation stage until fruit ripening and also, polysaccharides content is increased, leading to a slow rate of sugars accumulation.

## CONCLUSIONS

This study analyzed the effects of black plastic on tomato physiological behavior, soil physical and physico-chemical features such as compaction, respiration and water flux with the

aim to provide a deeper insight on the cultivation of tomato planted in protected spaces with an organic technology. Black plastic mulch (polyethylene cover) on the entire surface of soil from high plastic tunnel provoked soil compaction, in the areas located between plants rows. Some indicators of strong compacted soil observed were: the smooth soil surface, the presence cracks after soil drying, distribution uniformity of plant roots associated with morphological type of structure and degree of structure development and are also an additional indicators of that phenomenon, soil compaction.

The results showed that plots without black plastic mulch has higher soil respiration because of the exchange flux between air and soil movement (soil respiration). The humidity revealed by water flux was higher in variant with black polyethylene cover. In the analyzed period, some foliar gas - exchange parameters (photosynthesis, transpiration rate) have increased from flowering stage to ripening stage in Prekos tomato variety at uncovered black polyethylene plot. In variant with black cover polyethylene on soil surface, the higher stomatal conductance is linked with reduced photosynthesis rate and respectively, a higher disaccharides amount. Sugars leaf fraction increased more higher from flowering until ripening stage in tomato fruit, in uncovered variant especially polysaccharides in correlation with maturation fruit at this stage and also sugars accumulation in fruit.

## ACKNOWLEGMENTS

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## REFERENCES

**Acatrinei, L., 2009** - *Ecophysiological responses of some vegetable species cultivated under different greenhouses technological systems (ecological and conventional)*. Lucrări Ştiinţifice – vol. 52 :136-141, seria Agronomie, Iasi.

**Acatrinei L., 2010 -** *Photosynthesis rate, transpiration and stomatal conductance of vegetable species in protected organic crops*, Lucr. Ştiinţif." Ion Ionescu de la Brad" University of Agricultural Sciences and Veterinary Medicine Iaşi, vol. 53 (1):32-35.

**Acatrinei L., 2010 -** *The dynamics of the carbohydrates accumulation in solanacee leaves cultivated in different technological systems*. Analele Stiintifice ale Universitatii Alexandru Ioan Cuza, Sectiunea Genetica si Biologie Moleculara, XI(1), pg.93-99.Ed. Univ. „Al. I Cuza" Iaşi. ISSN 1582-3571.

**Acatrinei L., Călugăr A., 2010 -** *Effects of some agricultural practices in solarium on plant growth, soil respiration and edaphic mesofaun*a – Lucrările celei de a – XIX - a Conferinţe Naţionale pentru Ştiinţa Solului, organizată de Societatea Naţională Română pentru Ştiinţa Solului, vol 53(3):193-198.

**Barden, J. A.; Halfacre R., G.; Parrish., David J.,1987** *Plant science.* McGraw-Hill, Inc: New York, pp. 233.

**Canarache A., 1991** *-Factors and indices regarding excessive compactness of agricultural soils.* Soil& Tillage Research, 19: 145-164, 1991, p. 145-161.

**Filipov F., 2013-***The Effect of the Drip Irrigation and Plastic Mulch on the Compaction of Greenhouses Soil.* In: Recent advances in Energy, modelling Enviroment and Geology*.* Proceedings of the 2nd International Conference on Natural Resources management. WSEAS Press Antalya, Turkey, octombrie 8-10, 2013. ISSN: 2227-4359; ISBN: 978-960-474-338-4 pp. 107-112 (6p.) *http://www.wseas.org/multimedia/books/2013/Antalya/NEGIC*

**Filipov F., Lupaşcu D., Răducu A., Beldiman B.E., 2001** - *Influența măsurilor ameliorative asupra însușirilor morfologice, fizice și chimice ale solurilor cu exces de umiditate din Podișul Sucevei*. Editura Junimea, ISBN 973-37-0679-5.

**Gago, J.; Menezes Daloso, D.; Figueroa, C. M.; Flexas, J.; Fernie, A. R.; Nikoloski Z.,** 2016 - *Relationships of Leaf Net Photosynthesis, Stomatal Conductance, and Mesophyll Conductance to Primary Metabolism: A Multispecies Meta-Analysis Approach*, Plant Physiology, Vol. 171, pp. 265 – 279

**Feizienė, D.; Povilaitis, V.; Kadžienė G., *2008*** *Springtime soil surface respiration and soil vapour flux in different long-term agro-ecosystems* Ekologija. Vol. 54(4): 216–225.

**Kasirajan S, Ngouajio M., 2012 -** *Polyethylene and biodegradable mulches for agricultural applications: A review Agron. Sustain. Dev.* 32:501–529.

**Nederhoff, E.M.,1988** - *Dynamic optimization of the CO2 in greenhouses: an experiment with cucumber (Cucumis sativus L.).* Acta Hortic.,1988, 229: 341-348.

**Osorio S, Ruan Y. L., Fernie A.R., 2014 -** *An update on source-to-sink carbon partitioning in tomato*. Front. Plant Sci. **5**:516.

**Portree, J. 1996** - *Greenhouse vegetable production guide for commercial growers. Province of British Columbia* Ministry of Agriculture, Fisheries and Food.

**Snyder K., Grant A., Murray C., Wolff B., 2015** - *The Effects of Plastic Mulch Systems on Soil Temperature and Moisture in Central Ontario* HortTechnology 25(2):162-170.

# INFLUENCE OF THE WETTING PROCESS IN THE CONVENTIONAL SYSTEM ON THE QUALITATIVE INDICES OF WHEAT FOR MILLING

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**Abstract**

The wheat conditioning determines a series of transformations of the mechano-structural and biochemical properties of the grains. Proper wetting of the wheat grain on the outside succeeds in the peeling process in removing the upper layers of its coating without water entering the endosperm, so that in the end high quality flours will be obtained. In this study, two influencing factors were followed: the temperature in the grain mass and the rest time of grains after wetting, finally obtaining a multifactorial experience with 72 experimental variants. The experiments, performed in the present paper, revealed a close connection between the rest time of grains and their humidity after the hydrothermal treatment. Also, the three temperature ranges (10°C - 15°C, 15°C - 20°C and 20°C - 25°C) of the cereal mass for which the study was performed, had a direct influence on the water speed penetration from the outside of the grains to the inside. By establishing individually, the optimal conditioning recipe for each batch of wheat with different characteristics, the wetting period is significantly reduced in the technological process of preparing wheat grains for milling.

**Key words**: conditioning, wetting, wheat, peeling, flour

The technological operation of conditioning consists in the processing of wheat grains with water or water and heat. Among the operations applied to the mass of cereal seeds before milling, conditioning has the greatest influence on the technological properties of wheat, as well as on the baking characteristics of the resulting flour (Racz I., 2013; Vizitiu D., 2012).

Despite the existing shortcomings in the exact determination of the optimal parameters of hydrothermal treatments, it is unanimously recognized that the conditioning process acts on the properties of wheat grains and flour and directly influences the energy consumption of the grinding section.

So far, researchers have shown that applying the hydrothermal conditioning operation creates a difference in humidity between the coating and the endosperm of the grain, the former becoming more elastic and the latter more friable, which automatically leads to better separation of the bran, obtaining whiter flours and decreasing the ash content. (Dubei T., 2008; Moroz SM *et al*, 2014)

## MATERIAL AND METHOD

For this study, wheat from the Glossa variety was used, from the agricultural production of 2014 in the area of Iaşi county, within the communities of Hălăuceşti and Mogoşeşti-Siret. Wheat sampling was performed using the method listed in SR ISO 13690/2001, the received wheat being standardized and stored in order to conduct research on the working process of the conditioning plant.

The raw material used was analized at the Feed Quality Control Laboratory from Faculty of Animal Science at "Ion Ionescu de la Brad" University of Agricultural Sciences and Veterinary Medicine of Iasi and it's characteristics were established (*table 1*).

Table 1

**Physico-chemical characteristics of the wheat batch used in experimental research**

| Quality indices | | UM | Glossa wheat variety |
|---|---|---|---|
| Humidity | | % | 13.80 |
| Hectolitre mass | | kg/hl | 81.60 |
| Foreign impurities | white | % | 1.00 |
| | black | % | 0.50 |
| Wet gluten | | % | 24.40 |
| Gluten deformation index | | mm | 3.50 |
| Protein content | | % | 11.60 |
| Ash content | | % | 1.654 |
| Falling number | | sec. | 312 |
| Acidity | | grade | 4.00 |

The methods and apparatuses used for the analysis of wheat samples, before and after their conditioning are presented in *table 2*.

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Table 2

**Methods and apparatuses used for wheat analysis** (C.N.G.S.C., 2013)

| Quality parameters | U.M. | Method | Apparatus |
|---|---|---|---|
| Sensorial characteristics | - | STAS 6253 /1980 | - |
| Humidity | % | SR EN ISO 712:2010 | Oven/ Magic FSA device |
| Hectolitre mass | Kg/hl | SR EN ISO 7971-1:2010 | Hectolitre balance/ Magic FSA device |
| Foreign corps | % | SR ISO 7970/2001 | Sieves |
| Ash content | % | SR EN ISO 2171:2010 | Calcinator |
| Protein content | % | SR EN ISO 20483:2014 | Kjeldahl installation |
| Wet gluten | % | SR EN ISO 21415-3:2007 | Oven |
| Deformation index of gluten | mm | SR 90-2007 | Thermostat |
| Falling number | sec | SR EN ISO 3093/2010 | Falling Number tester |

In order to optimize the working process for the conventional wetting system for wheat it was used a seed treatment (*figure 1*).

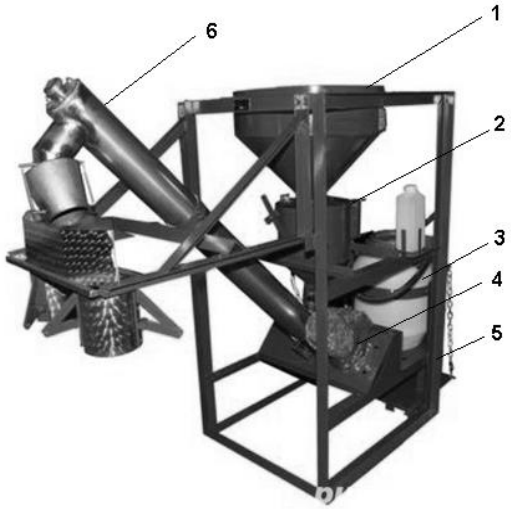



Figure 1 - **Seed treatment device**
1 – row material inlet; 2 - product mixing chamber; 3 – water tank; 4 – electromotor; 5 – Framework; 6 - helical conveyor

In order to obtain the most accurate data, a MAGIC FSA (*figure 2*) type humidometer was used to analyze the wheat before and after wetting.



*Figure 2 -* ***MAGIC FSA humidometer***

This computerized grain moisture analyzer with integrated hectoliter mass determination system has also features for as infrared temperature scanning / compensation function. First-class accuracy, classification class A, being the only one on the market that measures humidity at a precision of 0.01, while scanning the temperature without coming into contact with the sample. The accuracy of the hectoliter mass is 0.1 Kg/hectoliter.

The experimental protocol used to study the working process of the hydrothermal treatment plant for wheat grains in a conventional system consisted in designing a multifactorial experiment, in which the following influencing factors varied: grain mass temperature (F1) and wheat rest time (F2). In order to analyze the influence of the functional parameters of the humidification installation on the grain moisture and to establish the way of water migration into the grain, a number of 72 variants were performed (table 3), as follows:

3 (temperature ranges) x 24 (resting times) = 72 (experimental variants)

Table 3

**Experimental variants performed on the humidifier**

| Nr. var. | Influence factors | | Nr. var. | Influence factors | | Nr. var. | Influence factors | |
|---|---|---|---|---|---|---|---|---|
| | $F_1$ [˚C] | $F_2$ [ore] | | $F_1$ [˚C] | $F_2$ [ore] | | $F_1$ [˚C] | $F_2$ [ore] |
| $V_{u1}$ | 10 ÷ 15 | 1 | $V_{u25}$ | 15 ÷ 20 | 1 | $V_{u49}$ | 20 ÷ 25 | 1 |
| $V_{u2}$ | | 2 | $V_{u26}$ | | 2 | $V_{u50}$ | | 2 |
| $V_{u3}$ | | 3 | $V_{u27}$ | | 3 | $V_{u51}$ | | 3 |
| $V_{u4}$ | | 4 | $V_{u28}$ | | 4 | $V_{u52}$ | | 4 |
| $V_{u5}$ | | 5 | $V_{u29}$ | | 5 | $V_{u53}$ | | 5 |
| $V_{u6}$ | | 6 | $V_{u30}$ | | 6 | $V_{u54}$ | | 6 |
| $V_{u7}$ | | 7 | $V_{u31}$ | | 7 | $V_{u55}$ | | 7 |
| $V_{u8}$ | | 8 | $V_{u32}$ | | 8 | $V_{u56}$ | | 8 |
| $V_{u9}$ | | 9 | $V_{u33}$ | | 9 | $V_{u57}$ | | 9 |
| $V_{u10}$ | | 10 | $V_{u34}$ | | 10 | $V_{u58}$ | | 10 |
| $V_{u11}$ | | 11 | $V_{u35}$ | | 11 | $V_{u59}$ | | 11 |
| $V_{u12}$ | | 12 | $V_{u36}$ | | 12 | $V_{u60}$ | | 12 |
| $V_{u13}$ | | 13 | $V_{u37}$ | | 13 | $V_{u61}$ | | 13 |
| $V_{u14}$ | | 14 | $V_{u38}$ | | 14 | $V_{u62}$ | | 14 |
| $V_{u15}$ | | 15 | $V_{u39}$ | | 15 | $V_{u63}$ | | 15 |
| $V_{u16}$ | | 16 | $V_{u40}$ | | 16 | $V_{u64}$ | | 16 |
| $V_{u17}$ | | 17 | $V_{u41}$ | | 17 | $V_{u65}$ | | 17 |
| $V_{u18}$ | | 18 | $V_{u42}$ | | 18 | $V_{u66}$ | | 18 |
| $V_{u19}$ | | 19 | $V_{u43}$ | | 19 | $V_{u67}$ | | 19 |
| $V_{u20}$ | | 20 | $V_{u44}$ | | 20 | $V_{u68}$ | | 20 |
| $V_{u21}$ | | 21 | $V_{u45}$ | | 21 | $V_{u69}$ | | 21 |
| $V_{u22}$ | | 22 | $V_{u46}$ | | 22 | $V_{u70}$ | | 22 |
| $V_{u23}$ | | 23 | $V_{u47}$ | | 23 | $V_{u71}$ | | 23 |
| $V_{u24}$ | | 24 | $V_{u48}$ | | 24 | $V_{u72}$ | | 24 |

## RESULTS AND DISCUSSIONS

Because an industrial wheat seed treatment plant was used in the research, the outdoor temperature could not be strictly controlled, so the temperature in the grain mass could not be adjusted exactly. Thus, the conducted experiments were performed in three temperature ranges from the grain mass, namely 10°C ÷ 15°C, 15°C ÷ 20°C and 20°C ÷ 25°C. Measurements of grain mass

temperature were performed hourly over 24 hours for all the 72 experimental variants, the results being shown in *figure 3*.

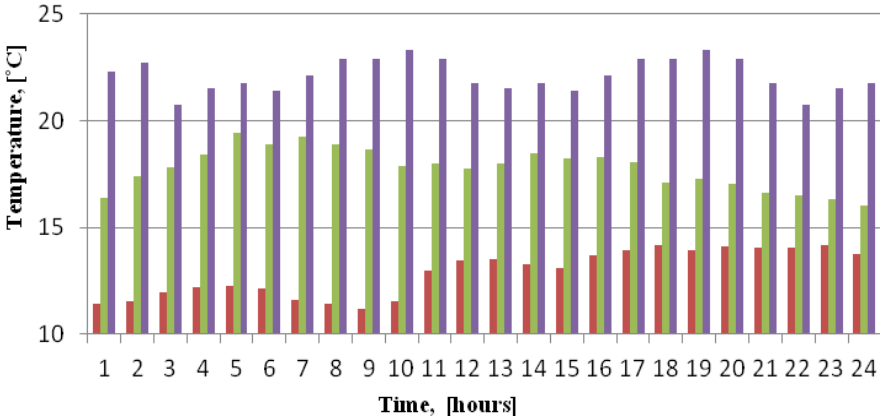



Figure 3 - **Temperature of wheat seeds during wetting process**

After each experimental variant, a sample was taken and analyzed with the Magic FSA humidometer. The humidity value was recorded hourly during the rest period and the data obtained is highlighted in *figure 4.*

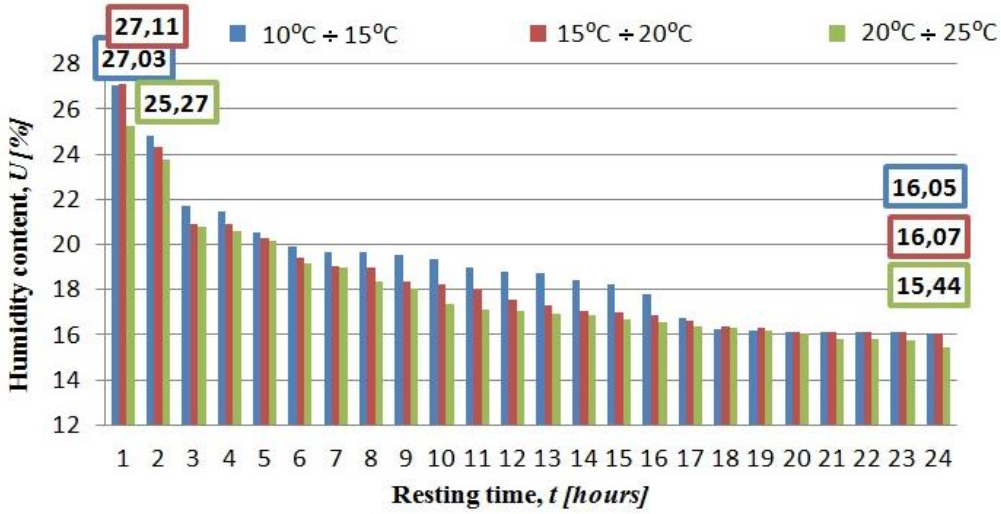



Figure 4 - **Variation of humidity depending on the rest time and temperature of the grain mass**

The research shows that after the first rest hour grain humidity reaches values of 25-27%, because water is concentrated on the outside of the particles. With the increase of the grain resting time, there is a sharp decrease in the humidity percentage, about 2-3% per hour in the first three hours of rest, for all temperature ranges in the grain mass. Starting with the fourth hour of rest, the percentage of humidity shows a slow decrease, about 0.2-0.3% per hour, and after 8-9 hours of rest, the humidity stabilizes for the temperature range 15°C ÷ 20°C respectively 20°C ÷ 25°C. For the temperature range of 10°C ÷ 15°C in the grain mass, the wheat humidity uniformity occurs after about 17 hours of rest, much later than the other two studied temperature ranges, a phenomenon explained by the fact that the water speed penetration, from the outside to the inside of the particles, is directly influenced by the temperature in the grain mass. Thus, as the grain temperatures increase, the speed of water migration also increases. At the same time it is observed that after 10 hours for the temperature range between 20°C ÷ 25°C ($\mathbf{V_{u58}}$), after 13-14 hours for the temperature range between 15°C ÷ 20°C ($\mathbf{V_{u37}}$, $\mathbf{V_{u38}}$) and after 17 hours for the temperature range between 10°C ÷ 15°C ($\mathbf{V_{u17}}$) the wheat humidity percentage is stabilized, which means that the water must have penetrated into the grain cover, and the resting process for cereals must be interrupted by introducing the raw material into the next processes from technological flow (peeling, grinding ).

In order to determine the influence of the grain mass temperature and the resting time upon the quality indices of wheat, the hectolitre mass characteristic was followed through this study. The results regarding the variation of the hectolitre mass in the conventional hidrothermal treatment are presented in *figure 5.*

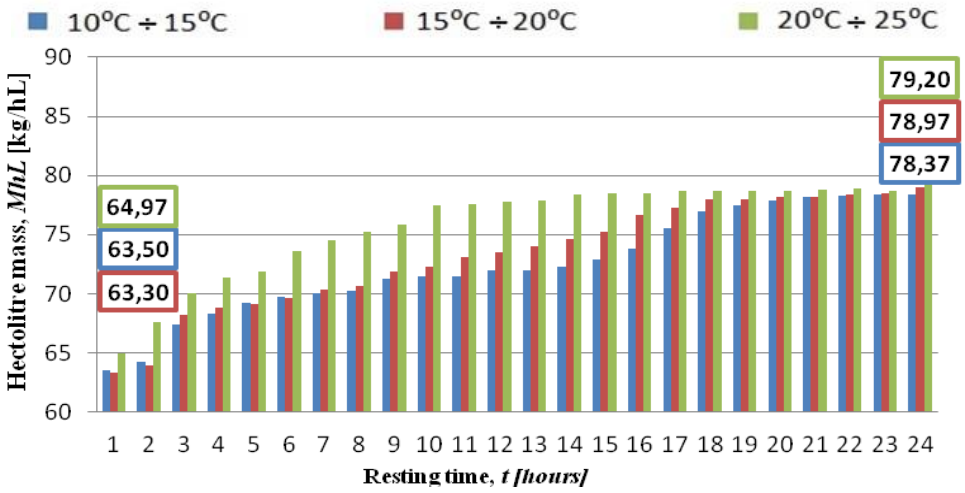



Figure 5 - **Variation of the hectolitre mass depending on the resting time and the grain mass temperature**

Regarding the hectolitre mass of the wetted grain seeds, it can be seen that during the early hours of rest this quality index of grains had values of 63.30 kg/hL (for the temperature range between 15°C and 20°C), 63.50 kg/hL (for the temperature range between 10°C and 15°C) and 64.97 kg/hL (for the temperature range between 20°C and 25°C). The values resulted from the experiments revealed a decrease of the hectolitre mass index in the first hours of rest by up to 18% compared to the control sample (the hectolitre mass in the case of non-moisted wheat was 81.6 kg/hL). The study also revealed that the temperature of the grains influences the hectolitre mass. At higher temperatures the hectolitre mass index reaches early the values imposed by the national standards for wheat of first and second grade in the temperature range between 20°C and 25°C compared to the other two temperature ranges studied (according to Romanian National Commission for Grading Seeds for Consumption first grade wheat must have the hectolitre mass index of 77 kg/hL and second grade at least 75 kg/hL).

## CONCLUSIONS

The researches carried out established the exact moments in witch humidity has stabilized, for each temperature range studied. The current paper made possible to identify the time required for moisten the grain cover and also the period after which the migration of water from the coating to the endosperm begins. If the water penetrates into the endosperm of the wheat kernel peeling can no longer properly remove the outer layers of the coating and in the end poor quality flours will be obtained, with a high ash index.

Because the value of the hectolitre mass index is closely related to the extraction coefficient of wheat flour, the quality index must remain at values above 75 kg/hL after wetting.

Analyzing and correlating the results obtained for humidity percent and hectolitre mass index from these experimental researches, choosing the parameters indicated by the variants: $\mathbf{V_{u58}}$ for the mass grain temperature range between 20°C ÷ 25°C, $\mathbf{V_{u63}}$ or the mass grain temperature range between 20°C ÷ 25°C and $Vu_{17}$ for the mass grain temperature range between 10°C ÷ 15°C, the wheat wetting process in the conventional system was optimized.

## REFERENCES

**C.N.G.S.C.**, **2013** - *Comisia Naţională de Gradare a Seminţelor de Consum*. Retrieved 2013, from:http://domino.iqm.ro/gradare/home.nsf/Produse/grau.

**Cozma D., Tenu I., Zăpodeanu C.V., 2014** – *Influence of Hydrothermal Treatment on Wheat for Milling*. Applied Mechanics and Materials Vol. 659 pag. 511-514, doi: 10.4028/www.scientific.net/AMM.659.511.

**Vizitiu D., 2012** – „*Cercetări privind asigurarea indicilor calitativi optimi ai făinurilor pentru câteva grupe de produse de panificaţie şi patiserie în cazul variaţiei calitative a loturilor de grâu procesate la unitatea de morărit*". Teză de doctorat, Universitatea „Lucian Blaga" din Sibiu.

**Zăpodeanu C.V., 2020** – *Research regarding optimization of working process of wheat conditioning for milling*, PhD Thesis, "Ion Ionescu de la Brad" University of Agricultural Sciences and Veterinary Medicine from Iasi.

# SOME BIOLOGICAL FEATURES AND BIOMASS QUALITY OF *LUPINUS ALBUS* AND *LUPINUS LUTEUS* IN MOLDOVA

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**Abstract**

*Fabaceae* species play a crucial role in natural ecosystems and agriculture, because they have the potential to symbiotic fixation of atmospheric nitrogen and soil carbon sequestration, improve biological activity and soil structure, increase the quality and quantity of food and feed, bring improvements resource efficiency in various biorefinery systems. We have studied biological features, biochemical composition and nutritive value, and have estimated the biomethane potential of aerial biomass of the *Fabaceae* species *Lupinus albus* and *Lupinus luteus*, which have been cultivated in the experimental plot of the "Alexandru Ciubotaru" National Botanical Garden (Institute), Chisinau, R. Moldova, *Medicago sativa* and *Onobrychis viciifolia* were used as control variants. The results of our research revealed that the dry matter of harvested whole plants of *Lupinus* species contained 166-206 g/kg CP, 86-110 g/kg ash, 221-258 g/kg ADF, 337-339 g/kg NDF, 31-40 g/kg ADL, 190 - 218g/kg Cel and 116-141 g/kg HC. The nutritional value of *Lupinus* green mass:75.5- 80.9 % DDM, 72.9-76.6 % DOM, RFV 168-208, 13.45-13.96 MJ/kg DE, 11.04- 11.46 MJ/kg ME and 7.06-7.48 MJ/kg NEl. It has been found that the biomethane potential of the *Lupinus* substrates varied from 309 to 324 l/kg ODM.The annual species *Lupinus albus* and *Lupinus luteus* are a promising source of fodder and feedstock for biomethane production.

**Keywords:** biochemical composition, *Lupinus albus*, *Lupinus luteus*, nutritive value

People are currently confronting many global challenges. The global population is increasing at an exponential rate, leading to unprecedented crises, among which food and energy security, risk of climate change, air pollution and emissions greenhouse gases, rising prices of production means, decreasing farmland area and reducing the reserves of fossil energy and uncertainties about future reliability of supply are of prominent concerns. World protein needs are and will continue rising in the future due to the world population increase, the living condition improvement and the evolution toward an animal and plant protein based diet. To face the global crisis, particular attention has been paid to the reassessment of the value of neglected and underutilized crops, mobilization and domestication of new species would promote agricultural diversity, encourage scientists to create new varieties with increased genetic potential for productivity, quality and increased resistance to harmful biotic and abiotic factors, farmers search and apply agrotechnologies which would guarantee satisfactory yield, high quality and positive influence on the natural environment.

*Fabaceae* (*Leguminosae*) is the third largest family of flowering plants, after the *Orchidaceae* and *Asteraceae.* Economically, legumes, *Fabaceae*, represent the second most important family of crop plants after the grass family, *Poaceae*, grain legumes account for 27 % of world crop production and provide 33 % of the dietary protein consumed by humans, while pasture and forage legumes provide vital part of animal feed. They provide important sources of oil, fiber, and protein-rich food and feed while supplying nitrogen (N) to agro-ecosystems via their unique ability to fix atmospheric $N_2$ in symbiosis with the soil to create symbiotic relations with nitrogen fixing bacteria, as *Rhizobium* species, increasing soil carbon content, and stimulating the productivity of the crops that follow. Increasing the role of legumes plants are attractive and necessary in the context of sustainable development of agriculture, reconnection of crop and livestock production, their potential to contribute to the mitigation of climate change by reducing fossil fuel use or by providing feedstock for the emerging biobased economies where fossil sources of energy and industrial raw materials are replaced in part by sustainable and renewable biomass resources. Many legumes can be produced on marginal/surplus lands and on degraded or drastically disturbed soils (Duke J.A., 1981; El

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Bassam H, 2010; Jensen E.S. *et al*, 2012; Murphy-Bokern D. *et al*, 2017).

The genus *Lupinus* L. tribe *Genisteae*, *Fabaceae* family currently includes about 300 species. Most species grow on the American continent and 12-13 annuals species grow in the African and Mediterranean highland. Many *Lupinus* spp. are ornamental garden plants, and five species are cultivated on a larger scale as agricultural crops: *Lupinus albus*, *Lupinus anugustifolius*, *Lupinus cosentenii*, *Lupinus luteus* and *Lupinus mutabalis* in climates ranging from northern Europe and Russia, to the arid Australian plains and the Andean highlands. Bähr M. *et al*, (2014) believe that lupines are an alternative to soybeans, as they contain comparable amounts of proteins of a similar amino acid profile, but more fiber content, which is favorable from the dietary point of view, compared to beans.

The oldest record of *Lupinus albus* dates back to around 3500 years BC, in the Late Neolithic, was first cultivated as green manure, as forage and probably also for human consumption. In Germany in the 1930s, von Sengbusch identified natural sweet-seeded mutants, which heralded the beginning of modern *Lupinus albus* breeding (Gladstone J.S., 1970). White lupin, *Lupinus albus L.*, is annual, erect, branched, bushy, short-hairy herb up to 120 cm tall, with a strong taproot can grow 70 cm deep. Leaves alternate, digitately compound with 5–9 leaflets; stipules linear to narrowly triangular, up to 1 cm adnate to the base of the petiole; petiole 3.5–7(–12) cm long; leaflets obovate, 2–6 cm × 0.5–2 cm, cuneate at base, rounded and mucronate at apex, nearly glabrous above, hairy beneath. Inflorescence a terminal false raceme 3–30 cm long, many-flowered, lower flowers alternate, upper ones in whorls; peduncle short or absent. Flowers bisexual, papilionaceous; pedicel 1–2 mm long; calyx 8–14 mm long, densely hairy outside, tube 4 mm long, 2-lipped, upper lip entire, lower lip entire or slightly 3-toothed; corolla white to violet-blue, standard obovate, 15–18 mm × 8–12 mm, margins partly reflexed, wings obovate, 13–17 mm × 6–10 mm, keel ladle-shaped, 12–15 mm × 4 mm, beaked; stamens 10, all joined into a tube; ovary superior, 1-celled, style 7.5 mm long with a ring of small hairs below the stigma. The pods are 3-6 seeded, narrowly oblong, laterally compressed, (6-) 9-15 cm long × 1-2 cm wide, yellow in colour. The weight of 1000 seeds is 200-350 g. 2n = 50 (Kurlovich B.S., 2002; Jansen P.C.M., 2006; El Bassam H, 2010; Clark S., 2014). The average seed yield of white lupine ranges from 0.5 to 4 t/ha (Jansen P.C.M., 2006). In Romania, the seed yield was 3.033 kg/ha and the protein yield 1.077 kg/ha **(**David G. *et al*, 2014).

Yellow lupine, *Lupinus luteus* L., is an annual plant herb, rosetted in the beginning and subsequently becoming erect, with vigorous basal branching. It is strongly taprooted and its stalk up to 80 cm tall is densely hairy. The leaf consists of 7–9 (11) ovate-oblong or lanceolate leaflets, prolate at the basis, densely villous on both sides, sized 30–60 x 8–15 mm. Stipules of the rosetted leaves are crescent and chuffy on stalks, linear-obovate in shape. The inflorescence is a terminal spicate raceme up to 25 cm long, set on a peduncle of 5–12 cm, containing 6-10 whorls of 5 fragrant yellow papillonaceous flowers each. Floral bracts are small-sized, obovate, silky-pubescent, easily falling. The upper lip of the calyx is bipartite, the lower one has 3 small denticles. The corolla is 14-16 mm long, bright gold-yellow in colour. Petals are yellow, orange, or whitish; 9 stamens; 5 upper ones are longer. The fruits are densely hairy flat pods, 4-5 cm long x 1.1-1.3 cm wide. The pods contain 4-6 seeds. The seeds are reniform, smooth, white or white with brown to black speckles. The weight of 1000 seeds is 120-140 g (Kurlovich B.S. 2002; Terekhina N. V., 2008; El Bassam H., 2010). *Lupinus luteus* appeared in Russia about 1811 y. as ornamental plant. Being cultivated since the end of the 19th century, it occupies about 2 million hectares within the territory of the former USSR, but in the 21$^{st}$ century, it has been used to produce plant-based feed and its role in animal husbandry, in Russia, is limited (Lukashevich M.I. *et al*, 2018). Modern *Lupinus luteus* cultivars are resistant to pod shattering, though improvements are still necessary in Mediterranean-type environments, which experience hot, dry conditions at harvest time (Wolko B. *et al*, 2010).

Lupine has modeate requirements towards temperature; however, white lupine is more demanding than yellow lupine. Lupine is generally drought tolerant, the most resistant is the yellow lupine, the less resistant – the blue lupine, and the white lupine "requires" a humid and warm spring, then it withstands drought well. In terms of photoperiodism, annual lupine species are long-day plants. White lupine reacts less to the length of the day than the yellow lupine. The requirements of lupine to the soil are relatively low, due to the development of the root system (even over 2 m), the high capacity to solubilise phosphorus and other elements from combinations that, for other plants, are difficult to solve. Pollination is autogamous in white lupine and allogamous in yellow lupine.

Lupines are N-fixing legumes, and white lupine has been reported to fix 400 kg N/ha

(Jansen P.C.M., 2006), but yellow lupine can fix in one year between 150 to 169 kg N/ha (Lança A.C., 1993). Utilizing lupine as green manure helps to protect environments from pollution, go without expensive fertilizers and obtain ecologically clean products (Kurlovich B.S., 2002). In mixed cultures of bioenergy crops, lupines (*Lupinus albus* and *Lupinus angustifolius*) have the ability to mobilize trace elements and make these elements available for co-cultured species. Lupines mobilize trace elements by carboxylates and enzyme exudation and by lowering the pH value in the rhizosphere. In a comparison between white and blue lupine for trace element mobilization, white lupine was more effective than blue lupine and thus recommended for phytoremediation (Hentschel W. and Wiche O., 2016). Lupine is studied and cultivated in many regions of the world, used in animal feed as form of seeds, green forage and silage, in industry as raw material for the production of bioenergy and various chemicals, in human nutrition as an alternative protein and bioactive component source, as green manure and ameliorative plant growth and soil fertility of the sandy acid soils, in medicine and as an ornamental plant (Aniszewski T., 1993; Zraly Z. *et al*, 2006; Doležal P. *et al*, 2008; Bhardwaj H. *et al*, 2010; Wolko B. *et al*, 2010; Lucas M.M. *et al*, 2017; Abraham E.M. *et al*, 2017; Pietrzykowski M. *et al*, 2017; Prusinski J., 2017; Criste F.L., 2020; Struti D.I. *et al*, 2020). Lupine production and cultivated area worldwide for 2017 is estimated at about 1.610.969 tonnes and 930.717 ha respectively. The percentage of global production attributed to Europe increased remarkably from 17.6% in 2013 to 29% in 2017 (Abraham E.M. *et al*, 2017). In 2016, lupine in Russia was cultivated on an area of 135 thousand hectares (Lukashevich M.I. *et al*, 2018). This research was aimed at evaluating the biological features, biochemical composition of non-traditional annual species *Lupinus albus* and *Lupinus luteus* grown under the conditions of the Republic of Moldova, and the possibility to use them as fodder for ruminant animals or as biogas substrate.

## MATERIALS AND METHODS

The annual *Fabaceae* species: white lupine, *Lupinus albus* L., and yellow lupine, *Lupinus luteus* L., which were cultivated in the experimental plot of the National Botanical Garden (Institute) of Moldova, Chişinău, N 46°58′25.7″ latitude and E 28°52′57.8″, served as objects of study; the traditional crops alfalfa, *Medicago sativa*, and common sainfoin, *Onobrychis viciifolia*, were used as control variants. The experimental design was a randomised complete block design with four replications, and the experimental plots measured 10 $m^2$. Sowing was done in April at a depth of 4.0 cm on rows distance 45 cm, the sowing density of *Lupinus albus* was 80 seeds/ $m^2$ and *Lupinus luteus* – 110 seeds/$m^2$. The plant growth, development and productivity were assessed according to methodical indications (Novoselov Y. K. *et. al,* 1983). The green mass was harvested in the flowering period. The green mass yield was measured by weighing. The dry matter content, or total solids (TS), was detected by drying samples up to constant weight at 105 °C. The leaves/stems ratio was determined by separating the leaves and flower from the stem, weighing them separately and establishing the ratios for these quantities (leaves/stems). For chemical analysis plant samples were dried in a forced air oven at 60°C, milled in a beater mill equipped with a sieve with diameter of openings of 1 mm and some assessments of the main biochemical parameters: crude protein (CP), ash, acid detergent fibre (ADF), neutral detergent fibre (NDF) and acid detergent lignin (ADL), digestible dry matter (DDM), digestible organic matter (DOM) have been determined by near infrared spectroscopy (NIRS) technique PERTEN DA 7200. The concentration of hemicellulose (HC), cellulose (Cel), digestible energy (DE), metabolizable energy (ME), net energy for lactation (NEl) and relative feed value (RFV) were calculated according to standard procedures.

The carbon content of the substrates was obtained using an empirical equation reported by (Badger *et al*, 1979). The biochemical biogas potential (Yb) and methane potential (Ym) were calculated according to the equations of Dandikas *et al,* 2014, based on the concentration of acid detergent lignin (ADL) and hemicellulose (HC):

Yb=727+0.25 HC-3.93 ADL

Ym=371+0.13HC-2.00ADL

## RESULTS AND DISCUSSIONS

After the phenological observations, it was found that, the growth and development rates of the studied *Lupinus* species differed from those of the traditional leguminous forage crops. Thus, the seedlings emerged uniformly on the soil surface 15-17 days after sowing, or, 5-7 day longer period as compared with traditional forage crops, probably due to the fact that the seeds of this species were characterized by a denser coat, but water availability and temperature could also influence germination. Emergence is epigeal, cotyledons emerge above ground before development of true leaves, and early seedling growth is considerably slower than later vegetative stages. Over a period of 18-23 days, the plants developed fine roots, which grew 20-23 cm long and ensured the necessary water and nutrients for growth and development. We found that during the first month after the emergence of seedlings, the growth and development rate of the aerial part of the plant was very slow, the rosette formed. *Lupinus albus*

needed a shorter period to develop the rosette (17 days), but *Lupinus luteus* – a longer one (25 days). Then, the growth rate accelerated and allowed the development of an erect stem; bud initiation started. It was determined that the period of time from the emergence of plantlets till the formation of flower buds was shorter for *Lupinus albus* and constituted 52 days, but for the *Lupinus luteus* species – 61 days, the established phenological differences were maintained until the end of the growing season. In the next period, the main stem elongated and flowers, axillary buds near the inflorescence started their development into branches. During the bud formation till the full flower stage, a faster growth rate of aerial part was observed in *Lupinus albus.* In flowering stage, *Lupinus albus* plants reached 76.20 cm and *Lupinus luteus* – 64.4 cm, while the traditional leguminous forage crops reached 84.5-93.1 cm (*table 1*). The bio-morphological characteristics of the whole plant have significant impact on the forage productivity and quality. At the time of the harvest, *Lupinus albus* had the greatest mass of a single plant. The biomass productivity of *Lupinus luteus* was 2.64kg/m$^2$ green mass or 0.48 kg/m$^2$ dry matter with 75 % leaves and flower in fodder, but *Lupinus albus* - 3.92 kg/m$^2$ green mass or 0.66 kg/m$^2$ dry matter with 63 % leaves and flower. The *Lupinus* forages were richer in leaves, but poorer in dry matter, in comparison with the control variants.

Literature sources indicate considerable variation in yield both between individual lupine species and their cultivars. The forage yield reported by Bhardwaj H. *et al*. (2010) of white lupines in the United States ranged between 0.8-2 t/ha dry matter. In Serbia, the forage productivity of twelve studied white lupine cultivars on chernozem alkaline soils was 21.3-53.3 t/ha green mass or 3.6 – 8.7 t/ha dry matter (Mihailovic V. *et al*, 2008). In Poland, the white lupine yield harvested in flat pod stage was 20.4 t/ha green mass or 3.4 t/ha dry matter, but yellow lupine – 43.1t/ha green mass or 6.4 t/ha dry matter (Faligowska A. and Szukała J., 2009). Fikadu T.R., 2017, found that sweet white lupine high plant ranged from 58.96 to 85.63 cm, the harvested herbage – from 17.33 to 39.58 t/ha and the dry matter yield – from 2.53 to 4.85 t/ha, this variation in forage dry matter yield could be due to differences in the growth environment, planting spacing, harvest period and the lupine varieties evaluated. According to Lukashevich M.I. *et al*, (2018), the developed yellow lupine cultivars in the All-Russian Lupine Research Institute reached the productivity 55.41-64.76 t/ha green mass, 8.94 – 12.37 t/ha dry matter and 1.42 - 2.12 t/ha protein.

Table 1

**Some agrobiological peculiarities of *Lupinus albus* and *Lupines luteus***

| Species | Plant height, cm, | Leaf and flower, g | | Stem, g | | Yield, kg/ m$^2$ | |
|---|---|---|---|---|---|---|---|
| | | green mass | dry matter | green mass | dry matter | green mass | dry matter |
| *Lupinus albus* | 76.2 | 24.04 | 4.34 | 17.72 | 2.55 | 3.92 | 0.66 |
| *Lupinus luteus* | 64.4 | 18.40 | 3.23 | 5.36 | 1.08 | 2.64 | 0.48 |
| *Medicago sativa, first cut* | 84.5 | 5.38 | 1.38 | 4.92 | 1.41 | 20.8 | 0.56 |
| *Onobrychis viciifolia, first cut* | 93.1 | 12.50 | 2.86 | 10.10 | 2.49 | 25.8 | 0.61 |

The optimum use of forage resources in animal diets depends on the availability of detailed information on their chemical composition, biological properties and nutritional value, which may vary between plant species and varieties. Analyzing the results of the green mass quality of the studied *Lupinus* species (*table 2*), we found that the dry matter content and its chemical composition varied in comparison with alfalfa and common sainfoin

It has been proved that proteins have high biological value for growth and serve as structural elements in all plant tissues. In the animal body, they are utilized for growth, replacement of old, damaged or worn-out cells/tissues and formation of milk. They are of particularly great value to young growing animals and lactating ruminants (McDonald P. *et al*, 2010). It has been found that *Lupinus luteus* is characterized by high content of protein in dry matter (20.6%). *Lupinus albus* has about the same amount of protein in the fodder (16.6%) as *Onobrychis viciifolia*, but a lower one in comparison with *Medicago sativa.* The presence of minerals in animal nutrition is indispensable for their growth and health, because they are essential components of all tissues and organs that maintain osmotic pressure at a constant level, participate in the regulation of acid-base balance, activate a number of enzymes, moderate the neuromuscular activity and prevent the emergence and development of diseases of animals (McDonald P. *et al*, 2010). We could mention that *Lupinus albus* has low content of minerals (8.6%), but *Lupinus luteus* high content of minerals (11.0%) in comparison with traditional leguminous forage crops. Plant cell walls provide the basic mechanical support that allows plants to stand upright, play important roles in plant

responses to various abiotic stresses, such as drought, flooding, heat, cold, and salt and is essential in stress sensing and signal transduction. Cell wall components such as NDF, ADF, cellulose, hemicellulose and lignin are very important limiting factors to the feeding processes and to the ability of the animal to utilize the consumed forage. Carbohydrates are the most important source of energy and are the main precursors of fat and sugar (lactose) in milk. The level of structural carbohydrates were substantially reduced in the *Lupinus* fodder: 221-258 g/kg ADF, 337-339 g/kg NDF, 31-40 g/kg ADL, which had a positive effect on dry and organic matter digestibility, relative feed value and energy content.

Table 2

**The biochemical composition and fodder value of the *green mass of Lupinus albus* and *Lupinus luteus***

| Indices | *Lupinus albus* | *Lupinus luteus* | *Medicago sativa* | *Onobrychis viciifolia* |
|---|---|---|---|---|
| Crude protein, g/kg DM | 166 | 206 | 172 | 166 |
| Minerals, g/kg DM | 86 | 110 | 91 | 96 |
| Acid detergent fiber, g/kg DM | 258 | 221 | 347 | 309 |
| Neutral detergent fiber, g/kg DM | 399 | 337 | 510 | 447 |
| Acid detergent lignin, g/kg DM | 40 | 31 | 58 | 49 |
| Digestible dry matter, g/kg DM | 755 | 809 | 623 | 669 |
| Digestible organic matter, g/kg DM | 729 | 766 | 579 | 615 |
| Relative feed value | 168 | 208 | 118 | 142 |
| Digestible energy, MJ/ kg DM | 13.45 | 13.96 | 12.20 | 12.73 |
| Metabolizable energy, MJ/ kg DM | 11.04 | 11.46 | 10.03 | 10.46 |
| Net energy for lactation, MJ/ kg DM | 7.06 | 7.48 | 6.04 | 6.48 |

The nutritive value and energy value of *Lupinus luteus* was RFV= 208, 13.45 MJ/kg DE, 11.04 MJ/kg ME and 7.06 MJ/kg; *Lupinus albus*- RFV=168, 13.45MJ/kg DE, 11.04MJ/kg ME and 7.06MJ/kg NEl; *Onobrychis viciifolia* - RFV=142, 12.73MJ/kg DE, 10.46MJ/kg ME and 6.48MJ/kg NEl; *Medicago sativa*- RFV=118, 12.20MJ/kg DE, 10.03MJ/kg ME and 6.04MJ/kg NEl, respectively. Some authors mentioned various findings about the green mass quality of the *Lupinus* ssp. The harvested whole lupine plant in wax ripeness stage of the seed were characterized by 187.2 g/kg DM, 208.2 g/kg CP, 221.7 g/kg of CF, 290.4 g/kg ADF, 410.9 g/kg NDF, 140.5 g/kg of starch, 31.5 g/kg WSC, 60.18 % rumen degradability of crude protein (Doležal P. *et al*, 2008). According to Faligowska A. and Szukała J., 2009, the harvested white lupine green forage in flat pod stage contained 16.9% DM, 16.3 % CP, 2.44% fat, 24.1% CF, 49.1% nitrogen-free extract, 7.94% ash, but yellow lupine green forage – 16.9% DM, 17.6 % CP, 1.39% fat, 29.3% CF, 42.3% nitrogen-free extract, 9.38% ash. Bhardwaj H.L *et al*, (2010) remarked that the chemical composition of white lupine forage varied in dependence of growing location: crude protein – from 167.1 to 217.8 g/kg and acid detergent fiber – from 189.2 to 303.9 g/kg. In Chile, the chemical composition of lupine forages harvested in early bloom period was: 17.1 % CP, 18.7% CF, 29.9% NDF with 81.2% IVOMD and 12.0 MJ/kg ME, but in mid-bloom period – 14.9 % CP, 19.3% CF, 27.7% NDF, 80.8% IVOMD and 12.2 MJ/kg ME (Valderrama X., Anrique R., 2011). Faligowska A. *et al*, (2014), reported that white lupine green mass was characterized by 158-253 g/kg DM, 141-154 g/kg CP, 261.8-266.1 g/kg NDF and 399.9-422.1 g/kg WSC, but prepared lupine silage – 218.6-220.9 g/kg DM, 151.4-152.5 g/kg CP, 319.4-351.4 g/kg NDF, 7.3-13.7 g/kg WSC with pH=4.5-4.6.

Heuzé (2019), revealed that the aerial part of *Lupinus albus* contained 20.2% dry matter, 21.53% CP, 23.5% CF, 31.1% NDF, 25.6% ADF, 3.1% ether extract, 4.1% lignin, 8.0 % ash, 71.7% organic matter digestibility, 13.0 MJ/kg DE, 10.3 MJ/kg ME. Baizán G. S. *et al* (2015) reported that, under the climatic conditions of Spain, the nutrient contents of *Lupinus albus* grown in monoculture was: 10.63% CP, 50.07% NDF, 26.94.22% ADF with 74.51% IVOMD and 10.51 MJ/kg ME, but in mixtures with Italian lupine – 17.85% CP, 45.02% NDF, 29.22% ADF with 67.65% IVOMD and 9.60 MJ/kg ME. Fikadu T.R. (2017) remarked that nutritional value of sweet lupine cultivars was 21-24% CP, 47-49% NDF, 34-39% ADF, 5.2-5.6% ADF, 66.9-69.1% IVOMD, with metabolizable energy content 9.04-9.44 MJ/kg.

Lukashevich M.I. *et al*, (2018) mentioned that green forage from yellow lupine cultivars contained 15.9-17.9 % CP, 2.16- 2.54% fat, 0.030-0.041% alkaloids, 23.68-28.85 mg/g carotene. During our previous research, it has been found that the chemical composition and the nutritive values of *Lupinus perennis* dry mass were: 144.2 g/kg CP, 39.1 % g/kg EE, 254.4 g/kg CF, 105.6 g/kg minerals, 456.7 g/kg NFE, 0.96.2 nutritive

units, 9.87 MJ/kg metabolizable energy and 105.3 g/kg digestible protein (Ţîţei V. *et al*, 2015).

In a biobased economy, fossil resources are replaced by biomass for the production of industrial chemicals, transportation fuels, electricity, heat, and other products. Second-generation biofuels, power and heat generated by combustion and production of industrial raw materials could be based on legume biomass and residues. Legumes have high contents of constituents (*table 3*) other than carbohydrates, which may be relevant in biorefinery concepts in which the different components could be used for a variety of biobased products. Anaerobic digestion is an optimal conversion technology containing legume biomass since the valuable content of N, P, and other nutrients is exploited efficiently via the digestate biofertilizer. High C/N biomass feedstock low in crude protein and fat, such as maize and grasses, could benefit by being enriched with crude protein by mixing legume foliage to improve efficiencies. But sole crop legume biomass with a high N content would not be optimal either because the concentration of $NH_4$ in the reactor may become too high and stop the digestion process. Currently, biogas is produced from monoculture maize feedstock in many European countries, but legume-based energy crops for biogas should be integrated in sustainable crop rotations. The ratio of the content of carbon and nitrogen (C/N) of the raw material is essential in the production of biogas.

Table 3

**The biochemical biogas and biomethane production potential of *Lupinus albus and Lupinus luteus* substrates**

| Indices | *Lupinus albus* | *Lupinus luteus* | *Medicago sativa* | *Onobrychis viciifolia* |
|---|---|---|---|---|
| Crude protein, g/kg DM | 166 | 206 | 172 | 166 |
| Minerals, g/kg DM | 86 | 110 | 91 | 96 |
| Nitrogen, g/kg DM | 26.6 | 33.0 | 27.5 | 26.6 |
| Carbon, g/kg DM | 507.7 | 494.4 | 505.5 | 502.2 |
| Ratio carbon/nitrogen | 19.1 | 15.0 | 18.4 | 18.9 |
| Cellulose, g/kg DM | 218 | 190 | 289 | 260 |
| Hemicellulose, g/kg DM | 141 | 116 | 163 | 138 |
| Acid detergent lignin, g/kg DM | 40 | 31 | 58 | 49 |
| Bio gas potential, L/kg VS | 605 | 634 | 540 | 569 |
| Biomethane potential, L/kg VS | 309 | 324 | 276 | 291 |

The production of biomass from legumes for energy purposes is considered an important element of sustainable agriculture. The ratio of the content of carbon and nitrogen (C/N) of the raw material is essential in the production of biogas. We could mention that the nitrogen content in the studied legume substrates ranges from 2.66% to 3.3 %, the estimated content of carbon – from 49.44% to 50.77 %, the C/N ratio varied from 15 to 19. The essential differences were observed between the content of cellulose, hemicellulose and lignin. *Lupinus luteus* substrate is characterized by low cell wall compounds. The *Lupinus albus* substrate contained acceptable amounts of hemicellulose and lignin, in comparison *Medicago sativa* substrate. Dobre P. *et al*, (2014), mentioned that the optimal C/N ratio is expected to be in the range 15-25, when the anaerobic digestion process is carried out in a single stage, and for the situation when the process develops in two steps, the optimal C/N ratio will range: for step I: 10-45; for step II: 20-30.

The gas forming potential of the studied substrates varied from 540 to 664 litre/kg VS. The best biogas yield was achieved in *Lupinus luteus* substrates with methane potential yield of 324 l/kg VS, the lowest – in the biomass of *Medicago sativa*. The methane yield per ha of studied *Lupinus* species reached 1864 $m^3$/ha on *Lupinus albus* and 1384 $m^3$/ha *Lupinus luteus* substrate.

According to Lehtomäki A., 2006, the methane yield for lupine was 360 l/kg. Carvalho L. *et al*, (2013) remarked that the yellow lupine silage substrate made it possible produce 665 $m^3$/t biogas and 409 $m^3$/t methane, the annual methane yield was 6871 $m^3$/ha, but oilseed radish silage produced 447 $m^3$/t, 294 $m^3$/t and 1600 $m^3$/ha. Dubrovskis V. *et al*, (2011) mentioned that biogas potential of large leaf lupine (*Lupinus polyphyllus* L.) was 520 l/kg, the methane content was 61.9 % or 322 l/kg and an annual energy productivity 82 GJ/ha. Hensgen F., Wachendorf M., (2016) remarked that in anaerobic digestion tests the ensiled *Lupinus polyphyllus* in pure and mixture with semi-natural grassland mean methane yields between 251 and 270 l/kg VS.

Pakarinen A. *et al*, (2012), indicated the fresh white lupine produced the highest methane yield (343 ± 33 $dm^3$ /kg TS), mainly due to its highest amount of proteins. Kintl A. *et al*, 2019

reported that lupine silage has a methane yield of 244 l/kg, maize silage – 327 l/kg, but highest methane yield, 330 l/kg, was detected in mixed silage of 10% lupine and 90% maize.

## CONCLUSIONS

Under the climatic conditions of the Republic of Moldova, *Lupinus albus* plants grow and develop more intensively in comparison with *Lupinus luteus.*

In the flowering stage, the productivity of *Lupinus luteus* achieved 2.64 kg/m$^2$ green mass or 0.48 kg/m$^2$ dry matter and *Lupinus albus* – 3.92 kg/m$^2$ green mass or 0.66 kg/m$^2$ dry matter, respectively.

The dry matter of harvested *Lupinus* species whole plants contained 166-206 g/kg CP, 86-110 g/kg ash, 221-258 g/kg ADF, 337-339 g/kg NDF, 31-40 g/kg ADL, 190 -218g/kg Cel and 116-141 g/kg HC.

The nutritional value of *Lupinus* green mass: 75.5- 80.9 % DDM, 72.9-76.6 % ODM, RFV 168-208, 13.45-13.96 MJ/kg DE, 11.04- 11.46 MJ/kg ME and 7.06-7.48 MJ/kg NEl.

The *Lupinus* green mass substrates for anaerobic digestion characterized by optimal C/N ratio and hemicelluloses and low amount of lignin, the biomethane potential varied from 309 to 324 l/kg ODM.

*Lupinus luteus* green mass was characterized by high content of protein, ash and low cell wall compounds, which had a positive effect on matter digestibility, nutritive value and biomethane potential.

These *Lupinus* species can serve as starting material in crop improvement and implementation of new leguminous species for animal fodder diversification and feedstock for anaerobic digestion and biomethane production.

## REFERENCES


**Aniszewski, T. 1993 -** *Lupin: a potential crop in Finland. Studies on the ecology, productivity and quality of Lupinus ssp.* PhD thesis summary, Joensuuu, Finland.

**Abraham E.M., Ganopoulos I., Madesis P., Mavromatis A., Mylona P., Nianiou-Obeidat I., Parissi Z., Polidoros A., Tani E., Vlachostergios D., 2019 -** *The use of lupin as a source of protein in animal feeding: genomic tools and breeding approaches.* International Journal of Molecular Sciences, 20(4). doi:10.3390/ijms20040851.

**Badger C.M., Bogue M.J., Stewart D.J., 1979 -** *Biogas production from crops and organic wastes.* New Zeland Journal of Science, 22: 11-20.

**Bähr M., Fechner A., Hasenkopf K., Mittermaier S., Jahreis, G., 2014 -** *Chemical composition of dehulled seeds of selected lupin cultivars in comparison to pea and soya bean*. Food Science and Technology, 59: 587-590.

**Baizán S.G., Vicente F.M, González M.A., González C., De la Roza B., Soldado A., Martínez-Fernández A., 2015 -** *Alternativas forrajeras sostenibles como cultivo invernal en zonas templadas = Alternative sustainable forages as winter crop in temperate areas*. Pastos**,** 45(2): 23-32.

**Bhardwaj H.L., Starner D.E., Van Santen E., 2010 -** *Preliminary evaluation of white lupin (Lupinus albus L.) as a forage crop in the mid-atlantic region of the United States of America.* Journal of Agricultural Science, 2:13-17.

**Borreani G., Chion A.R., Colombini S., Odoardi M., Paoletti R., Tabacco E., 2009 -** *Fermentative profiles of field pea (Pisum sativum), faba bean (Vicia faba) and white lupin (Lupinus albus) silages as affected by wilting and inoculation.* Animal Feed Science and Technology, 151: 316–323.

**Carvalho L., Di Berardino S., Duarte E., 2011 -** *Biogas production from mediterranean crop silages.* In: Thirteenth International Waste Management and Landfill Symposium S. Margherita di Pula, Cagliari, Italy.

**Clark S., 2014 -** *Plant guide for white lupine (Lupinus albus L.).* USDA-NRCS, Big Flats Plant Materials Center, Corning, New York *https://plants.usda.gov/plantguide/pdf/pg_lual22.pdf*

**Criste F.L., 2020 -** *Studies on the efficiency of using lupine seeds (Lupinus albus L.) as alternative protein source in poultry feeding.* PhD thesis summary, Cluj-Napoca.

**Dandikas V., Heuwinkel F., Drewes J.E., Koch K., 2014 -** *Correlation between biogas yield and chemical composition of energy crops.* Bioresource Technology, 174: 316–320.

**David G., Borcean A., Rada L., Imbrea F., Neșcu V., Botoș L., 2015 -** *Researches concerning the introduction of white lupin (Lupinus albus) into the agricultural crop in depressions from the Western part of Romania*. Research Journal of Agricultural Science, 47(1):63-67.

**Dobre P., Farcaş N., Matei F., 2014 -** *Main factors affecting biogas production - an overview.* Romanian Biotechnological Letters, 19(3): 9283-9286.

**Doležal P., Zeman L., Skládanka J., 2008 -** *Effect of supplementation of chemical preservative on fermentation process of lupine silage.* Slovak Journal of Animal Science, 41(1): 30 – 38.

**Duke J.A., 1981.** Handbook of legumes of world economic importance. Plenum Press, New York, USA, pp.345.

**Dubrovskis V., Adamovics A., Plume I., Kotelenecs V., Zabarovskis E., 2011 -** *Biogas production from greater burdock, largeleaf lupin and sosnovsky cow parsnip.* In: Proceedings of the 10th International Scientific Conference, Engineering for Rural Development, Jelgava, Latvia, 26-27 May 2011, 388-392.

**El Bassam N., 2010 -** *Handbook of bioenergy crops: a complete reference to species, development and applications.* Earthscan, London, UK, p.516.

**Faligowska A., Szukała J., 2009 -** *Influence of harvest date on chemical composition and yield of green forage white, yellow and narrow-leaved lupine.* Fragmenta Agronomica, 26(2):26–32. [in Polish].

**Faligowska A., Selwet M., Panasiewicz K., Szymańska G., 2014.** *Quality and hygienic conditions of white lupin silage, affected by forage stage of growth and use of silage additives.* Turkish Journal of Field Crops, 19(2): 261-266.

**Fikadu T.R., 2017**. *Biomass yield and nutritive value of sweet lupine in mid altitudes of Lemo district, Hadiya zone, Southern Ethiopia.* MSc thesis. Woliata Sodo University.

**Gladstones J.S., 1970.** Lupins as crop plants. Field Crops Abstr, 23:123–148.

**Hentschel W., Wiche O., 2016.** *Exudation of organic acids by Lupinus albus and Lupinus angustifolius as affected by phosphorus supply.* Geophysical Research Abstracts, 18: 16986 EGU2016-16986

**Hensgen F., Wachendorf M., 2016.** *The effect of the invasive plant species Lupinus polyphyllus Lindl. on energy recovery parameters of semi-natural grassland biomass.* Sustainability, 8, 998; doi:10.3390/su8100998

**Heuzé V., Thiollet H., Tran G., Lessire M., Lebas F., 2018.** *Yellow lupin (Lupinus luteus) seeds.* Feedipedia, a programme by INRA, CIRAD, AFZ and FAO. *https://www.feedipedia.org/node/23097*

**Heuzé V., Thiollet H., Tran G., Nozière P., Lessire M., Lebas F., 2019.** *White lupin (Lupinus albus) forage.* Feedipedia, a programme by INRA, CIRAD, AFZ and FAO. https://www.feedipedia.org/node/24347

**Jensen E.S, Peoples M.B., Boddey R.M., Gresshoff P.M, Hauggaard-Nielsen H., Alves B.J.R., Morrison M.J., 2012.** *Legumes for mitigation of climate change and the provision of feedstock for biofuels and biorefineries.* A review. Agronomy for Sustainable Development, Springer Verlag/EDP Sciences/INRA, 32 (2):329-364.

**Jansen P.C.M., 2006.** *Lupinus albus L. http://www.prota4u.org/search.asp*

**Kintl A., Vitez T., Elbl J., Vítězová M., Hammerschmiedt T., Nedělník J., Skládanka J., Brtnický M., 2019.** *Mixed culture of corn and white lupine as an alternative to silage made from corn monoculture intended for biogas production.* Bioenergy Research, 12: 694–702 10.1007/s12155-019-10003-y.

**Kurlovich B.S. (ed.) 2002.** *Lupins: Geography, classification, genetic resources and breeding*. St. Petersburg, Publishing house "Intan" p.468.

**Lança A.C., 1993.** A tremocilha (Lupinus luteus L.) na silvopastorícia do sul. Colectânea SPOC – Comunicações, 4, 111-119.

**Lucas M.M., Stoddard F.L., Annicchiarico P., Frías J., Martínez-Villaluenga C., Sussmann D., Duranti M., Seger A., Zander P.M., Pueyo J.J., 2015.** *The future of lupin as a protein crop in Europe*. Frontiers in Plant Science, 6, 705. doi: 10.3389/fpls.2015.00705

**Lehtomäki A., 2006.** *Biogas production from energy crops and crop residues*, University of Jyväskylä, p. 94.

**Lukashevich M.I., Ageeva P.A., Novik N.V., Zakharova M.V., 2018.** *Achievements and prospects of lupine breeding.* Dostizheniya nauki i tekhniki APK, 32(2):29-32 [in Russian]. doi: 10.24411/0235-2451-2018-10207.

**McDonald P., Edwards R., Greenhalgh J.F.D., Morgan C.A., Sinclai L.A., Wilkinson R.G., 2010.** Animal nutrition (7th edition). *http://gohardanehco.com/wpcontent/uploads/2014/02/Animal-Nutrition.pdf.*

**Mihailović V., Hill G. D., Mikić A., Ćupina B., Vasiljević S., 2008.** White lupin as a forage crop on alkaline soils. In: Proceedings 12th International Lupin Conference, Fremantle, Western Australia, p.79–82.

**Murphy-Bokern D., Stoddard F., Watson C., 2017.** Legumes in cropping systems. CAB International, p.270.

**Novoselov Y. K., Kharkov G.D., Shekhovtsova N.S., 1983.** *Methodical instructions for conducting field experiments with forage crops.* Ed.VNNIK, Moscow. [in Russian].

**Pakarinen A., Kymalainen M., Stoddard F.L., Viikari L., 2012.** *Conversion of carbohydrates in herbaceous crops during anaerobic digestion.* Journal of Agricultural and Food Chemistry, 60 (32): 7934-7940 DOI: 10.1021/jf301549b.

**Pietrzykowski M., Gruba P., Sproull G., 2017.***The effectiveness of Yellow lupine (Lupinus luteus L.) green manure cropping in sand mine cast reclamation.* Ecological Engineering, 102: 72-79.

**Prusinski J., 2017.** *White lupin (Lupinus albus L.) – nutritional and health values in human nutrition – a review.* Czech Journal of Food Sciences 35: 95–105.

**Struti D.I., Mierlita D., Simeanu D., Pop I.M., Socol C.T., Papuc T., Macri A.M., 2020.** *The effect of dehulling lupine seeds (Lupinus albus L.) from low-alkaloid varieties on the chemical composition and fatty acids content.* Revista de Chimie, 71(4):59-70.

**Terekhina N. V., 2008.** *Lupinus luteus* L.. http://www.agroatlas.ru/en/content/cultural/Lupinus_luteus_K/index.html

**Ţîţei V., Teleuţă A., Coşman V., Lupan A., Coşman S., 2015.** *Some biological peculiarities and biochemical composition of the species Lupinus perennis L. in the Republic of Moldova.* Lucrări Ştiinţifice, seria Agronomie, 58(2):169-174.

**Valderrama X., Anrique R., 2011.** In *situ rumen degradation kinetics of high-protein forage crops in temperate climates.* Chilean Journal of Agricultural Research, 71(4): 572-577. https://dx.doi.org/10.4067/S0718

**Wolko B., Clements J.C., Naganowska B., Nelson M. N., Yang H., 2010.** *Lupinus.* In: Kole C. (eds), Wild Crop Relatives: Genomic and Breeding Resources, Springer, Berlin, Heidelberg

**Zraly Z., Písariková B., Trãková M., Herzig I., Juzl M., Simeonovová J., 2006.** *Effect of lupine and amaranth on growth efficiency, health, and carcass characteristics and meat quality of market pigs.* Acta Veterinaria Brno, 75: 363-372.

# THE EFFICACY OF DIFFERENT IRRIGATION LEVELS ON THE YIELDS OF SOME SUMMER CROPS UNDER INTERCROPPING SYSTEMS

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**Abstract**

Field studies were performed between 2014 and 2019 on clay soil in a farmer's field in Al - Yadudeh area south of Amman - Jordan, to investigate the efficacy of different irrigation levels (0.40, 0.60 and 0.80 of field capacity) on the yields of bean, squash and okra as they are grown under sole cropping and intercropping systems, using 1:2 and 2:1 row arrangements. Results showed that the highest significant yields of bean (10.20 ton $ha^{-1}$) and squash (37.05 ton $ha^{-1}$) were obtained when minimum soil moisture level was maintained throughout the growing season at 0.60 of field capacity (FC) under 1:2 intercropping row arrangement, while the highest significant yield of okra (13.64 ton $ha^{-1}$) was registered when it was intercropped with bean in 1:2 row arrangement at minimum soil moisture level of 0.80FC. Additionally, okra intercropped with squash affected each other negatively and obtained the lowest significant yields specially, when they were grown under minimum soil moisture of 0.40 FC in 1:2 and 2:1 row arrangement respectively. Moreover, the highest significant yields of bean, squash and okra, as they are grown under sole cropping were obtained at minimum soil moisture level of 0.80FC, as compared to minimum soil moisture level of 0.40 and 0.60FC. It seems that squash was more beneficial to bean than okra and bean was more beneficial to okra and squash than squash to okra and okra to squash. Regarding the efficiency of intercropping as it was evaluated by land equivalent ratio (LER), the results showed that all the three combinations of intercropping with their row arrangements and under the three soil moisture levels gave LER values more than one, demonstrating the superiority of intercropping than sole cropping.

**Key words**: intercropping, soil moisture level, summer crop yields, efficiency

Irrigated agriculture in Jordan, as in many other countries, uses less of the available fresh water, and its contribution to the national products is also low. However, there is an increasing competition for water demand among household, industry and tourism; therefore, the efficiency of water use in irrigated agriculture must be raised to make it clear there is room for these requirements (IWAUP 2009).

Therefore, crop productivity and saving irrigation water are two main issues that raising a lot of concern nowadays. However, the scientific challenge is to find out a cropping system that could address these two issues considering water scarcity, in many of countries including Jordan.

Jose G.F Jr. (2018), indicated that intercropping could be a method, used to increase overall crop production without increasing water inputs. Willey R.W. (1979) and Sharaiha R., and Gliessman S. (1992) pointed out that intercropping is one of the multiple cropping systems, involving growing two or more crops in a given piece of land to produce a greater yield resulted from the complementary use of growth resources over time and space.

Additionally, Yu. Hong *et al*, (2019), mentioned that intercropping can reduce pressure on water resources through exploitation of complementarities between species. Moreover, Gaballa *et al*, (2007), concluded that soybean intercropped with corn in 1:2 row arrangement, could save up to 7% of irrigation amounts. Philip T. *et al* (2007), found that squash intercropped with corn affects corn yield negatively under limited soil moisture. Furthermore, Sharaiha R. and Hadidi N. (2008), in their study on microclimate effects on bean and potato yields grown under intercropping system, showed that bean plant seems to have beneficial effect on potato regardless to the variety.

It can be concluded also, that the higher yield of been as it was intercropped with potato resulted from the significant higher water use efficiency and lower evapotranspiration, especially under 2:2 bean/potato intercropping row arrangement. Moreover, Sharaiha R. *et al* (2012)

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and Bucur D. (2017, 2019) concluded that the highest yields of corn and potato yields were obtained under intercropping at soil moisture level of 75% FC, while that of fava bean intercropping was at 65% FC.

Since the amount of water applied under intercropping system depends on the crops combination and on intercropping row arrangements, more work of this nature is needed to provide more information and better understanding of these principles in order to optimize crop water productivity. Therefore, the objectives of this experiment were to study the effect of different soil moisture levels on the yields of bean squash and okra as they were grown under intercropping and sole cropping, and to evaluate the efficiency of intercropping according to land equivalent ratio (LER) under different row arrangements and soil moisture levels.

## MATERIALS AND METHODS

The experiment was initiated in the year 2014 and carried out in a farmer's field located in Yadudeh in Madaba region.

The farm is situated on a latitude 31°59°N, longitude 35°59°E, and at an altitude around 820m above sea level. Soil pH varied between 7.6 - 8.2, classified as a clay soil (66% clay, 21% silt and 13 % sand).

The climate of Madaba is a Mediterranean, characterized by dry hot summer (maximum average temperature of 32.7°and minimum average temperature of 20.4°C), mild wet winter (maximum average temperature of 12°C and minimum average temperature of 4.2°C), and extreme variability in rainfall within and among years. Composed poultry manure was applied (25 Mt. ha-1) two weeks before planting.

The manure used contained 1.22 % N, 1.3 % K and 1.5% P. Three summer crops namely okra (*Ablmoschus esculentus*, Local variety, squash (*Cucurbita maxima*), Jazi variety and been (*Phaseolus vulgaris*), Bronco variety were planted late March, using the same two row arrangements (1:2, and 2:1) for the three combinations; bean/ squash, bean/ okra, and squash okra), in addition to their sole crops.

However, three levels of soil moisture (40% FC, 60% FC and 80% FC) were used. Split plot design was employed with three replications, intercropping being the main plot, and the levels of soil moisture as sub plot (Figure 1). Each plot consisted of six rows 0.65 m apart and 4 m long, and within row spacing of 0.15 m for bean: 0.25 m for okra, and 0.35 m for squash.

Weeds were kept under control by hand weeding. Drip irrigation system was used by installing surface lateral plastic pipes of 16 mm diameter on every planting row in order to deliver water to plants. In line drippers with a discharge rate of 4 liters/hour and 40 cm spacing were used.

To monitor the applied volume of water, flow meters were connected to three replicates that have the same level of soil moisture (fig 1). Soil moisture measurements were taken in order to calculate the soil moisture level (SML), and amount of water is calculated according to the required SML using the following formulas SML= PWP+ 2/3(FC- PWP) and the amount of water for each level A= S x Bd x Rd x (FC - SML) / 100, where A= amount of water ($m^3$), S=surface area ($m^2$), Bd = bulk density ($m^3/m^3$), Rd=root depth (m).

However, the amount of water was recorded by water meter (Sisesti V. I., 1974). Average soil moisture measurements were taken by auger at 15, 45 and 75 cm depths.

## RESULTS AND DISCUSSION

*Bean Yield*

Results from this study (*table 1*), shows that bean sole crop gave different significant yield response when it was planted under three soil moisture levels (40%, 60%, and 80% of FC). However, bean sole crop grown under a soil moisture level of 80% FC, gave an increase in yield of 24% and 21% over the yield obtained by bean sole crop grown under 40% and 60% of FC, respectively. The higher yield of bean sole crop obtained under soil moisture of 80% FC could be attributed to the increasing in irrigation frequency that lead plant roots to absorb water from the soil much better and that might reflect positively on bean yield production. These present results are in general agreement with those obtained by Jianfang G. *et al*, (2019), in their study of the Effects of Irrigation Amount and Irrigation Frequency on Flue-Cured Tobacco Evapotranspiration and Water Use Efficiency.

When sole cropping and intercropping are considered, almost all intercropping combinations of bean with squash and with okra under the soil moisture levels of 40%, 60%, and 80% of FC, gave greater yields of bean than that produced under sole cropping at the same soil moisture levels. The higher intercropped bean yield might be due to the more efficient use of available resources per unit area. This fact has been reported previously by many researchers; S. Mahmud S. *et al,* 2018; Sharaiha R. *et al,* 2012; Yuan Y. *et al,* 2017.



Soil moisture level 0.40 FC



Soil moisture level 0.60 FC



Soil moisture level 0.80 FC

| | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T1 | | S | S | S | S | S | S | | T5 | B | B | O | B | B | O | | T3 | B | S | S | B | S | S |
| T2 | | S | S | O | S | S | O | | T7 | O | O | B | O | O | B | | T8 | O | O | O | O | O | O |
| T3 | | B | S | S | B | S | S | | T4 | O | O | S | O | O | S | | T7 | O | O | B | O | O | B |
| T4 | | O | O | S | O | O | S | | T8 | O | O | O | O | O | O | | T1 | S | S | S | S | S | S |
| T5 | | B | B | O | B | B | O | | T3 | B | S | S | B | S | S | | T2 | S | S | O | S | S | O |
| T6 | | B | S | S | B | S | S | | T1 | S | S | S | S | S | S | | T4 | O | O | S | O | O | S |
| T7 | | O | O | B | O | O | B | | T9 | B | B | B | B | B | B | | T5 | B | B | O | B | B | O |
| T8 | | O | O | O | O | O | O | | T6 | B | S | S | B | S | S | | T9 | B | B | B | B | B | B |
| T9 | | B | B | B | B | B | B | | T2 | S | S | O | S | S | O | | T6 | B | S | S | B | S | S |

Note: O: Okra. S: Squash B: Bean

Figure 1 **Experiment layout for one replicate**

*Table 1*, showed that bean intercropped with squash, under the three soils moisture levels (40% FC, 60% FC and 80% FC), gave a significant more yield production than bean planted with okra. The resulting average yield of bean planted with squash in 1:2 row arrangement was higher by 24.6% than the average yield of been grown with okra under the same row arrangement, regardless of the soil moisture levels.

While the resulting average yield of bean planted with squash in 2:1 row arrangement was higher by18.4% than the average yield of been grown with okra under the same row arrangement, regardless of the soil moisture levels. Moreover, when soil moisture levels (40% FC, 60% FC and 80% FC) are considered, the resulting average yields of bean planted with squash gave greater yields by 26.3%, 15.1% and 25.6% respectively, than the average yields of bean planted with okra under the same soil moisture level, regardless to the patterns of row arrangements.

Furthermore, when bean was intercropped with squash in 1:2 and 2:1 row arrangement under the three soil moisture levels (*table 1*), significant differences were not obtained. This could be due to the associated crop (squash plant) that might act as natural mulch reducing soil temperature, helping to hold moisture in soil, and might hide the effect of

the different soil moisture levels on bean yields. However, the same trend was obtained with bean when it was planted with okra. Moreover, contrary to these results was the effect of soil moisture levels on bean yields as it was planted with okra under the same row arrangement.

Table 1

**Effect of soil moisture levels, crop combination and intercropping row arrangements on yield of bean (ton ha$^{-1}$)**

| Treatments | Soil moisture level | | |
|---|---|---|---|
| | 0.40 FC | 0.60 FC | 0.80 FC |
| 1 row Bean 2 rows Squash | 9.80 ab | 10.20 a | 9.65 ab |
| 2 rows Bean 1 row Squash | 9.58 ab | 9.51 ab | 9.20 bc |
| 1 row Bean 2 rows Okra | 8.08 def | 8.42 de | 7.30 gh |
| 2 rows Bean 1 row Okra | 7.35 fg | 8.70 cd | 7.63 efg |
| Sole crop | 8.43 de | 6.93gh | 6.79 h |

The greatest bean yields were obtained when it was planted with okra under 60 % of FC in 2:1 (sig.) and 1:2 (insig.) as compared with the soil moisture level of 40% and 80 % of FC. It seems that bean grown with okra under 40% of FC is more sensitive to stress conditions due to long intervals between irrigations and also might be sensitive to soil moisture level of 80% of FC due to short intervals between irrigations.

Furthermore, almost all the intercropping results of bean gave higher significant yield production as compared to yield of bean sole crop under the same soil moisture levels. It is obviously clear that the best soil moisture level for bean as it was grown with okra in 2:1 row arrangement, under 60 % of FC, where it gave a significant increase of 14% and 18% over bean yield grown under 40% and 80% of FC within the same row arrangement, respectively, the same trend was observed when bean was intercropped with okra in 1:2 row arrangement. These cases might be due to the efficient use of resources. This fact has been mentioned by many researchers Yaan, R. *et al*, 2017; Sharaiha R. *et al*, 2004; Francis, 1985.

Additionally, when combinations (bean / squash and bean okra), cropping patterns (1:2 and 2:1 row arrangements), and the three soil moisture levels are considered (*table 1*). It seems that squash plants were more beneficial to bean than okra, under the same soil moisture levels and under the same row arrangements. It seems that the beneficial effect of squash on bean can be attributed to the efficient use of light due to the wider spaces between rows of bean created by the creeping stems of squash in 1:2 and 2:1 row arrangement. This fact was reflected significantly on the yields of bean that were intercropped with squash as compared to the bean intercropped with okra under the different soil moisture levels and the different cropping pattern. These results also could be attributed to the contrasting nature of the two associated crops, whereas squash with its creeping stem sprawling around the bush bean plants.

Thus, squash plant might act as a natural mulch and helping to hold moisture in soil that was utilized by bean plants instead of being lost through soil evaporation as in the case with okra. Similar results were obtained by Gliessman S (1988), working on Corn, bean and squash intercropping, and Haddidi *et al* (2011), working on the effect of intercropping on the performance of some summer crops grown under different row arrangements.

*Squash Yield*

There were no significant differences in yield of squash grown as a sole crop under the different soil moisture levels used (40%, 60 % and 80 % of FC) (*table 2*). This might indicate that there was no intra-specific competition among squash plants, since the stem of squash plants were creepy and prone to lighting. In addition, the creepy stem of squash might act as natural mulch, thus reducing soil temperature and helping to hold moisture in soil. As such, the effect of different soil moisture levels on bean yields might be hidden. Moreover, the competition for nutrition was also excluded since organic fertilizer was provided in adequate quantities. When a comparison is made between the yields of squash grown with bean or with okra, it is obvious that the yield of squash intercropped with bean gave greater yields than squash intercropped with okra, under all soil moisture levels used. Whereas, it gave an average significant increase of 15.1%, 33% and 26.7% over the average yields of bean grown with okra under the three soil moisture

levels of 40%, 60 % and 80 % of FC, respectively, regardless to the cropping pattern of row arrangement used. It was noticed that squash grown with bean in 1:2 intercropping row arrangement gave a significant increase of 34% in average yield over the average yield of bean grown with okra under the same row arrangement, regardless of soil moisture level. However, when squash was grown with bean under 2:1 intercropping row arrangement, an increase in average yield of 16.5 % was obtained over the yield produced by squash grown with okra under the same row arrangement (2:1), regardless of soil moisture levels. The beneficial effect of bean on squash was expected since been used to fix atmospheric nitrogen in the soil that might be beneficial to squash crop. This fact was revealed by other researchers [Sharaiha, R. and R. Kluson (1994), Ananthi, T. et al., (2017), and Michael K. et al., (2017).

Table 2

**Effect of soil moisture levels, crop combination and intercropping row arrangements on yield of squash (ton ha$^{-1}$)**

| Treatments | Soil moisture level | | |
|---|---|---|---|
| | 0.40 FC | 0.60 FC | 0.80 FC |
| 1 row Squash 2 rows Bean | 30.82 b | 37.05 a | 28.57 cd |
| 2 rows Squash 1 row Bean | 35.77 a | 29.70 bc | 28.72 cd |
| 1 row Squash 2 rows Okra | 25.58 d | 23.09 e | 22. 83 e |
| 2 rows Squash 1 row Okra | 26.84 d | 27.05 d | 26.92 d |
| Sole crop Squash | 28.41 cd | 28.37 cd | 27.82 cd |

Furthermore, when squash was intercropped with bean in 1:2 and 2:1 row arrangement, higher been yields were obtained under all soil moisture levels than squash sole crop under the same soil moisture level. However, the greatest significant yields were obtained in 60% and 80% of FC as compared with squash sole crop grown under the same soil moisture level. Moreover, when squash was intercropped with okra, no significant differences in squash yields were obtained under all soil moisture levels compared to sole squash yield grown under the same moisture level.

An exception was recorded when squash was planted with okra in 1:2 row arrangement, under 40% and 60% of Fc where it gave a significant decrease in yield of 21.2% and 22.9% over the yield of squash sole crop grown under the same row arrangement. This variation in squash yields might indicate that the different amounts of water applied under the three soil moisture levels, the two different patterns and the associated crops might play an important role in modification of microclimate and consequently reflect on the yield of squash. Similar results were obtained by Sharaiha, R. and A. Battikhi (2002), in their study on potato / corn intercropping - Microclimate modification and yield advantages and by Sharaiha R. and Hadidi N. (2007) in their work on environmental impact on yield of peas and okra grown under intercropping.

*Okra Yield*

The combined analysis of variance for okra yield showed significant variation for its yield when it was grown under sole cropping and intercropping with bean and squash under three soil moisture levels (40%, 60% and 80% of Fc) Table (3). However, when okra was planted as a sole crop under 80 % of FC, a significant increase in yield of 91% and 94.8% over the yield of okra sole crop grown under 40 % and 60% of FC, respectively. Similar results were obtained by Fapohunda H.O. (1992) in his study on irrigation frequency and amount for okra and tomato using a point source sprinkler system, and in full agreement with Ganesh B. I. *et al*, (2015).

Additionally, the same trend was with okra grown in association with bean under 80% of FC, where it gave an average increase in yield of 48% and 42% over the average yields obtained under 60% and 40% of FC, respectively, regardless to the row arrangement patterns.

However, the same trend was observed when okra was grown with squash under 80 % of FC, where an average increase in okra yield of 32% and 55.8 % over the average yields of okra grown with squash under 60% and 40% of FC, respectively. This fact has been postulated by Hassan *et al*, (2011), who explained that the shorter intervals between irrigations gave the highest fruit yield and greatest number of roots than longer intervals.

On the other hand, when okra was grown in association with squash and bean in 1:2 and 2:1

row arrangement under the three treatments of soil moisture levels, significant higher yields were obtained compared to okra sole crop grown under the same soil moisture level. These results might suggest that the associated crops (squash and bean) have beneficial effect on okra.

However, the beneficial effect of bean on okra generally was much better than squash on okra under the same soil moisture levels (40%, 60% and 80% of Fc), and under the same two patterns of row arrangements (1:2 and 2:1). This could be explained that the fixation of atmospheric nitrogen in the soil by bean crop, hence, nitrogen contribution to okra plants during the same growing season. This fact has been indicated by many researchers (Olasantan, F. (1998); (Sharaiha, R. and R. Kluson, 1994); (Ruschel *et al*, 1979); and (Lal *et al*, 1978).

Moreover, okra grown with squash also gave significant higher yield than the yield of okra sole crop regardless of the soil moisture levels. The beneficial effect of squash on bean provided from the efficient use of light due to the wider spaces between rows of bean created by the creeping stems of squash in 1:2 and 2:1 row arrangement that might create different micro-environments and reflect positively on okra yield. These results appeared to be in full agreement with the findings of Trenbath, B. R. (1976) who elucidated that a plant with usually long shoot, such as okra, in a dens sole crop would negatively affect lighting and, consequently leads to a poor root / shoot ratio due to the scarce of photosynthesis.

Furthermore, Table (3), showed that when okra was intercropped with bean in 1:2 and 2:1 row arrangement, no significant differences in yields were obtained between the two row arrangement under the same soil moisture level. In contrast, significant difference in okra yields were obtained within each row arrangement among the three soil moisture levels. These results might indicate that the effect of soil moisture levels on okra yield is stronger than the effect of row arrangement, (in case of okra was planted with bean). However, when okra was planted with squash, this conclusion was not observed since there is a significant difference in okra yield between the two row arrangements under 60% of FC.

Table 3

**Effect of soil moisture levels, crop combination and intercropping row arrangements on yield of okra (ton ha$^{-1}$)**

| Treatments | Soil moisture level | | |
|---|---|---|---|
| | 0.40 FC | 0.60 FC | 0.80 FC |
| 1 row Okra<br>2 rows Bean | 13.64 a | 9.37 cd | 9.26 cd |
| 2rows Okra<br>1 row Bean | 12.99 a | 8.59 d | 9.44 cd |
| 1 row Okra<br>2 rows Squash | 10,58 b | 8.42 d | 6.47 e |
| 2 rows Okra<br>1 row Squash | 9.93 bc | 7.02 e | 6.69 e |
| Sole crop Okra | 8.92 d | 4.58 f | 4.67 f |

Therefore, the varied results of okra yields are due to soil moisture level, intercropping combination (as it was grown in association with bush bean and squash), and intercropping pattern (1:2 and 2:1). Similar results were obtained by Sharaiha R. *et al*, (2012) in their work on intercropping of potato, faba bean and corn under different intercropping levels of irrigation.

*Land Equivalent Ratio*

Land equivalent ratio (LER) is the measure of production efficiency of different systems by convening the production in terms of land. The FAO defines land equivalent ratio (LER) as the ratio of the area under sole cropping to the area under intercropping needed to give equal amounts of yield at the same management level. Therefore, it is the sum of the fractions of the intercropped yields divided by the sole-crop yields. It has been used by many researchers; Willey (1979); Natrajan and Wiley (1980); Gliessman (1998), Sharaiha and Battikhi (2004), and Aliyeh *et al*, (2018).

When the value of LER is greater than one, it indicates the efficiency of intercropping system over the sole cropping system. Thus, *table 4* verified that all intercropping combinations under two patterns and three soil moisture levels gave a LER more than one. This could be credited to better use of resources by the two crops that are grown in association. The total LER and the relative LER values were variable and affected by the soil moisture levels, crop combinations and intercropping patterns (row arrangements).

This was expected, since each combination and row arrangement pattern under different soil

moisture levels, create a different local climate that might change the competition for light moisture and nutrients. Furthermore, when soil moisture levels are considered, the lowest values of LER were obtained under 80% of FC, regardless to crop combinations and row arrangements.

However, this was not found to be true in 1:2 bean / squash intercropping row arrangement *Table 4*, where the highest LER value (1.23) was obtained with more contribution of squash. Squash gave 18% more than it was expected from a sole squash crop planted in 2/3 of the land, while the contribution of bean was only 6%, but more than it was expected from sole bean crop planted in 1/3 of the land.

Table 4

**Relative land equivalent ratio (LER), total LER of bean, squash and okra grown in different row arrangements (1:2 and 2:1) and soil moisture levels (SML)**

| Treatments | SML 0.40 FC | | Total LER | SML 0.60 FC | | Total LER | SML 0.80 FC | | Total LER |
|---|---|---|---|---|---|---|---|---|---|
| | R Y | R LER | | R Y | R LER | | R Y | R LER | |
| 1 row Bean<br>2 rows Squash | 3.21<br>19.15 | 0.47<br>0.68 | 1.15 | 3.40<br>19.80 | 0.49<br>0.70 | 1.19 | 3.27<br>23.85 | 0.39<br>0,84 | 1.23 |
| 2 rows Bean<br>1 rows Squash | 6.13<br>9.52 | 0.90<br>0.34 | 1.24 | 6.34<br>12.35 | 0.91<br>0.43 | 1.34 | 6.38<br>10.27 | 0.76<br>0.36 | 1.12 |
| 1 row Bean<br>2 rows Okra | 2.43<br>6.29 | 0.36<br>1,35 | 1.71 | 2.81<br>5.73 | 0.40<br>1.25 | 1.65 | 2.69<br>8,66 | 0.32<br>0.97 | 1.29 |
| 2 rows Bean<br>1 row Okra | 5.09<br>3.09 | 0.75<br>0.66 | 1.41 | 5.80<br>3,12 | 0.84<br>0.68 | 1.52 | 4.90<br>4.55 | 0.58<br>0.51 | 1.09 |
| 1 row Okra<br>2 rows Squash | 2.15<br>17.95 | 0.46<br>0.64 | 1.10 | 2,81<br>18.03 | 0.61<br>0.64 | 1.25 | 3.53<br>17.89 | 0,39<br>0.63 | 1.02 |
| 2 rows Okra<br>1 row Squash | 4.46<br>7.61 | 0.95<br>0.27 | 1.22 | 4,68<br>7.70 | 1.02<br>0.27 | 1.29 | 6.62<br>8.53 | 0.74<br>0.30 | 1.04 |

Note: Yields of bean ton $ha^{-1}$ sole crop at: 0.40 FC = 6.79; 0.60 FC = 6.93; 0.80 FC Bean= 8.43
Yields of squash ton $ha^{-1}$ sole crop at: 0.40 FC = 27.82; 0.60 FC = 6.93; 0.80 FC Bean= 8.43
Yields of okra ton $ha^{-1}$ sole crop at: 0.40 FC= 4.67; 0.60 FC = 6.93; 0.80 FC Bean= 8.4

Both crops were benefited from each other but to varying degrees in favor of squash and this was termed by Willey (1979); and Gliessman (1988); as mutual cooperation. Similar results were obtained by Sharaiha and Battikhi (2002) in their study on potato / corn intercropping: Microclimate modification and yield advantages.

Moreover, bean planted with squash gave higher values of relative LER than bean planted with okra under the same soil moisture levels and row arrangements. This could be attributed to okra plant because it became more competitive and depressed the associated crop bean yields to a greater degree with decreasing soil moisture levels.

Accordingly, the contribution of bean planted with squash was much better than the contribution when it was planted with okra under all soil moisture levels used. This was expected due to the contrasting nature of the two associated crops (okra and bean) that reflected on their yield production and consequently on the relative values of LER.

This trend was observed when okra was planted with squash as compared to bean planted with squash, and hence, the contribution of squash was much better with bean than with okra. The negative effect of okra on the relative LER of squash was stronger than on the relative LER of bean. This is because the values of relative LER for squash grown with okra were less than expected from a sole squash crop planted in 2/3 and/or 1/3 of the land, under all soil moisture levels and row arrangements.

From the above discussion, it seems that LER was affected to a certain degree by the interaction among soil moisture levels, crop combination and by cropping pattern. Thus, each factor affects and is affected by, all the other.

## CONCLUSSIONS

1. The results of this work indicated that the yields of bean, squash and Okra grown under intercropping were more affected by soil moisture levels as compared with the corresponding sole crops.

2. Bean and squash gave higher yields under a soil moisture level of 0.60 FC when they are grown under 1:2 intercropping row arrangement, while that of okra was at 0.80 FC under 1:2 okra / bean intercropping row arrangement.

3. Bean seems to have more beneficial effect on okra and squash than that of each other.

4. The efficiency of intercropping as it was judged by LERs was higher than that of sole cropping, but their values depended on soil moisture level, crop combinations and raw arrangements.

## REFERENCES


**Aliyeh S., Sina F., Reinhard N., Bano M., Hans P. K., 2018** - *Growth analysis and land equivalent ratio of fenugreek buckwheat intercrops at different fertilizer types*. Journal of Land Management, Food and Environment Volume 69, Issue 2, 105-119.

**Al-Qahwaji A., 1995** - *Production Function Determination of Row Intercropping between Broad Bean and Potato under Different Water Amounts under Central Jordan Valley Condition*. M.Sc. Thesis, Univ. of Jordan, Amman.

**Ananthi T., Amanullah M. M., Al-Tawaha A. M. 2017** - *A Review on Maize- Legume Intercropping for Enhancing the Productivity and Soil Fertility for Sustainable Agriculture in India*. Advances in Environmental Biology, 49 - 63.

**Bucur D. ed., 2019** - *Advanced Evapotranspiration Methods and Applications*, IntechOpen, London, DOI: 10.5772/intechopen.73720, 128 pages, ISBN: 978-1-78985-811-2 https://www.intechopen.com/books/current-perspective-to-predict-actual-evapotranspiration.

**Bucur D. ed.**, **2017** - *Current Perspective to Predict Actual Evapotranspiration*, InTech, Rijeka, ISBN 978-953-51-3173-1, 114 pages.

**Francis C.A., 1985** - *Variety Development for Multiple Cropping Systems*. CRC. Critical Review LN Pl. Sc. 3, (2):133- 138

**Gaballa M.S., Quda S. A., Khalil F. A. l., 2008** - *Effect of Water Stress on The Yield of Soybean and Maize Grown Under Different Intercropping Patterns*. Twelfth International Water Technology Conference, IWTC12, Alexandria Egypt. 611-624.

**Ganesh R. B., Bhaskara I.R.A., Raja K.N. R., 2015** - *Response of Okra to Different Levels of Drip Irrigation on Growth, Yield and Water Use Efficiency*. International Journal of Agricultural Engineering, Volume 8, Issue 1, 47-53.

**Gliessman S. R., 1988** - *Agroecology: Ecological Process in Sustainable Agriculture*. Chap. 14. Genetic Res. In agroecosystem. Edit. Eric Engles. Ann Arbor Press: 193 - 212.

**Hadidi N., Sharaiha R.K., 2011** - *Effect of Intercropping on the Performance of some Summer Crops Grown under Different Row Arrangements*. Lucrări ştiinţifice - vol. 54, Nr. 2/2011,

**I.W.A.U.P., 2009** - *Irrigation Water Allocation and Use Policy*_ar.doc-

**Jose G.F., Stepphen R.K., Volder A., 2018** - *Component Crop Physiology and Water Use Efficiency in Response to Intercropping*. European Journal of Agronomy 93:27-39 ·

**Jianfang G., Shao X.H., Miao Q., Yang X., Gao C., 2019** - Effects of Irrigation Amount and Irrigation Frequency on Flue-Cured Tobacco Evapotranspiration and Water Use Efficiency Based on Three-Year Field Drip-Irrigated Experiments. Agronomy J. 9(10), 624.

**Lal R., De R., Singh R. K., 1978** - Legume Contribution to Fertilizer Economy in Legume Cereal Rotations. India J. Agr. Sc. :48:419 = 424.

**Mahmud S., Alam M.M., Rahman M.M., Amin M., Hassan M.M. H., 2018** - *Productivity and Economics of Maize-Squash Intercropping at Different Planting Systems*. J Bangladesh Agricultural Univ. 16(1): 23-26.

**Natrajan M.A., Willey R.W., 1980** - *Sorghum Pigeon Pea Intercropping and The Effect of Plant Population Density to Resource Use*. J. Agr. Sc. Camb. 95: 59 - 69.

**Olasantan F.O. 1998** - *Effects of Preceding Maize and Cowpea in Sole-Cropping and Intercropping on Growth Yield and Nitrogen Requirement of Okra*. J. Agric, Sc. Camp. 131:293- 298.

**Philip T.F., S.R. Gliessman J.H. Langgenheim, 2007** - *Factors in The Suppression of Weeds by Squash Inter-Planted in Corn*. J. Of Weed biology and management.Vol.7 Issues2.

**Ruschel A.P., E. Salati, P.B. Vosc, 1979** - *Nitrogen Enrichment of Soil and Plant by Rhizobium Phasoeoli, Phaseolus Vulgaris Sybiosis*. Plant soil 51, :425- 429.

**Sharaiha R.K., H. M. Saoub, O. Kafawin, 2004** - Varietal Response of Potato, Bean and Corn Intercropping. J. Dirasat, Agr. Sc., Vol. 31, No.1

**Sharaiha R.K., M. Shatanawi, N. Haddidi, 2012** - *Intercropping of Potato, Faba Bean and Corn under Different Intercropping Levels of Irrigation*. Agricola montologie cadastru, Lucrari Stiintifice. Vol. XLII. 20 - 28.

**Sharaih R.K., Battikhi A.M., 2004** - A *Study on Potato Corn Intercropping-Microclimate Modification and Yield Advantages*. Dirasat Journal, Vol.29, No. (2), 97-107

**Sharaiha R.K., Kluson., R. A. 1994** - *Di Nitrogen Fixation of Faba Bean as Affected by Intercropping System with Pea and lettuce*. Dirasat. Agrc. Sci., 21B. (4):127-133.

**Sharaiha R.K., Hadidi N.A., 2008** - *Micro Environmental Effects on Bean and Potato Yields Grown Under Intercropping System*. Lucrări - Ştiinţifice. Editura Ion Ionescu de la Brad. Iasi. Vol. 51: 209-219.

**Sharaiha R.K., N. Hadidi, 2007** - *Environmental Impact on Yield of Peas and Okra Grown Under intercropping*. Lucrări - Ştiinţifice. Editura Ion Ionescu de la Brad. Iasi. Vol. 50 :313-323.

**Sisesti V. I., 1971** - *CulturIrigate, Editura Didactica Si Pedagogica-Bucuresti*.

**Trenbath B.R., 1976** - *Plant Interactions in Mixed Crop Communities*. Multiple Cropping Symposium Proceedings, American Society of Agronomy. Annual Meeting. Tennessee, 24 - 29 August.

**Willey R.W. 1979** - *Intercropping and Research Needs*. Part 1. Competition and yield advantages. Field crops Res. 25: 83 - 97

**Yuan Y., U. Ren X.L., Wang S.Q., Zhang J. ., Palta Yi., Chen. L. 2017** - *Influence of Spatial Arrangement in Maize-Soybean Intercropping on Root Growth and Water Use Efficiency*. Plant and Soil, 415:131-144.

# THE EFFECT OF *CHAETOMIUM GLOBOSUM* AND ORGANIC FERTILIZER ON THE SWEET PEPPER VARIETIES GROWTH AND YIELD UNDER THE GREENHOUSE CONDITIONS

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**Abstract**

This experiment was conducted at horticulture college (USAMV Bucharest) during the summer season of the year 2017 to investigate the growth and yield of sweet pepper varieties (Dinamica f1, Abadia f1 and Abadia f1-grafted on emperador) planted under the greenhouse as influenced by Dix 10 n (organic fertilizer) with dose (300 g/m2 dix 10n) and soil contaminated with *Chaetomium globosum* fungus. The results of the experiment demonstrated that the highest plant height between the varieties were represented by Dinamica recorded 69.66cm while the maximum plant height between the interaction treatments recorded with (Dinamica + (D+CG), Dinamica + CG and Abadia G+ CG evaluated (89.66, 87.66, 84.00 cm) respectively. While the highest percentage of aerial plant dry matter represented by the interaction treatments of Dinamica + (D + CG) and Abadia G + (D + CG) which reached to (18.56 and 18.53 %) respectively. While the minimum effect for percentage of root dry matter obtained (15.20 and 16.20 %) for control treatment of (Abadia and Abadia G) respectively. The highest yield of plant (Dinamica + (D + CG), Abadia G (D + CG) and Abadia (D + CG)) were recorded lowest yield per plant were (1367.66, 1363.00 and 1325.66 g) respectively. The highest chlorophyll content in leaves were (135.30 and 117.53 µmol m-2) in Abadia G (D + CG) and Abadia G + CG respectively. The minimum photosynthesis value was 7.36 µmol m-2 s-1 in Abadia G (D + CG). The maximum of highest N-$NO_3$ was in Dinamica + (D+CG) treatment which reached to 90.13 ppm, while the highest $PO_4$ level was observed in Abadia + D treatment which recorded 198.87 ppm and the highest level of K was in Abadia G + CG which reached to 4066.66 ppm.

**Key words**: *Chaetomium globosum*, fertilizer, greenhouse, plant growth, sweet pepper varieties

Sweet pepper (*Capsicum annuum L*) is a member of the solanaceous fruity vegetables group (El-Bassiony *et al*, 2010). Pepper is grown as an annual crop because of its sensitivity to frost and it is in fact an herbaceous perennial and a good survivor and gave a yield for several years in tropical climates (Vasile *et al*, 2010). The nutritional significance of the pepper crop is due to its high vitamin C content which reached to six times as much vitamin C as orange (Bosland and Votava, 2007).

Pepper is a very rich source of vitamin A, which consider as opulent source of beta-carotene which turns into vitamin A and work on protects the skin and body tissues, the green bell pepper can supply up to 8 percent of the recommended daily allowance of Vitamin A, 180 percent of Vitamin C, 2 percent of calcium and 2 percent of iron (Kelley and Boyhan, 2009). Sweet peppers *Capsicum annuum L.* (*C. annuum*) are an excellent source of phenolic compounds, which are important antioxidant components that may reduce the risk of diseases (Yazdizadeh Shotorbani *et al*, 2013).

Chaetomium species are usually found in soil and organic fertilizer. *Chaetomium* is one of the largest genera of saprobic ascomycetes with more than 300 species worldwide (Soytong and Quimio, 1989). *Chaetomium globosum* is a potential bio control agent against various seed and soil borne pathogens. Plant pathogens are the main threat for profitable agricultural productivity. In the modern, intensified agriculture, the efficient management of plant diseases is essential. At present the most reliable means of doing this is by the use of fungicides. Fungicides are the toxic substances which either kill or check the growth of the fungi. During the last two decades, fungicide research has produced a diverse range of fungicidal products with novel modes of action which had a significant impact on plant disease control. The

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need for new and innovative fungicides is driven, among other factors, by resistance management, regulatory hurdles, and increasing customer expectations. Compounds having a novel mode of action are of course of special interest, since they play a key role in resistance management strategies, but equally important are new fungicides with enhanced characteristics such as systemicity, curativity, and longevity of disease control. The technical feature of new generation fungicides is to target specific action and to be safer to non-target sites. Over the past few years, however, several truly novel compounds have been launched commercially and have reached an advanced stage of development, which include with effects on respiration, cell membrane components, protein synthesis, signal transduction and cell mitosis. Many of the important plant diseases, which were not controlled satisfactorily by the previous traditional fungicides, can now be well managed by the new compounds which are mostly systemic in nature. In view the risk of resistance development with most of the systemic, site specific compounds, there is a need to develop more classes of fungicide with novel target sites (Nadi *et al,* 2017). Currently, Chemical fungicides are highly effective and convenient to use but they are a potential threat for the environment. Therefore, the use of biocontrol agents for the management of plant pathogens is considered as a safer and sustainable strategy for safe and profitable agricultural productivity. Many experiments and studies revealed by various researchers *C. globosum* used as plant growth promoter and resulted into high yield of crops in field conditions. *C. globosum* produces pectinolytic enzymes polygalacturonate transeliminase (PGTE), pectin trans-eliminase (PTE), viz., polygalacturonase (PG), pectin methyl esterase (PME), protopectinase (PP), xylanase and cellulolytic (C and C) 1 xenzymes and various biologically active substances, such as chaetoglobosin A, *Chaetomium* B, C, D, Q, R, T, chaetomin, chaetocin, chaetochalasin A, chaetoviridins A and C (Ashwini, 2019). Bio-control technology of plant diseases has successfully been demonstrated, either completely or partially, when integrated with other control measures for appropriate disease management. Biological products are useful, not only for the protection against plant diseases, but can also be used for curative effects of plant diseases, and also promote plant growth (Soytong *et al,* 2001). The aim of experiment was to determine nutritional quality of DIX 10N (organic fertilizer) and *C. globosum* to produce highest parameters growth and yield in sweet pepper varieties.

## MATERIAL AND METHOD

This experiment was conducted at Horticulture Faculty (USAMV) in Bucharest during the summer season of the year 2017 to investigate the effect of providing DIX 10N (D) (organic fertilizer) at rate (300 g/m2) and soil contaminated with *C. globosum* at rate (1% fungus per water) on growth and yield of sweet pepper varieties: Dinamica F1, Abadia F1 (non-grafted) and Abadia grafted (G) on emperador variety (tomato rootstock). All the seedlings bought from the local market and planted in 14-04-2017 under the greenhouse. The distance 0.5 m between plants in the same row and 0.8 m between rows, the Dix10N fertilizer was provided to the soil before planting and the contamination with *C. globosum* done by injected to the root system after planting by a week.

The experimental soil was sandy loam in texture with pH of 6.55, E.C of 0.180 $dSm^{-1}$. The available $N\text{-}NO_3$ of 34.33 ppm, $N\text{-}NH_4$ of 112.54 ppm, phosphorus and potassium contents were 21.0 ppm and 177.72 ppm respectively. Randomized complete block design (factorial) consisted of 3 randomized blocks with 4 treatments of bio fertilizer (Dix10 N, *C. globosum* (CG), Dix10 N (N) + *C. globosum* (N+CG) and control (C)) and 3 cultivars (Dinamica, Abadia and Abadia G). Each treatment consisted of 3 replicates and each replicates cultivated by 5 plants. Plants were irrigated using drip irrigation when needed depending on the moisture status of the soil and requirement of plants, also plants were kept free from weeds, insects, and diseases using standard growing management. The results were taken after 9 weeks for each plant harvested, the data were subjected to analysis of variance (ANOVA) the statistical systems (SAS 6.12) package. Comparison of multiple means was performed using the least significant difference (LSD) test at the 5% the following growth and yield parameters were measured:

Plant height (cm): Measured the length of the plant from the soil surface up to the highest point in the main stem every week.

2. Total yield (g): done by collect the fruits from each replicate then weight them and divided to get the average of plant yield.

3. Photosynthesis (µmol $m^{-2}$ $s^{-1}$): estimated after 4 weeks by using a portable device LCi (ADC BioScientific Ltd.).

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

5. Chlorophyll content in leaves (µmol $m^{-2}$): determinate by using Chlorophyll meter device (CCM-200 PLUS).

6. N-$NO_3$ leaf content according to Katrina (2001)
7. (P-$PO_4$ and $KO_4$) leaf content according to (Ministerul Agriculturii Si Indutiei Almentare Academia De Stilnte Agricole Sisilvice, 1981).

## RESULTS AND DISCUSSIONS

All treatments tended to increase the yield and vegetative growth parameters of sweet pepper compared with the control. The unfertilized plants produced the poorest plants compared with other fertilizer treatments. In (*figure 1*), it's clearly showed difference in the growth pattern between the pepper varieties due to the effect of varieties and the application of Dix 10N and *C. globosum* which improved nutrition of the plants. The highest plant height between the varieties were represented by Dinamica recorded 69.66 cm while the maximum plant height between the interaction treatments recorded with (Dinamica + (D+CG), Dinamica + CG and Abadia G+ CG evaluated (89.66, 87.66, 84.00 cm) respectively.

*Chaetomium* spp. has been reported to increase plant growth parameters and yields of many kinds of plants. The natural products or fungal metabolites released from *Chaetomium spp.* also reported to increase plant growth, yield and induce plant immunity. It can be developed as a bio fertilizer to increase in plant growth and yield in several kind of economic plants (Song and Soytong, 2017). Also, this results agree with (Volkan and Hakan, 2018) found that plants of pepper height were slightly influenced by grafted. In addition to the effect of organic fertilizer Dix 10 N (D) contains a large percentage of organic elements that are essential for maintaining soil fertility, eases up the gradual absorption of the nutrients from the soil, improves soil structure and increases water retention capacity (Nicolae *et al*, 2014).

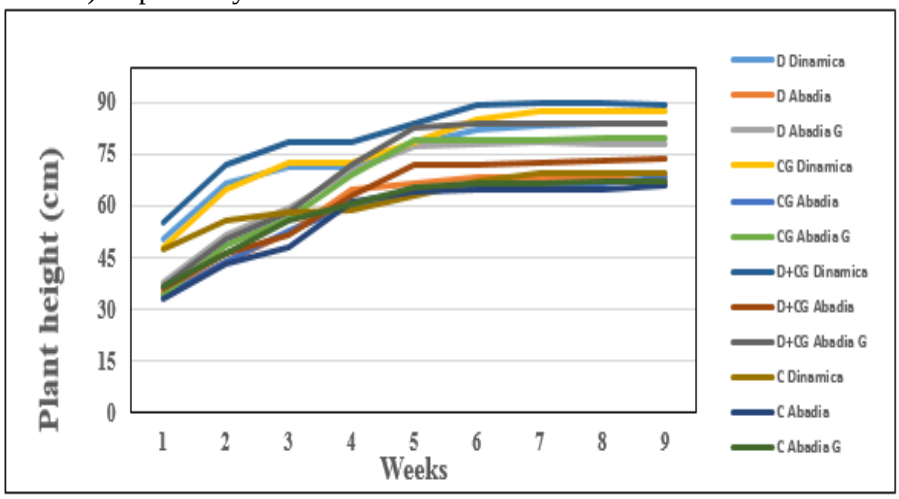



Figure 1 **The effect of varieties and the application of Dix 10N and *Chaetomium globosum* on pepper growth**

**Effect the interaction between (D and *CG*) and varieties on some plant growth, yield parameters, chlorophyll and photosynthesis**

Data in *table 1* showed significant effects of the interaction treatments between varieties and (D and CG). All the individual interaction treatments between the varieties and any of applications D or CG indicated differences in the degree of response between the individual interactions. However, the highest percentage of aerial plant dry matter represented by the interaction treatments of Dinamica + (D + CG) and Abadia G + (D + CG) which reached to (18.56 and 18.53 %) respectively.

While the minimum effect for percentage of root dry matter obtained (15.20 and 16.20 %) for control treatment of (Abadia and Abadia G) respectively. The highest yield of plant (Dinamica + (D + CG), Abadia G (D + CG) and Abadia (D + CG)) were recorded lowest yield per plant were (1367.66, 1363.00 and 1325.66 g) respectively. The highest chlorophyll content in leaves were (135.30 and 117.53 µmol $m^{-2}$) in Abadia G (D + CG) and Abadia G + CG respectively. The minimum photosynthesis value was 7.36 µmol $m^{-2}$ $s^{-1}$ in Abadia G (D + CG).

Table 1

**Table 1 The effect varieties with D and CG on yield and some growth properties of sweet pepper**

| Treatments | Varieties | Plant dry matter% | Root dry matter % | Plant yield (g) | Chlorophyll µmol $m^{-2}$ | Photosynthesis µmol $m^{-2}$ $s^{-1}$ |
|---|---|---|---|---|---|---|
| D | Dinamica | 17.63 | 22.36 | 1288.66 | 107.70 | 6.40 |
| | Abadia | 16.36 | 20.73 | 1194.00 | 102.80 | 7.10 |
| | Abadia G | 18.06 | 21.96 | 1293.00 | 103.23 | 6.86 |
| CG | Dinamica | 15.66 | 20.93 | 1285.66 | 112.50 | 6.10 |
| | Abadia | 16.26 | 22.86 | 1181.00 | 104.33 | 6.06 |
| | Abadia G | 16.20 | 24.33 | 1235.33 | 117.53 | 6.13 |
| D + CG | Dinamica | 18.56 | 22.06 | 1367.66 | 114.73 | 6.90 |
| | Abadia | 17.40 | 22.96 | 1325.66 | 108.23 | 6.70 |
| | Abadia G | 18.53 | 24.90 | 1363.00 | 135.30 | 7.36 |
| C | Dinamica | 13.06 | 19.13 | 1178.33 | 75.46 | 5.36 |
| | Abadia | 14.80 | 15.20 | 1132.66 | 92.06 | 5.23 |
| | Abadia G | 13.06 | 16.20 | 1196.00 | 90.63 | 5.87 |
| **L.S.D** | | **1.25** | **1.09** | **22.41** | **2.17** | **1.19** |

**Effect the interaction between (D and T) and varieties on NPK concentration in leaves**

The analysis showed in Table (2) superior concentration of NPK in pepper leaves with all combinations between varieties and (D + CG).

For the individual interactions between varieties and/or D and CG estimated that all varieties interactions with CG application recorded highest effect for NPK. The maximum of highest $N\text{-}NO_3$ was in Dinamica + (D+CG) treatment which reached to 90.13 ppm, while the highest $PO_4$ level was observed in Abadia + D treatment which recorded 198.87 ppm and the highest level of K was in Abadia G + CG which reached to 4066.66 ppm.

Table 2

**The effect of D and *CG* on NPK content in leaves of sweet pepper varieties**

| Treatments | Varieties | $N\text{-}NO_3$ ppm | $PO_4$ ppm | K ppm |
|---|---|---|---|---|
| D | Dinamica | 85.13 | 149.66 | 3973.33 |
| | Abadia | 61.33 | 198.87 | 3620.00 |
| | Abadia G | 77.40 | 156.33 | 3486.66 |
| CG | Dinamica | 77.10 | 144.33 | 3186.66 |
| | Abadia | 62.70 | 176.94 | 3351.66 |
| | Abadia G | 74.93 | 138.26 | 3260.00 |
| D + CG | Dinamica | 90.13 | 163.33 | 3826.66 |
| | Abadia | 83.03 | 188.00 | 3740.00 |
| | Abadia G | 74.26 | 189.00 | 4066.66 |
| C | Dinamica | 58.90 | 116.33 | 3320.00 |
| | Abadia | 46.86 | 107.96 | 2625.33 |
| | Abadia G | 63.63 | 136.85 | 2793.33 |
| **L.S.D** | | **10.69** | **15.35** | **68.52** |

The maximum of highest growth characters may be due to the better physic-chemical properties of Dix 10N (D) which contains 10% N, 3% $P_2O_5$ and 3 $K_2O$ and It is a good source

of organic matter 41% which would have improved the physic-chemical properties of soil. Although using organic fertilizers led to lower soil bulk density produced growth promoting hormone that causes better root network of plant and can improve plant growth development by providing better soil physical condition for root growth and development that causes higher root dry weight% this results agree with (Dynes, 2003). Generally, it has been reported that grafting promotes vegetative growth at different levels dependent on rootstock (Colla *et al*, 2008). Promoted vegetative growth (plant height) was explained by the vigorous root system of rootstocks, which are often capable of absorbing water and plant nutrients more efficiently than scion roots and serve as a good supplier of endogenous hormones (Cohen and Naor, 2002). In addition to the plants affected by the status of soil nutrients, especially N Therefore, the pepper crop is expected to benefit from N fertilizer application as the adequate supply would correct N deficiency and result in rapid vegetative growth, deep green colour and higher fruit yield. Brady and Weil (2002). Also the fungus that works on the readiness of the elements and make them soluble in facilitating the plant absorption, especially the element of phosphorus, nitrogen and potassium (Matrood, 2015).

## CONCLUSIONS

Chemical fungicides are highly effective and convenient to use but they are a potential threat for the environment. Therefore, the use of biocontrol agents for the management of plant pathogens is considered as a safer and sustainable strategy for safe and profitable agricultural productivity. In order to reduce plant disease losses, it is necessary to devise strategies to overcome these problems. Plant diseases are the cause of a variety of microorganisms that include fungi, bacteria, viruses, viruses, and plant plasma. The largest number of plant diseases caused by fungi, and the most common and economical chemical tools for controlling fungal plant diseases are fungicides. The history of the use of chemical fungicides in agriculture began to combat plant diseases since the nineteenth century, when B. Prevost efficacy of copper for controlling seed-borne disease in wheat. Since then, fungicides have been used in agriculture to protect crops from losses from plant diseases and it is recognized as an essential component of crop protection programs. Sweet pepper is a member of the solanaceous fruity vegetables group. Pepper is grown as an annual crop because of its sensitivity to frost and it is in fact a herbaceous perennial and a good survivor and gave a yield for several years in tropical climates. The nutritional significance of the pepper crop is due to its high vitamin C content which reached to six times as much vitamin C as orange. *Chaetomium* species are usually found in soil and organic fertilizer. *Chaetomium* is one of the largest genera of saprobic ascomycetes with more than 300 species worldwide. *C. globosum* is a potential bio control agent against various seed and soil borne pathogens. Plant pathogens are the main threat for profitable agricultural productivity. The aim of experiment was to determine nutritional quality of DIX 10N (organic fertilizer) and *C. globosum* to produce highest parameters growth and yield in sweet pepper varieties. Our present study showed that some of plant growth parameters such as plant height, Total yield, Plant and Root dry, Chlorophyll content in leaves and photosynthesis and some plant metals are affected by the use of Dix N10 and *C. globosum* either together or alone. Also the impacts were diverse between sweet pepper varieties, but the most positively effect was the Dinamica with Dix N 10 or/and *C. globosum*.

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## REFERENCES

**Ashwini C., 2019 -** *A review on Chaetomium globosum is versatile weapons for various plant pathogens.* Journal of Pharmacognosy and Phytochemistry, 8(2): 946-949.

**Bosland P. W. Votava, E.J., 2007 -** *Peppers: Vegetable and spice capsicums.* CABI Nth America, Cambridge, MA. Georgia, Cooperative Extension. Available at: http://pubs.caes.uga.edu/caespubs/pubs/PDF/B13.

**Brady N.C., Weil R.R., 2002 -** *The Nature and Properties of Soil.* 13th Edition. Pearson Education Publication, New Delhi, India, pp. 188.

**Cohen S., Naor A., 2002** -*The effect of three rootstocks on water use, canopy conductance and hydraulic parameters of apple trees and predicting canopy from hydraulic conductance*. Plant, Cell and Environment, 25: 17-28.

**Colla G., Rouphae Y., Cardarelli M., Temperini O., Rea E., Salerno A., Pierandrei F., 2008 -** *Influence of grafting on yield and fruit quality of pepper (Capsicum annuum L.) grown under greenhouse conditions.* Acta Horticulturae, 782; 359-364s.

**Dynes R. A., 2003 -** *Earthworm: Technology information to enable the development of earthworm production.* A report for the rural industries

research and development corporation. Australian government. Canberra, Australia p.33.

**El-Bassiony A. M., Fawzy Z. F., Abd El-Samad E.H., Riad G.S., 2010 -** *Growth, yield and fruit quality of sweet pepper plants (Capsicum annuum L.) as affected by potassium fertilization.* Journal of American Science, 6(12): 722-729.

**Kelley W. T., Boyhan G., 2009 -** *Commercial methods. Pepper Production Handbook*. The University of Georgia. https://hortintl.cals.ncsu.edu/

**Matrood A. A., 2015 -** *Integration to control charcoal rot disease in sunflower that caused by Macrophomina phaseolina (Tassi) Goid*. PhD thesis. University of Kufa, p.127.

**Nabi S.U., Raja W. H., Dar M. S., Kirmani S. N., Magray M. M., 2017** - *New Generation Fungicides in Disease Management of Horticultural Crops*. Indian Horticulture Journal, 7(1): 01-07.

**Nicolae I., Camen D., Lascu N., Ploae Marieta., 2014** - *Physiological research in Citrullus lanatus (Thunb.) Matsum and Nakai plants cultivated on sandy soils organic fertilized*. Journal of horticulture, forestry and biotechnology, 18(2): 84-89.

**Song J. J., Soytong K., 2017 -** *Chaetomium spp as biological fertilizer for plant growth.* International Journal of Agricultural Technology, 13(6): 941-951.

**Soytong, K., Kanokmedhakul, S., Kukongviriyapa, V. and Isobe, M., 2001 -** *Application of Chaetomium species (Ketomium®) as a new broad spectrum biological fungicide for plant disease control: A review article*. Fungal Diversity, 7: 1-15.

**Soytong, K., Quimio, T. H., 1989 -** *Antagonism of Chaetomium globosum to the rice blast pathogen, Pyricularia oryzae.* Kasetsart Journal (Natural Science), 23: 198-203.

**Vasile G., Artimon M., Halmajan H., Pele M., 2010 -** *Survey of nitrogen pollutants in horticultural products and their toxic implications*. Proceeding of the international conference bio atlas, Transilvania University of Brasov, Romania 23 2018.

**Volkan E., Hakan A., 2018 -** *Effect of grafting on yield and fruit quality of pepper (Capsicum annuum L.) grown under open field condition.* Scientific Papers. Series B, Horticulture, LXII, ISSN 2285-5653, Online ISSN 2286-1580, ISSN-L 2285-5653.

**Yazdizadeh Shotorbani N, Jamei R, Heidari R., 2013 -** *Antioxidant activities of two sweet pepper Capsicum annuum L. varieties phenolic extracts and the effects of thermal treatment. Avicenna J Phytomed*, 3(1): 25-34.

# WATERING UNIFORMITY OF DRIP IRRIGATION SYSTEMS USING IN IRRIGATION OF MAIZE FOR KONYA-ÇUMRA PROVINCE, TURKEY

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**Abstract**

This study was conducted to determine water distribution uniformity of emitters at different drip irrigation systems using at maize farms in Çumra region of Konya, Turkey. Watering performance of drippers was classified by using two criteria namely Uniformity Coefficient, UC, and Emission Uniformity, EU. In results, UC varied from 68% to 84% with an average of 75% and water delivery class was 'Moderate' in accordance of such a mean value. EU varied from 44% to 71% with an average of 55%, and watering performance was 'Poor' or 'Unacceptable' in regard to average of EU value. Variations in emitter discharge rates in all examined drip irrigation systems were found higher than 10%. Drip irrigation system should be designated in accordance of hydraulic principles, installed by experienced people and timely maintenance-repair works are needed for maximizing water distribution uniformity consequently improvement grain/ silage yields as well as more economical returns.

**Key words**: maize, drip irrigation systems, watering efficiency of drippers

Agriculture is huge fresh water user sector worldwide. As we know that irrigation is backbone input for increasing crop yield, and productive utilization of water resources are great interests particularly in regions having water scarcity (Hanson and May, 2007; Acar *et al*, 2014; Yavuz *et al*, 2017).

In water shortage environments, pressurized irrigation techniques are very efficient in respect to well crop developments, and yield consequently better economical returns. It is possible for farmers to obtain high water, energy, and fertilizer savings in such irrigation systems under proper water management (Şimşek *et al*, 2004; Zamanian *et al*, 2014; Yavuz *et al*, 2015 a,b; Yavuz *et al*, 2016; Yavuz *et al*, 2019; Santana Junior *et al*, 2020).

Drip irrigation, one of the pressurized irrigation systems, has allowed to more uniform water application through root zone depth with greater water economy consequently optimal crop yield. Pressure variations within laterals have direct effect on water delivery efficacy of drippers (Mohanty *et al*, 2016).

In recent years, corn production has increased step by step due to resulting better income for farmers at Konya region, Turkey. It is impossible for producers to obtain economical income without irrigation in such environment even for winter cereals. In recent, drip irrigation system has used for irrigation of corn with an increasing trend. Yavuz *et al*, (2018) stated that full or irrigation at whole plant growth stages has resulted optimum yield and quality so such strategy could be highly beneficial particularly in environments having plenty water supplies.

Drip irrigation system has caused more water economy, possible to reach up to 90 or 95% water application efficiency, and manpower savings (Amoo *et al*, 2019; Patil and Patil, 2019; Selvaperumal *et al*, 2019; Trivedi and Gautam, 2019), and is also possible to use water more productive with deficit irrigation by drip irrigation system (Attila *et al*, 2019).

The main goal of irrigation activity is application of water to crops as uniform as possible. The flow variations among emitters should be little (less than 10% of acceptable range) to accomplish adequate water uniformity a cross to irrigated fields (Omofunmi *et al*, 2019; Trivedi and Gautam, 2019).

In drip irrigation system design, emitter spacing and wetting front are paramount useful information for obtaining optimal water content within root zone. The wetted volume, mainly depending on soil properties, is amount of available water for plants e.g. maximal width and depth of wetting advance were determined as 0.35 m and 0.56 m, respectively for sandy-loam soil under usages emitter with flow rate of 1.3 and 3 L/h (Mirjat *et al*, 2010).

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Correct design, installation, timely maintenance-repair works such as well filtration of irrigation water and proper management of drip irrigation systems are very important role to play for obtaining satisfactory water delivery performance (Hanson and May, 2007; Mostafa and Thörmann, 2013; Cannan *et al,* 2020). Among those, clogging and huge pressure variations in pipe networks are two common problems causing fluctuations in water level (Trivedi and Gautam, 2019). Amer and Gomaa (2003), found UC values as almost 92%, 94%, and 94% for 2% upslope, zero slopes, and 2% downslope, respectively; EU values as around 79%, 84%, and 88%, respectively for similar slopes. Yavuz *et al*, (2010) found mean UC values of 98% and 80%, and EU values of 97% and 73% for none-used and aging-laterals, respectively under 100 kPa pressure head. Omofunmi *et al*, (2019) found both UC and EU as about 99%, respectively; consequently, system was perfect designated.

In research region, Konya-Çumra, none study was performed about assessment of water uniformity under drip irrigation systems using for corn irrigation. The aim of the study, therefore, was to research water application uniformities in corn farming under drip irrigation systems.

## MATERIAL AND METHOD

This study was carried out at Çumra province belonging to Konya city of Turkey. The research area, situated at Middle Anatolian Region, is 1013 m above sea level and has popularity in productions of cereals, sugar beet, corn, alfalfa, dry bean, sunflower and some vegetables such as carrot, pepper, tomato, and lettuce. The region has semi-arid climate and almost 40% of precipitation has observed during crop growth period (Yavuz *et al,* 2014).

Water distribution uniformity of drip irrigation systems was evaluated by measuring volume of collected water from some emitters on selected laterals. In position of water inlet representative three laterals situated at initial, middle, and far or end on manifold were used. The emitter flow rates were between 1.9 and 2.6 L/h. About 36 plastic containers having capacity of 200 ml were placed just under selective emitters on those three lateral lines (each lateral had 12 measurement points). Then, drip irrigation systems were run about 10 or 15 minutes. After all drops ended in drip irrigation system, water volumes within plastic cups were measured by using graded cylinder and then they were converted to unit of L/h as suggested by Mostafa and Thörmann (2013).

Emitter performance was determined by using Uniformity Coefficients UC, and Emission Uniformity, EU.

UC was calculated by (Capra and Tanburina, 1995):

$$UC = \left[ (1 - (\frac{Dq}{qmean}) \right] \times 100$$

where, UC- Uniformity Coefficient, %, Δq – Mean of absolute deviation from mean emitter discharge, L/h, and qmean – Mean emitter discharge, L/h. Emitter watering performance, EWP, was classified by using *table 1* (Tüzel, 1993).

Table 1

**Relationships between UC and EWP**

| UC (%) | Emitter watering performance, EWP |
|---|---|
| > 90 | Very Well |
| 80 – 90 | Well |
| 70– 80 | Moderate |
| 60 – 70 | Poor |
| < % 60 | Not Acceptable |

EU was calculated by (Keller and Karmeli, 1974):

$$EU = \frac{q_{25}}{qmean} x100$$

where; EU - Emission uniformity, %, q25- Mean of the lowest quarter of the emitter discharge, L/ h. In regard to EU values, water distribution quality was classified by use of *table 2*.

Table 2

**Relationships between EU and EWP**

| EU (%) | EWP (Merriam and Keller, 1978) | EWP (Anonymous, 1983) |
|---|---|---|
| <70 | Poor | No-Acceptable |
| 70–80 | Acceptable | Poor |
| 80–86 | Well | Acceptable |
| 86–90 | Well | Well |
| 90–94 | Very Good | Well |
| >94 | Very Good | Very Good |

## RESULTS AND DISCUSSIONS

Characteristics of pipes of drip irrigation systems were presented at *table 3*. In examined drip irrigation systems, main, manifold and lateral diameters varied from 110 mm to 175 mm; from 90 mm to 125 mm and from 22 mm to 25 mm, respectively. In general lateral length was measured as 250 m with emitter spacing of 25-30 cm.

The maximum UC was determined as 84% and performances of drippers was **well** in regard to such value. However, minimum UC was determined as 68% and emitter water application performance was classified as **poor**. In general, water distribution performance was **moderate** in current study.

UC values reported as about 94% by Amer and Gomaa (2003), 98% for new or 80% for using three-year lateral by Yavuz *et al*, (2010), 82-87% by Mirjat *et al*, (2010), 98% for on-line and 97%

for in-line drippers by Popale *et al,* (2011), 44%-99% by Acar and Yılmaz (2018); 62%-95% by Acar *et al,* (2009); 52-95% by Acar *et al,* (2015), 78-99% by Ünal *et al,* (2015), 95% by Arya *et al,* (2017), around 99% by Omofunmi *et al,* (2019) and almost 98% by Sadatiya *et al,* (2019). The finding of current study was as an average of 75%, and is almost agreement with Acar *et al,* (2009), Acar *et al,* (2015), and Acar and Yılmaz (2018) but lower than results of somewhere else (Amer and Gomaa, 2003; Yavuz *et al,* 2010; Mirjat *et al,* 2010; Popale *et al,* 2011, Ünal *et al,* 2015; Arya *et al,* 2017; Omofunmi *et al,* 2019; Sadatiya *et al,* 2019).

Table 3

**Pipe components of drip irrigation systems**

| Farms | Main line (mm) | Manifold (mm) | Lateral tube (mm) | Lateral length (m) | Emitter spacing (cm) |
|---|---|---|---|---|---|
| 1 | 125 | 125 | 22 | 247 | 30 |
| 2 | 175 | 125 | 25 | 250 | 25 |
| 3 | 175 | 90 | 25 | 250 | 25 |
| **4** | 175 | 125 | 25 | 250 | 25 |
| 5 | 175 | 125 | 25 | 230 | 25 |
| 6 | 110 | 90 | 25 | 250 | 25 |
| 7 | 110 | 90 | 25 | 250 | 25 |
| 8 | 125 | 125 | 22.5 | 250 | 30 |
| **9** | 175 | 125 | 22.5 | 250 | 30 |
| 10 | 175 | 125 | 25 | 250 | 25 |
| 11 | 175 | 125 | 22.5 | 250 | 30 |

EU values were maximum as 71% and minimum as 44% with mean of 55%. In result, almost all drippers had as **poor** or **no-acceptable** performance. In that regard, it is possible to say that drippers resulted none-uniform water application for maize crops.

In some previous studies about EU values; about 75% by Soccol *et al,* (2002), 84% by Amer and Gomaa (2003), 97% for brandy or 73% for used 3-year lateral by Yavuz *et al,* (2010), 75-81% by Mirjat *et al,* (2010), 97% for on-line and 99% for in-line drippers by Popale et al, (2011), 23-99% by Acar and Yılmaz (2018), 23-82% by Acar *et al,* (2015), 65-99% by Ünal *et al,* (2015), and 91% by Arya *et al,* (2017), about 99% by Omofunmi *et al,* (2019), and around 96% by Sadatiya *et al,* (2019). Our finding of mean 55% is almost conformity with Acar and Yılmaz (2018), and Acar *et al,* (2015), but not-agreement with Soccol *et al,* (2002), Amer and Gomaa (2003), Yavuz *et al,* (2010), Mirjat *et al,* (2010), Popale *et al,* (2011), Ünal *et al,* (2015), Arya *et al,* (2017), Omofunmi *et al,* (2019), and Sadatiya *et al,* (2019).

In general, reasons of low watering uniformity in present study may be resulted from using age-distribution lines, narrower emitter spacing, and use of longer laterals, partial or complete clogging in some emitters, and improper maintenance-repair works in systems.

## CONCLUSIONS

In general, water distribution class was far from expectations since variations between the emitter flow rates were greater than the 10% in which is low acceptable threshold level for micro irrigation system. The reasons behind low water distribution efficiency could be as follows: poor design and installation of systems, preferences of laterals with longer lengths and narrower dripper spacing, improper selections of water delivery pipes, poor maintenance-repair works consequently great pressure variations through systems.

Proper design and installation as well as correct management of drip irrigation systems are vital important for accomplishing satisfactory water distribution uniformity. Farmers should be trained about efficient management of such system. It is obvious that drip irrigation system has led to savings in water and plant nutrients so farmlands having such systems should be widen particularly at water scant environments for sustainable utilization of current water resources.

## REFERENCES

**Acar B., Yavuz F.C., Topak R., Uğurlu N., 2009 -** *Water quality and uniformity in trickle irrigation systems: A case study of Antalya-Turkey.* Asian Journal of Chemistry, 21(5), 3981–3987.

**Acar B., Topak R., Yavuz D., Kalender M.A., 2014 -** *Is drip irrigation technique sustainable solution in agriculture for semi-arid regions? A case study of Middle Anatolian Region, Turkey.* International Journal of Agriculture and Economic Development, 2 (2) : 1-8.

**Acar B., Çicek Y., Topak R., 2015 -** *Water distribution uniformities of drip irrigation systems in olive trees for Izmir province of Turkey.* Analele Universitatii Din Craiova, 20 (LVI), 13-20.

**Acar, B. Yılmaz, A. M., 2018 -** *Dripirrigation systemperformance evaluation based on previous reserach.* 8 th International Conference on Ecosystems, Tirana - 2018, 236-241.

**Amer K.H., Gomaa A.H., 2003 -** *Uniformity determination in drip irrigation lateral design.* Misr J. Ag. Eng., 20(3): 405-431.

**Amoo M., Ademiju T., Adesigbin A., Ali G., 2019 -** *Performanceevaluation of dripirrigationsystems on production of Okra (Hibuscusesculentus) in Soutwestern, Nigeria.* Journal of Engineering Researchand Reports, 5 (3): 1-10.

**Anonymous., 1983 -** IRYDA (Instituto de Reforma Y Desarrollo Agrario): *Normas para la redacción de proyectos de riego localizado.* Ministerio de Agricultura, Pesca y Alimentación. Madrid, Spain.

**Arya C.K., Purohit R.C., Dashora L.K., Singh P.K., Kothari M., 2017 -** *Performance evaluation of drip irrigation systems.* International Journal of

Current Microbiology and Applied Sciences, 6 (4), 2287-2292.

**Attila S.S., El-Gindy,. A.M., Mansour H.A., Kalil S.E., Arafa Y.E. 2019 -** *Performance analysis of pressurized irrigation systems using simulation model technique.* Plant Archives, 19 (1): 721-731.

**Capra A., Tamburina V., 1995 -** *Evalution and control of distribution uniformity in farm irrigation systems.* Procedings of 46 th International Executive Council Meeting ICID,CIID special Technical session, Roma, Italy.

**Cannan B., Janani N., Thanganami S., Selvaperumal A., 2020 -** *Development and evaluation of low cost drip Filter.* CJAST, 39 (8) : 87-94.

**Hanson B., May D., 2007 -** *The effect of drip line placement on yield and quality of drip-irrigated processing tomatoes.* Irrig Drainage Syst , 21 :109–118.

**Keller J., Karmeli D., 1974 -** *Trickle irrigation design parameters.* Transactions of the American Society of Agri. Engi. 17 (4): 678-784.

**Merriam J. L., Keller J., 1978 -** *Farm irrigation system evaluation, a guide for management.* Utah state Univ. Utah.

**Mirjat M.S., Mirjat M.U., Chandio F.A., 2010 -** *Water distribution pattern, discharge uniformity and appliation efficiency of locally made emitters used in trickle subunit.* Pak. J. Agril., Engg., Vet. Sci., 26 (1) : 1-15.

**Mohanty B., Senepati S.C., Sahu A.P., Panigrahi B., 2016 -** *Clogging ratio of emitters as affected by single and double inlet laterals and sub-main sizes.* International Journal of Humanities and Social Sciences, 5 (4): 33-40.

**Mostafa H., Thörmann H., 2013 -** *On-farm evaluation of low-pressure drip irrigation system for smallholders.* Soil &Water Res., 8 (2) : 87-95.

**Omofunmi O.E., Ilesanmi O.A., Orisabinone T., 2019 -** *Performance evaluation of hydraulic parameters of a developed drip irrigation system.* Malysian Journal of Civil Engineering, 31 (2): 9-16.

**Patil M., Patil S.S. 2019 - Develoment of s system to** *compare and analyze the yield of drip and without drip irrigation plots of plants.* International Conference on Sustainable Computing in Science, Technology & Management (SUSCOM-2019), February 26-28, 2019. Amity University Rajathan, Jaipur, India: 1858-1864.

**Popale P.G., Bombale V.T., Magar A.P., 2011 -** *Hyraulic performance of drip irrigation sysem.* Engineering and Technology in India, 2 (1&2): 24-28.

**Sadatiya Y.R., Kapupara P.J., Patel R.J., Dwivedi D.K., 2019 -** *Hydraulic performance evaluation of different emitters at different operating pressures.* The Pharma Innovation Journal, 8 (8): 323-327.

**Santana Junior E.B., Coelho E.F., Cruz J.L., da S. Reis J.B.R., de Mello D.M., da S. Pereira B.L., 2020 -** *Trickle irrigation systems affect spatial distribution of roots of banana crop.* R. Bras. Eng. Agríc. Ambiental, 24 (5): 325-331.

**Selvaperumal A., Sujitha E., Muthuchamy I., 2019 -** *Evaluation of uniformity coefficient and soil moisture distribution under drip irrigation system.* CJAST, 34 (5): 1-9.

**Soccol O.J., Ullmann M.N., Frizzone J.A., 2002 -** *Performance analysis of a trickle irrigation subunit insalled in an apple orchard.* Brazilian Archives of Biology and Technology, 45 (4): 425-430.

**Şimşek M., Kacira M., Tonkaz T., 2004 -** *The effects of different trickle irrigation regime on watermelon (citrullus lanatus) yield and yield components under semi-arid climatic conditions.* Aust.J.Agric.Res., 55:1149-1157.

**Trivedi A., Gautam A.K., 2019 -** *Temporal effects on the performance of emitters.* Bulletin of Environment, Pharmacology and Life Sciences, 8 (2): 37-42.

**Tüzel I.H., 1993 -** *Evaluation of uniformity in drip irrigation systems.* Ege University, Journal of Faculty of Agriculture 30 (1–2): 119–126 (In Turkish).

**Ünal Y., Acar B., Direk M., 2015 -** *Research on water distribution uniformity for different drip irrigation laterals.* XXXVI CIOSTA§ CIGR Section V Conference, Environmentally Friendly Agriculture and Forestry for Future Generations, 26-28 May, Saint Petersburg, Russia :865-875.

**Yavuz M.Y., Demirel K., Erkan O., Bahar E., Deveciler M., 2010 -** *Emitter clogging and effects on drip irrigation systems performances.* African Journal of Agricultural Research, 5 (7): 532-538.

**Yavuz D., Topak R., Yavuz N., 2014 -** *Determining energy consumption of sprinkler irrigation for different crops in Konya Plain*. Türk Tarım ve Doğa Bilimleri Dergisi, 1(3): 312-321.

**Yavuz D., Yavuz N., Seymen M., Türkmen Ö., 2015a -** *Evapotranspiration, crop coefficient and seed yield of drip irrigated pumpkin under semi-arid conditions.* Scientia Horticulturae, 197: 33-40.

**Yavuz D., Seymen M., Yavuz N., Türkmen Ö., 2015b -** *Effects of irrigation interval and quantity on the yield and quality of confectionary pumpkin grown under field conditions.* Agricultural Water Management, 159: 290-298

**Yavuz D., Yavuz N., Süheri S., 2016 -** *Energy and water use for drip-irrigated potato in the Middle Anatolian region of Turkey.* Environmental Progress & Sustainable Energy, 35: 212-220.

**Yavuz N., Seymen M., Yavuz D., Acar B., Türkmen Ö., 2017 -** *Deficit irrigation effect on yield performance of pumpkin in semi-arid Middle Anatolian Region of Turkey.* International Journal of Agriculture and Economic Development, 5 (2): 1-10.

**Yavuz D., Acar B., Yavuz N., Çiftçi N., 2018 -** *Irrigation in various growth stages effect on yield and water productivity of drip- irrigated sunflower in semi-arid Konya environment, Turkey.* International Journal of Agriculture and Economic Development, 6 (2) : 7-17.

**Yavuz N., Çiftçi N., Yavuz D., 2019 -** *Effects of different irrigation interval and plant-pan coefficient applications on yield and quality parameters of oil sunflower grown in semi-arid climate conditions.* Arabian Journal of Geoscienses. https//doi.org/10.1007/s12517-019-4867-1

**Zamanian M., Fatahi R., Boroomand-Nasab S., 2014** - Field performance evaluation *of micro irrigation systems in Iran.* Soil§Water Res. 9 (3) : 135-142.

# GREEN PEACH APHID (*MYZUS PERSICAE*) CAN BE A SERIOUS PEST PROBLEM FOR OILSEED RAPE CROP, IN THE SOUTH-EAST OF ROMANIA

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**Abstract**

In this paper, it has reported a high attack of the green peach aphid (*Myzus persicae*), in late autumn of the year 2018, at oilseed rape crop, in the south-east of Romania. This pest has a wide range of host plants, attacking more than 240 species from 64 different botanical families. The evolution of green peach aphids at oilseed rape crop, during autumn, was assessed in this paper. A field experiment was carried out at NARDI Fundulea, both in 2017 and 2018. It has assessed untreated and treated seeds variants with systemic insecticides. Also, it has recorded percentage of parasitized aphids by *Aphidius* spp. and *Praon* spp. In the weather conditions from autumn of the year 2017, green peach aphids density at oilseed rape crops was insignificant with a maximum of 2.25 aphids/leaf at untreated plants and 0.38 aphids/leaf at plants emerged from treated seeds. However, in 2018 it has registered a high density of this pest at oilseed rape crop with a maximum of 243.25 aphids/leaf at untreated plants and 29.38 aphids/leaf at plants emerged from treated seeds. In weather conditions of the year 2018, in the experimental field from NARDI Fundulea, highest population amount of green peach aphids at untreated oilseed rape plants it has recorded in late autumn, on 12 November. Possible explication for this is because of higher temperatures and drought recorded both in October and the first half of November. At the same time, in autumn of 2018, parasitized aphids percent was 5.15 % at untreated variant and between 4.74 and 5.00 % at treated variants. This situation occurred in autumn of 2018, in the south-east of Romania must be a warming for the farmers for the following years. Increasing the temperature and drought can have an effect of increasing the attack of aphids at oilseed rape crops, in autumn.

**Key words**: oilseed rape, aphids, attack, autumn

According to MADR data (2020), in 2017 and 2018, the area cultivated with oilseed rape in Romania was higher than 590000 ha, being one of the most important crops for this country. According to Popescu A. et Dinu T.A. (2020), in 2018, Romania had 633 thousand ha cultivated with rape and produced 1673327 tons of seeds, 2.8 times more than in 2009. The same authors mentioned that the largest surfaces cultivated with oilseed rape in Romania are situated in the South Muntenia (39.07%), South-East (24.69%) followed by South-West Oltenia (10.03%) and the Western part of the country (9.07%). The main reason for increasing the area cultivated with oilseed rape is the higher profitability of this crop (Lup A. *et al*, 2013; Chiriac A.R. *et al*, 2019). Also, oilseed rape is a good crop for rotation with wheat and barley (Roman G.V. *et al*, 2012; Hoffmann M.P. *et al*, 2015; Darguza M. et Gaile Z., 2019). Oilseed rape yield losses can occur because of the non-biotic stress such as frost from the flowering period, the draught from the emergence period, heavy frost during winter, storms before harvest, and biotic stress such as weeds, pathogens, or pests (Halmajan V., 2006; Rasnoveanu L., 2011a; Panaitescu L. *et al*, 2013; Hess L. *et al*, 2015; Barbulescu A. et al, 1993; 1997; 2001; Popov C. et al, 2002, 2007; Williams I.H., 2010; Heimbach U. et Müller A., 2013; Dewar A.M., 2017; Skellern M.P. *et al*, 2018). Data from the literature make in evidence that in Romania, the main pests of the oilseed rape crop, during the autumn period, are cabbage flea beetles (*Phyllotreta atra*, *Phyllotreta nemorum*, *Phyllotreta undulata*), cabbage-stem flea beetle (*Psylliodes chrysocephala*), turnip sawfly (*Athalia rosae*) while the main pests of this crop from spring and the beginning of the summer are cabbage stem weevils (*Ceutorhynchus napi* and *Ceutorhynchus quadridens*), pollen beetle (*Meligethes aeneus*), cabbage seedpod weevil (*Ceutorhynchus assimillis*) and cabbage aphid (*Brevicoryne brassicae*)(Trotus E. *et al*, 2001; Popov C. *et al*, 2004; Popov C. et Barbulescu A., 2007; Rasnoveanu L., 2010, 2011b; Bucur A. and Rosca I., 2011; Rasnoveanu L. and Burtea C.,

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2012; Buburuz A.A. *et al*, 2013; Buburuz A.A. and Trotus E., 2014; Trasca F. *et al*, 2019). The same authors mentioned that in the climatic conditions from Romania, the maximum peek of the oilseed rape pest populations are in autumn when plans are in early vegetation stages and spring when plants are in flowering stage. Regard of the aphids attack at oilseed rape crop, researches effectuated in Romania make in evidence that in some favorable years it has observed colonies of the cabbage aphids (*Brevicoryne brassicae*), on pods, mainly in May and June, when plants are in different maturity stage (Popov C. and Barbulecu A., 2007; Rasnoveanu L., 2010, 2011a; Trotus E. *et al.*, 2019). Other authors mentioned that cabbage aphids (*Brevicoryne brassicae*) could be occur during autumn too, when plants were in the early vegetation stage, in the case of high pest densities and drought, the effect of the attack at OSR crop and yield losses can be higher (Popov C. *et al*, 2006). According to the same author, the aphid densities in 2001 were, in some cases, of several thousand per plants, requiring chemical treatments on large areas. It is also necessary to correctly apply the seed treatment with systemic insecticides to reduce the drought influence on cabbage aphids attack. However, according to the data from recent years, in Romania, the level of the cabbage aphids populations at oilseed rape crop was low (Buburuz A.A. *et al*, 2013; Buburuz A.A. and Trotus E., 2014; Trasca F. *et al*, 2019). This is the only aphid species mentioned in the Romanian literature that is producing damages, in some years, at OSR crop, mainly at the early maturity stage of the plants. Green peach aphid (*Myzus persicae*,Suzler, 1776) is one of the most harmful aphid specie for peach and apricot in Romania (Trandafirescu M. *et al*, 2004; Fericean L.M. *et al*, 2011; Dinu M.M. *et al*, 2014). The aphids formed colonies on the lower side of the leaves where they feeding. Meng J. et al. (2014) mentioned that the green peach aphid causes direct damages to crop plants by sucking phloem and can transmit over 100 different plant viruses. *M. persicae* is usually heteroecious and holocyclic, with the winter sexual phase on peach trees (*Prunus persica*), and the parthenogenetic (asexual) summer generations on a wide number of secondary herbaceous summer hosts such as tomato, potato, alfalfa, pea, bean, oilseed rape (Rosca I. and Rada I., 2009). The same author mentioned that the green peach aphid is polyphagous with a host range higher than 240 plant species from 64 different botanical families. Other authors mentioned that *M. persicae* is a highly adaptable and polyphagous insect pest that feeds on more than 400 plant species (Domokos E. *et al*, 2015). In Romania, the green peach aphid is considered a pest without economic impact at oilseed rape crop, in some rare cases the insects can transmit an OSR virus that can have effect on decreasing of the yield (Buzdugan L. and Nastase D., 2013). This paper is first mention from the Romanian literature concerning a high attack of the green peach aphids at OSR crop, in late autumn, in the south-east of the country (Fundulea, Calarasi County). Until now it wasn't any references in the literature about high densities and attack of *M. persicae* at oilseed rape crop in the late autumn, in Romania.

## MATERIAL AND METHOD

The field trials were carried out at Plants and Environment Protection Collective from National Agricultural Research and Development Institute (NARDI) Fundulea, Calarasi County (latitude: 44°46' N; longitude: 26°32 E'; alt.: 68 m a.s.l.), Romania, in 2017 and 2018. Over the course of the trial, the average temperatures and the rainfalls amount were recorded daily at automatic Pessl weather station, located at 100 m from the field trial. In 2017 oilseed rape was sowed on 8 September and plants emerged on 13 September while in 2018 oilseed rape was sowed on 3 September and plants emerged over 15 days, on 18 September. At the trial location from the NARDI Fundulea, the area of each experimental plot was of 2500 $m^2$. The experimental variants from this trial were: 1-Check (untreated); 2-seeds treated with imidacloprid (600 g/l) active ingredient, in the dose of 600 ml commercial product/100 kg of seeds; 3-seeds treated with clothianidin (400 g/l)+beta-cyfluthrin (80 g/l) a.i. in the dose of 1250 ml c.p./100 kg of seeds. Romania obtains derogations for the using these active ingredients for OSR seed treatment in autumns of 2017 and 2018. The assessments for the aphids were made each week after detecting the pests in the OSR field trial. On each variant it has established 10 assessment points on the plot diagonal. At each assessment point it has counted total numbers of the aphids per leaf and the number of the parasitized aphids by *Aphidius* spp. and *Praon* spp. species. For easy counting of the aphids, each assessed leaf was photographed with Panasonic Tz100 camera, then the images from the trial were downloaded on PC and the aphids were counted visualizing field image captures with OSR leaf on the screen. This new assessment method replaces classical counting of the aphids in the field with a magnifier glass (3x). The image capture of the lower side of the OSR leaf can be magnified on the PC screen; thus, each aphid can be individualized, and the precision of the assessments will increase. Also, according to with new assessment method, we can identify the number of parasitized aphids very precisely.

**Statistical analysis**. The results of the field observations were presented as the mean values for number of the green peach aphids (*Myzus persicae*) per OSR leaf and the parasitized aphids percentage, the standard deviation from the average values (SD) and the coefficient of variation (CV). Data were **statistically analyzed** using the Student-Newman-Keuls test (Student, 1927; Neuman D., 1939; Keuls M., 1952)

## RESULTS AND DISCUSSIONS

Data from *tables 1* and *2* show that weather conditions registered in autumn, at NARDI Fundulea, during the assessments period were atypical. In 2017, the average air temperature from September, October and November was higher than the multiyear average with a higher positive deviation from the average in September and November. In 2018, the average air temperature recorded in September and October was higher compared with a multiyear average with a positive deviation of 1.8 and 2.2 °C while average air temperatures recorded in November were close to multiyear the average, the positive deviation was only 0.1 °C. However, both in 2017 and 2018 temperatures recorded in autumn months, when OSR crop are in early vegetation stages were higher with multiyear average, sometimes with positive deviation higher than 2.0 °C. In 2017, the rainfalls amount registered at NARDI Fundulea in September was lower compared with a multiyear average with a negative deviation of 35.1 mm while in October it has recorded higher rainfalls amount compared with multi-year average, with a positive deviation of 66.4 mm. Only in two days (7 and 8 October) it has recorded 81.6 mm, this level is almost two times higher then multi-year average. Rainfalls recorded in November were slightly higher then multi-year average, with a positive deviation of 5.7 mm. In 2018, the rainfalls amount registered at NARDI Fundulea was lower compared with multiyear averages in all three months of autumn. In October, it has registered the highest negative deviation from the multiyear average (-32.2 mm), while in September and November, negative deviation from the multiyear average ranged from -11.1 to -16.9 mm.

Table 1

**Average air temperatures registered at NARDI Fundulea, during autumn, in 2017 and 2018**

| Year | Average air temperature (°C) | | | | | | Deviation from the average (°C) | | |
|---|---|---|---|---|---|---|---|---|---|
| | September | | October | | November | | September | October | November |
| | Current year | Multiyear average | Current year | Multiyear average | Current year | Multiyear average | | | |
| 2017 | 19.0 | 17.2 | 11.7 | 11.2 | 7.0 | 5.1 | +1.8 | +0.5 | +1.9 |
| 2018 | 19.1 | 17.2 | 13.4 | 11.2 | 5.2 | 5.1 | +1.9 | +2.2 | +0.1 |

Table 2

**Rainfall amounts registered at NARDI Fundulea, during autumn, in 2017 and 2018**

| Year | Rainfall amounts (°C) | | | | | | Deviation from the average (mm) | | |
|---|---|---|---|---|---|---|---|---|---|
| | September | | October | | November | | September | October | November |
| | Current year | Multiyear average | Current year | Multiyear average | Current year | Multiyear average | | | |
| 2017 | 15.0 | 50.1 | 112.6 | 46.2 | 49.2 | 43.5 | -35.1 | +66.4 | +5.7 |
| 2018 | 33.2 | 50.1 | 14.0 | 46.2 | 32.4 | 43.5 | -16.9 | -32.2 | -11.1 |

Table 3

**Level of the green peach aphid populations, at oilseed rape from the experimental field in 2017**

| Nr. crt. | Variant (active ingredients) | Number of the aphids/leaf | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 22.09.2017 | | 29.09.2017 | | 6.10.2017 | | 13.10.2017 | | 20.10.2017 | |
| 1 | Check (untreated) | 1.60 | a | 1.75 | a | 2.25 | a | 0 | a | 0 | a |
| 2 | imidacloprid (600 g/l) | 0.13 | b | 0.15 | b | 0.38 | b | 0 | a | 0 | a |
| 3 | clothianidin (400 g/l)+ +beta-cyfluthrin (80 g/l) | 0.10 | b | 0.13 | b | 0.30 | b | 0 | a | 0 | a |
| LSD P=0.05 | | 0.298 | | 0.171 | | 0.352 | | 0 | | 0 | |
| Standard deviation (SD) | | 0.172 | | 0.099 | | 0.203 | | 0 | | 0 | |
| Variation coefficient (C.V.) | | 28.340 | | 14.610 | | 20.870 | | 0 | | 0 | |

Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

Table 4

**Level of the green peach aphid populations, at oilseed rape from the experimental field in 2018**

| Nr. crt. | Variant (active ingredients) | Number of the aphids/leaf | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 29.10.2018 | | 5.11.2018 | | 12.11.2018 | | 20.11.2018 | | 27.11.2018 | |
| 1 | Check (untreated) | 24.45 | A | 160.48 | a | 243.25 | a | 175.93 | a | 161.00 | a |
| 2 | Imidacloprid (600 g/l) | 2.52 | B | 13.80 | b | 23.38 | b | 25.92 | b | 29.38 | b |
| 3 | clothianidin (400 g/l)+ +beta-cyfluthrin (80 g/l) | 1.33 | B | 12.80 | b | 17.65 | b | 14.88 | b | 19.67 | b |
| LSD P=0.05 | | 9.375 | | 85.446 | | 51.868 | | 61.178 | | 43.334 | |
| Standard deviation (SD) | | 5.418 | | 49.383 | | 29.976 | | 35.357 | | 25.045 | |
| Variation coefficient (C.V.) | | 57.440 | | 79.190 | | 31.630 | | 48.94 | | 35.77 | |

Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

From climatic point of view, in this study, in autumn of the 2018 it has registered the most favorable conditions for aphids attack, especially in October (high temperatures and drought). Data from *table* 3 demonstrate that, in autumn of 2017, it has recorded a low population of the green peach aphid in OSR crop from this field trial located at NARDI Fundulea. Maximum pest density has registered at the control variant on 6 October (2.25 aphids/leaf) while at treated variants it has registered 0.30 aphids/leaf at plants from seeds treated with imidacloprid active ingredient, and 0.30 aphids/leaf at plants from seeds treated with clothianidin+beta-cyfluthrin active ingredients. After 6 October, it hasn't recorded aphids on OSR leaves. Possible explication for this is heavy rains occurred in 48 hours (7-8 October). Also, it hasn't observed aphides parasitized by *Aphidius* spp. or *Praon* spp. species. According Student-Newman-Keuls test, in this field trial, in autumn of 2017 it has registered significant statistical differences concerning aphids density at untreated (control) variant, compared with treated seeds variants ($p<0.05$).

In autumn of 2018, at the experimental field from NARDI Fundulea, it has registered a high population of green peach aphids at OSR crop. First aphids were observed in the field on 29 October. The untreated variant has registered 24.45 aphids on the lower side of the OSR leaf (*table* 4). Aphids density from the untreated plants increasing in the first 15 days of November, arriving at a maximum peak of 243.35 aphids/leaf on 12 November (*figure 1*).



Figure 1 **Greed peach aphids (*Myzus persicae*) on OSR lower side of the leaf, 12.11.2018**

Even if the average air temperatures decreasing after 15 November, however at assessments made on 20 and 27 November it has registered high populations of the green peach aphids at OSR plants from the untreated (control) variant (175.93 aphids/leaf on 20 November and 161.00 aphids/leaf on 27 November). The aphids at OSR crop was stopped after decreasing of the minimum air temperatures bellow -10.7 °C on 1 December. Data from *table* 4 ascertained that at treated variants from this field trial the maximum peak of aphids populations have registered on 27 November (29.38 aphids/leaf at variant treated with imidacloprid active ingredient and 19.67 aphids/leaf at variant treated with clothianidin+beta-cyfluthrin active ingredients). Compared with the untreated variant, when the maximum peak was registered on 12 November, at seed treated variants, it has registered a constant and slow growth of the green peach aphid populations until the end of November (*figure 2*).

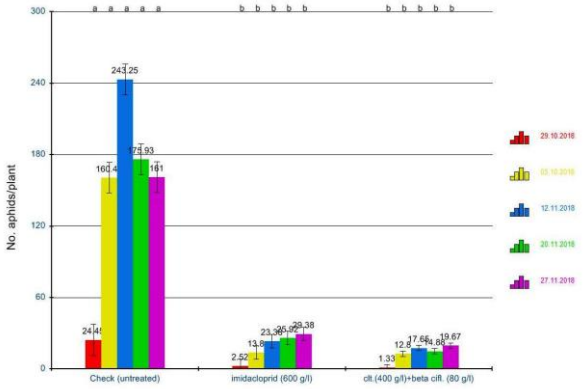



Figure 2 **Level of the green peach aphids (*Myzus persicae*) population at OSR crop, 12.11.2018**

However, in conditions of the high pest pressure from the experimental field in the autumn of 2018, it has registered significant statistical differences concerning aphids density at untreated variant, compared with treated seeds variants ($p<0.05$).

Data from *table* 5 reveals that in conditions of high pest pressure, registered in the

experimental field from the autumn of 2018, the maximum percentage of the parasitized aphids by *Aphidius* spp. or *Praon* spp. species has recorded on 20 November (5.15 % at untreated variant, and between 4.74 and 5.00 % at seed treated variants). On 12 November, when it has registered a higher level of the aphids on OSR leaves, the parasitized aphids percent was only 3.21 %.

Table 5

**Percentage of the parasitized aphids, at oilseed rape from the experimental field in 2018**

| Nr. crt. | Variant (active ingredients) | Percent of the parasite aphids (%) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 29.10.2018 | | 5.11.2018 | | 12.11.2018 | | 20.11.2018 | | 27.11.2018 | |
| 1 | Check (untreated) | 0.25 | a | 0.87 | a | 3.21 | a | 5.15 | a | 3.96 | a |
| 2 | imidacloprid (600 g/l) | 0 | a | 1.49 | a | 2.01 | a | 5.00 | a | 2.08 | a |
| 3 | clothianidin (400 g/l)+ +beta-cyfluthrin (80 g/l) | 0 | a | 0 | a | 2.56 | a | 4.74 | a | 4.11 | a |
| LSD P=0.05 | | 0.494 | | 1.855 | | 2.199 | | 1.632 | | 2.232 | |
| Standard deviation (SD) | | 0.286 | | 1.072 | | 1.271 | | 0.943 | | 1.290 | |
| Variation coefficient (C.V.) | | 346.410 | | 136.420 | | 49.010 | | 19.000 | | 38.170 | |

Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

In the conditions of high pest pressure, registered in late autumn from 2018, at this field trial, green peach parasitoids couldn't control the pest population. Climate changes can have a consequence in increasing the populations of pests considered until now less important for OSR crops, such as green peach aphid. Until now, it wasn't any data from the literature concerning the high level of the *M. persicae* populations at OSR crop, recorded in late autumn (12 November) in Romania.

## CONCLUSIONS

Weather conditions from autumn were favorable for green peach aphids (*M. persicae*), in 2018, in October and the first half of November.

In the autumn of 2017, at experimental field from NARDI Fundulea it was registered low level of the green peach aphids population at OSR crop.

In the autumn of 2018, at experimental field from NARDI Fundulea it was registered high level of the green peach aphids population at OSR crop with a maximum peak of 243.25 aphids/leaf, at untreated variant, registered on 12 November.

In condition of the high pest pressure from the autumn of 2018, parasitized green peach aphids percent was low, with a peak of 5.15 % at untreated variant, registered in late November.

These facts must be a warming signal for the farmers for the upcoming years.

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## REFERENCES

**Barbulescu A., Mateias M.C., Popov C., Rugina M., Guran M., Voinescu I., Bratu R., Vonica I., Kozinschi T., 1993 -** *Evolution of some diseases and pests of cereal, industrial and forage crops in our country during 1992*. Problems of Plant Protection, 21(1):47-65.

**Barbulescu A., Mateias M.C., Popov C., Voinescu I., Guran M., Raranciuc S., Mincu M., Spiridon C., Stanciu M., 1997 -** *Evolution of some diseases and pests of cereal, industrial and forage crops in our country during 1997*. Problems of Plant Protection, 25(1):51-72.

**Barbulescu, A., Popov, C., Mateias M.C., Voinescu I., Guran, M., Raranciuc S., Spiridon C., Vasilescu S., Valasn D., 2001 -** *Evolution of some diseases and pests of cereal, industrial and forage crops in our country during 2000*. Problems of Plant Protection, 29(1):1-16.

**Buburuz A.A., Trotus E., Talmaciu M., Pochiscanu S.F., 2013 -** *Some ecological indicators analysis of the harmful insect species from the winter rape fields*. Annals of NARDI Fundulea, 81:15-165.

**Buburuz A.A., Trotus E., 2014 -** *CONTRIBUTIONS TO The knowledge of epigeic Carabidae cenosis from rapeseed crop, under central Moldavia conditions.* Annals of NARDI Fundulea*, 82:289-301.*

**Bucur A., Rosca I., 2011 -** *Research regarding biology of rape pests*. Scientific Papers, UASVM Bucharest, Series A, 54:356-359.

**Buzdugan L., Nastase D., 2013 -** *Oilseed rape [Rapița de toamnă]*. Romanian Academy Publishing house, Bucharest, Romania, Chapter 15:369-370.

**Chiriac A.R., Mocuta D., Cristea, S., 2019 -** *The tendency concerning the evolution of oilseed market in Romania*. Agrofor International Journal, 4(1):14-23.

**Darguza M., Gaile Z., 2019 -** *Yield and quality of winter wheat, depending on crop rotation and soil tillage*. Agricultural Science, 2:29-35.

**Dewar A.M., 2017 -** *The adverse impact of the neonicotinoid seed treatment ban on crop protection in oilseed rape in the United Kingdom*. Pest management science, 73(7):1305-1309.

**Dinu M.M., Leman A., Messelink G.J., 2014 -** *Efficacy of commercial and non-commercial strains of entomopathogenic fungi against the peach aphid*

*Myzus persicae (Sulz.)*. IOBC-WPRS Bulletin, 102:259-264.

**Domokos E., Biro-Janka B., Kovacs E., Abraham B., Balog, A., 2015 -** *Genetic variability of the green peach aphid (Myzus persicae) populations in different host plants*. North-Western Journal of Zoology, 11(2):369-371.

**Fericean L.M., Palagesiu I., Palicica R., Prunar S, Varteiu A.M, 2011 -** *The behaviour, life cycle and biometrical measurements of Myzus persicae*. Research Journal of Agricultural Science, 43(2):34-39.

**Halmajan H.V., 2006** - *Oilseed rape growe guide [Ghidul cultivatorului de rapiță]*. Agris publishing house, Bucharest, Cap. 3:49-65.

**Heimbach U., Müller A., 2013 -** *Incidence of pyrethroid-resistant oilseed rape pests in Germany*. Pest Management Science, 69(2):209-216.

**Hess L., Meir P., Ian J.B., 2015 -** *Comparative assessment of the sensitivity of oilseed rape and wheat to limited water supply*. Annals of Applied Biology, 167 (1):102-115.

**Hoffmann M.P., Jacobs A., Whitbread A.M**., **2015 -** *Crop modelling based analysis of site-specific production limitations of winter oilseed rape in northern Germany*. Field Crops Research, 178:49-62.

**Keuls M**., 1952 - *The use of the "studentized range" in connection with an analysis of variance*. Euphytica, (1), 112–122.

**Lup, A., Miron, L., Roman, B., 2013 -** *Influence of market economy on arable crop structure*. Annals of NARDI Fundulea, 81:185-191.

**Meng J., Zhang C., Chen X., Cao Y., Shang S., 2014 -** *Differential protein expression in the susceptible and resistant Myzus persicae (Sulzer) to imidacloprid*. Pesticide Biochemistry and Physiology 115:1-8.

**Newman D**., 1939 - *The distribution of range in samples from a normal population, expressed in terms of an independent estimate of standard deviation*. Biometrika, 31(1):20–30.

**Panaitescu L., Lungu M., Nita S., 2013 -** *Agrometeorological and technological conditions for rape cultivation in Dobrudja*. Present environment and sustainable development, 7(1):116-125.

**Popescu A, Dinu T.A., 2020 -** *Rape production and its geographical concentration in Romania*. Scientific Papers: Management, Economic Engineering in Agriculture&Rural Development, 20(2):379-387.

**Popov C., Barbulescu A., Guran M., Raranciuc S., Spiridon C., Vasilescu S., Valsan D., Mateias M.C., Voinescu I., 2002 -** *Phytosanitary state of cereals, leguminous for grain, industrial and fodder crops in Romania in 2001*. Problems of Plant Protection, 30(1):1-21.

**Popov C., Guran M., Raranciuc S., Rotarescu M., Spiridon C., Vasilescu S., Gogu F., 2004 -** *Phytosanitary state of cereals, leguminous for grain, industrial and fodder crops in Romania in 2003.* Problems of Plant Protection, 32(1):1-23.

**Popov, C., Trotus, E., Vasilescu, S., Barbulescu, A., Rasnoveanu, L., 2006 -** *Drought effect on pest attack in field crops*. Romanian Agricultural Research, 23:43-52.

**Popov C., Raranciuc S., Spiridon C., Vasilescu S., Cana L., 2007 -** *Phytosanitary state of cereals, leguminous for grain, industrial and fodder crops in Romania in 2006*. Problems of Plant Protection, 35(1):1-24.

**Popov, C., Barbulescu, A., 2007** - *50 years of scientific activity in field crop protection area, against pests and diseases*, Annals of NARDI Fundulea, 75:371-404.

**Rasnoveanu L., 2010 –** *Influence of some agrotechnic factors concerning pests population at autumn oilseed rape in North-East Baragan area* [*Influenţa unor factori fitotehnici asupra populaţiei de dăunători la rapiţa de toamnă în zona Bărăganului de Nord-Est*]. Doctoral thesis, USAMV Bucharest.

**Rasnoveanu L., 2011a -** *Aspects of winter rape pests population control the fertility management in the conditions agricultural area north-east Baragan*. Scientific Papers, Series Agronomy, 54(1):156-162.

**Rasnoveanu L., 2011b -** *Influence of sowing time on evolution of pests population in rape crops under the North-East Baragan*. Annals of NARDI Fundulea, 79(1):153-160.

**Rasnoveanu L., Burtea C., 2012 -** *Aspects population control Ceuthorrynchus quadridens in the agricultural in area of Nord Eastern Bărăgan*. Scientific Papers, Serie Agronomy, Supplement, 2:71-76.

**Roman G.V., Morar G., Robu T., Ștefan M., Tabără,V., Axinte M., Borcean I., Solovastru, C**., 2012 **–** *Crop Science*, vol. II, Universitary Publishing house, Cap. 4:62-97.

**Rosca, I., Rada, I., 2009 -** *Entomology (Agriculture, Horticulture, Forest)*, Alpha MDN Publishing house, Chapter 15:369-372,

**Skellern M.P., Samantha M.C., 2018 -** *Prospects for improved off-crop habitat management for pollen beetle control in oilseed rape*. Arthropod-Plant Interactions 12(6):849-866.

**Student**. 1927 - *Errors of Routine Analysis*. Biometrika, 19(1/2):151-164.

**Trandafirescu M., Trandafirescu I., Gavat C., Spita V., 2004** - *Entomophagous complexes of some pests in apple and peach orchards in southeastern Romania*. Journal of Fruit and Ornamental Plant Research, 12:253-261.

**Trasca F., Trasca G., Georgescu E.I., 2019 -** *Management of the rape crop protection against soil pests by seed chemical treatment*. Annals of NARDI Fundulea, 87:271-280.

**Trotus E., Trif V., Mateias M.C., 2001 -** *Research regarding the rape crop protection against the specific pest attack*. Romanian Agricultural Research, 16:51-56.

**Trotus E., Mincea C., Dudoiu R., Pintilie P.L., Georgescu E.I., 2019 -** *The preliminary results regarding the impact of the neonicotinoids insecticides, applied at rape, sunflower and maize seed treatment, on the harmful entomofauna and honey bees*. Annals of NARDI Fundulea, 87:251-260.

**Williams I.H., 2010 -** *The Major Insect Pests of Oilseed Rape in Europe and Their Management: An Overview*. Biocontrol-Based Integrated Management of Oilseed Rape Pests, 1-43.

*****MADR data, 2020 -** https://www.madr.ro/culturi-de-camp/plante-tehnice/rapita-pentru-ulei.html

# THE ACTION OF GROWTH REGULATORS ON THE PROCESS OF PHOTOSYNTHESIS IN SUNFLOWER

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**Abstract**

One of the main physiological processes that are directly influenced by the action of biostimulants and which has a decisive factor in the quantity and quality of the crop is photosynthesis. That is why our study aimed to establish the main ways in which growth regulators intensify the process of photosynthesis. We followed the effect of some biostimulants on the intensity of the photosynthesis process in the sunflower crop, a crop that in recent years has remained in the top of UE countries with the largest cultivated land areas but also with high yields. The study was performed on the *NK NEOMA* sunflower hybrid, and the treatments were done with the biostimulants *Atonik* and *Terra - Sorb* in a concentration of 0.3%. Two treatments were made in two different phenophases: at the formation of the floral botton and before flowering. The evaluation of the intensity of the photosynthesis process was performed by: determining the total chlorophyll content (CCI) and by determining the content of photosynthetic pigments in the leaves, maintaining an interval of 7 days from the application of biostimulants. The results showed an intensification of the photosynthesis process in the flowering phenophase I for the variants treated with biostimulators. The group of plants treated with *Terra Sorb* is noted with the highest value, which coincides with the higher number of leaves/per plant recorded in the second phenophase studied. The obtained results demonstrate higher values of the chlorophyll a content for the variants treated with biostimulants, in both phenophases, the control group registering lower values.

**Key words**: sunflower, photosynthesis, biostimulants

Biostimulants are substances that ensure the metabolic balance of plants, improve vitality and at the same time provide a high resistance against the attack of phytopathogens and pests, as well as an increased tolerance to abiotic stressors. Therefore, these substances can be used successfully in agricultural crops (Carla Michelle da Silva *et al*, 2018; Magdalena Drobek *et al*, 2019).

One of the main physiological processes that are directly influenced by the action of biostimulants and that has a decisive factor in the quantity and quality of the crop is photosynthesis. (Akila N and Jeyadoss T, 2010; Sona Salem El-Nwehy *et al*, 2016).

In recent years, sunflower cultivation has remained in the top of UE countries with the largest cultivated land, but also with high yields. In 2016, according to the National Institute of Statistics, Romania ranked first in the area cultivated with sunflower and in the production obtained.

New strategies have been proposed to improve the productivity and resilience of sunflower crops to different types of biotic and abiotic stress. For this purpose, an important thing was the use of biostimulants, which are able to improve the quality parameters of the sunflower, the efficiency of fertilizers, as well as its tolerance to various stress conditions.

## MATERIAL AND METHOD

The experience was organized at the Ezareni farm, within the Teaching Station of the University of Agricultural Sciences and Veterinary Medicine Iasi, in the spring of 2019 and was placed according to the method of randomized blocks with three repetitions.

During the experiment, the NK NEOMA sunflower hybrid was studied, to which two treatments were applied by spraying at a distance of 7 days.

The treatments were performed with the biostimulants Atonik and Terra - Sorb in a concentration of 0.3%. The first spray was performed when the flower button appeared, and the second spray before flowering.

The analysis of physiological parameters was performed seven days after the application of biostimulants.

NK NEOMA is a semi-early hybrid of sunflower (vegetation period 112 - 114 days) adaptable in all areas of culture in Romania, has a high production potential, which has been proven

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over the years, responding favorably to intensive cultivation conditions.

***Atonik*** is a biostimulants based on polyphenols. It stimulates growth, increases the intensity of photosynthesis but also the degree of fertility of flowers thus ensuring a high productive potential.

***Terra – Sorb foliar*** is an ecological biostimulant with an increased content of free amino acids (approx. 9.3%), obtained by enzymatic hydrolysis and important microelements such as

(Mn, B and Zn), together contributing to vegetative growth, but also to increasing flower fertility.

The study followed the process of photosynthesis under the direct action of biostimulants. It was evaluated by determining the chlorophyll content index and by evaluating the content of photosynthetic pigments in the leaves.

**The determination of the chlorophyll content index** was performed using the CCM-200 (Chlorophyll Content Meter). In this case, the chlorophyll index represents the ratio between the transmittance of chlorophyll at the wavelength of 931 nm and that at the wavelength of 653 nm.

**The content of photosynthetic pigments and flavonoids** in leaves was achieved by the spectrophotometric method described by Jităreanu et *al*., 2011. The method allows testing pigments with absorption in the visible spectrum, between wavelengths of 400-700 nm and close UV, respectively 330- 400 nm. The content of different types of pigments was assessed based on the light absorption capacity of the acetonic extract (1%), analyzed by computer-aided spectrophotometer.

## RESULTS AND DISCUSSIONS

**Dynamics of total chlorophyll content (CCI)**

Following the analysis of the total chlorophyll content, an increase could be observed of this index in the variants treated with biostimulants (*figure 1*). At the formation of the flower button, the sunflower hybrid NK Neoma had the highest chlorophyll content in plants in the *Atonik* group (14.5 CCI), and in the first flowering phase in those in the *Terra Sorb* group the values recorded an average of 16.4 CCI.

The results obtained by analyzing this physiological parameter show that the total chlorophyll content increased in direct proportion to the average number of leaves/plant (*figure 2*) and also the high values of CCI, recorded in the two phenophase highlight the role of the two biostimulants in intensifying the content. total chlorophyll.

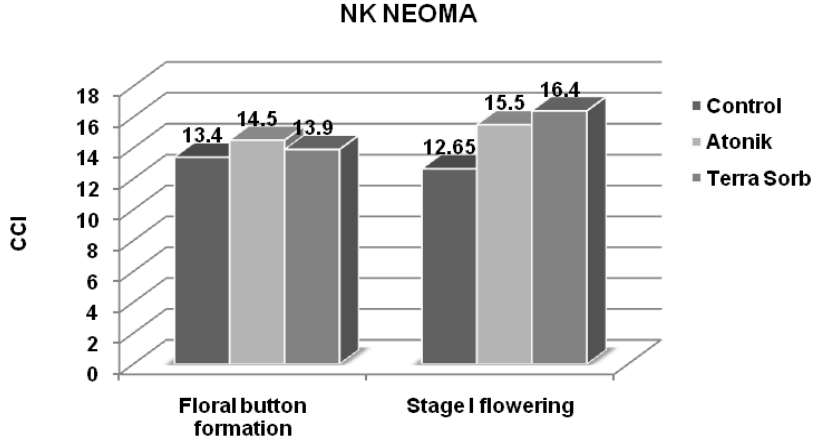



Figure 1 **Total chlorophyll content (CCI) at floral button formation and stage I flowering after application of biostimulant**

The foliar system plays a very important role in the formation of seed production (Michelle da Silva C., 2018; Dobrek M, 2019). The main role is played by the leaves of the middle floor (Bălteanu G., 2001). The leaves at the base and those at the top of the plant are less active, because the former age quickly and the others use, like the seeds, the nutrients produced by the leaves of the middle floor (Vrânceanu V., 2000; Petcu G. and Petcu E., 2008). One week after the application of the first treatment, there was an increase in the average number of leaves in the variants treated with the two biostimulants, the average being 24 leaves/plant, a trend that continues after the application of the second treatment.

By increasing the number of leaves/plant, the assimilation area increases, the photosynthesis process intensifies and therefore there is an accumulation of a larger amount of organic substances in the body of the plant.

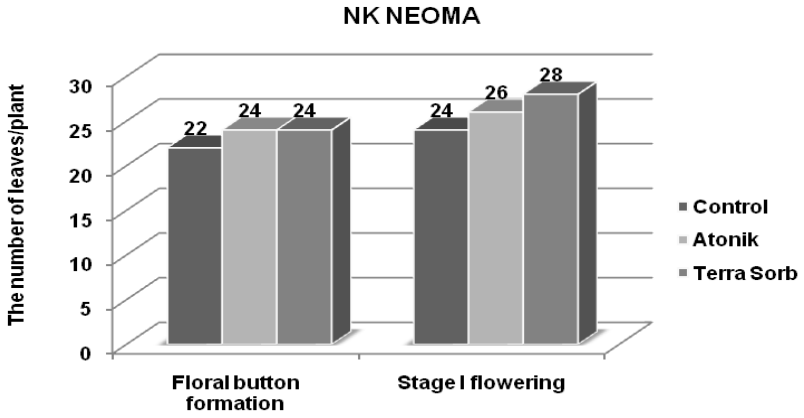



Figure 2 **The influence of biostimulants on number of leaves/plant**

Plants treated with *Terra - Sorb* recorded a higher number of leaves, which reveals that, from a physiological point of view, this biostimulants acts quite quickly on the basal meristems and as a result, the numerical growth of the leaves is more pronounced.

The results obtained from these biometric determinations in the foliar system are due to the balanced content of nitrogen, magnesium and phosphorus in the composition of the *Terra-Sorb* biostimulants which intensifies photosynthesis by participating in chlorophyll biosynthesis and stimulating photosynthetic reactions. Therefore, the plants to which this growth stimulant was applied also showed the highest chlorophyll content presented above.

**Dynamics of photosynthetic pigment content in sunflower leaves**

For the capture of light energy and its transformation into chemical energy in the process of photosynthesis, the primary role belongs to chlorophyll a. The absorption of light energy and it's transformation into chemical energy by triggering the transport of energizing electrons and photosynthetic phosphorylation is done by participating and SF II) (Toma L.D and Jităreanu C.D, 2007).

The photosynthetic system consists of a set of assimilating pigments, divided into an absorption and a reaction center, forming the photosynthesis unit. Chlorophyll *a 431 - 433* nm and chlorophyll *b 453 - 454* nm are components of the absorption center, and chlorophyll *a 662 - 663* nm and chlorophyll *b 616 - 617* nm are part of the reaction center (Jităreanu C.D., 2007). This is why these chlorophyll species were analyzed, and the results obtained demonstrate the variations between the control group and the variants treated with biostimulants in terms of energy capture potential depending on the amount of pigments and their absorption activity.

The highest values in light absorption from the visible spectrum and condensation in the form of potential chemical energy were found in plants treated with biostimulants.

The production is directly influenced by the intensity of photosynthesis, appreciated by the amount of photosynthetic pigments that has the ability to fix the light energy in the visible spectrum.

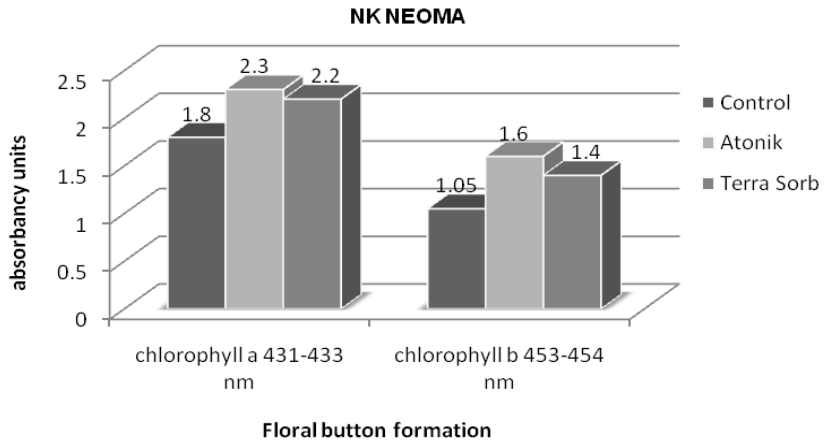



Figure 3 **The effect of biostimulants on chlorophyll content a 431 nm and b 453 nm to the floral button formation**

Spectrophotometric analysis on the content of photosynthetic pigments in sunflower leaves after the first treatment, showed the highest chlorophyll content of 431 nm in plants treated with the biostimulant *Atonik* (2.3 ua), followed by those treated with *Terra Sorb* (2.2 ua) (*figure 3*). The lowest value was recorded in the control variant (1.8 u.a.). In the phenophase of the formation of the floral button, the chlorophyll content *b 453* nm was maximum, also in the group treated with the *Atonik* biostimulant (1.6 u.a). In the period coinciding with the first stage of flowering, the same trend is maintained, the chlorophyll content of *431* nm and *b 453* nm showing the highest values in the plants to which the treatment with Atonik was applied (*figure 4*). In this situation, too, the control plants showed lower values of chlorophyll species content, which are components of the absorption center of photosynthetic systems.

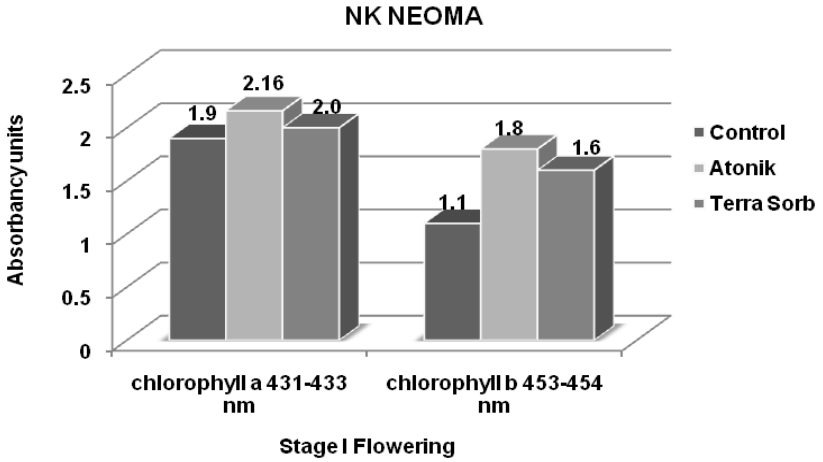



Figure 4 **The effect of biostimulants on chlorophyll content a 431 nm and b 453 nm to the stage I flowering**

The chlorophyll species of *662 nm*, component of the reaction center of photosynthetic systems, recorded high values in the variants treated with biostimulants, the maximum content during the formation of the floral button, being obtained in plants treated with Atonik (1.3 u.a) *(figure 5*).

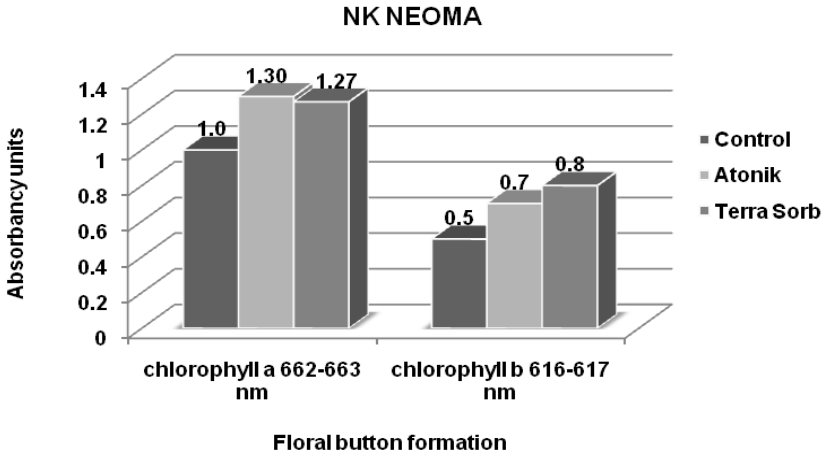



Figure 5 **The effect of biostimulants on chlorophyll content a 662 nm and b 616 nm to the floral button formation**

Note the same trend as in the case of the chlorophyll species of *431 nm*, a component of the center with a primary role in the absorption of light radiation and transfer to the reaction center.

The analysis of the chlorophyll content *b 616 n*m, which is part of the reaction center in photosynthetic systems, showed in the stage of formation of the floral button, higher values for plants in the *Terra Sorb* variant, the average being 0.8 u.a. It should be noted that in this case, the control group has the lowest content in chlorophyll *b 616*, which allows us to conclude that treatments with applied substances stimulated the activity of these pigments, creating the premises for intense photosynthetic activity.

After the application of the second treatment, in the first stage of flowering, there are slight changes in the chlorophyll content of *662 nm*, in this case the *Terra Sorb* group recording the highest values (1.18 u.a.) (*figure 6*). Changes are

also found for chlorophyll *b 616*, the highest values being evident in plants sprayed with *Atonik* (0.9 u.a.). That indicate that the assimilated substances have an intense transport to the fruits and thus a favorable prognosis in terms of production is obtained. These values classify biostimulants among the substances that can be used successfully in accelerating the process of photosynthesis and subsequently in intensifying production in sunflower culture.

The spectrophotometric method also allowed the evaluation of the content of flavonoid pigments responsible for the resistance of plants to stress factors (Moța C *et al*, 2013).

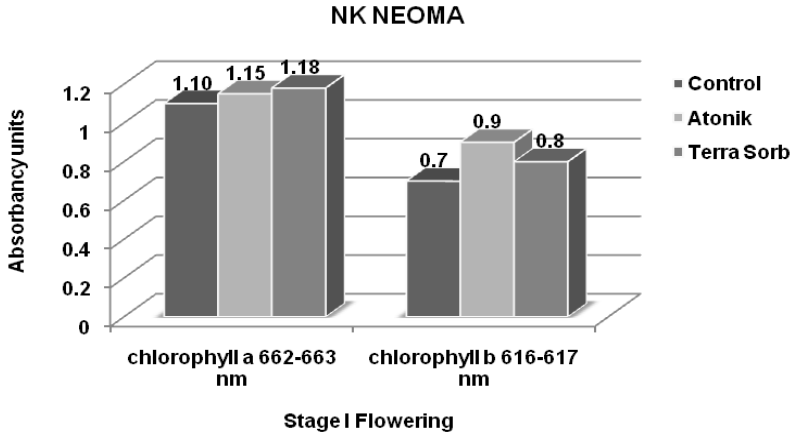



Figure 6 **The effect of biostimulants on chlorophyll content a 662 nm and b 616 nm to the stage I flowering**

Both in the formation of the floral button and in the first stage of flowering, the highest values were present in the *Terra Sorb* variant (*figure 7*), which indicates that the high content of amino acids in the chemical composition of this growth regulator increases the tolerance to abiotic stressors of the sunflower hybrid NK Neoma. Moreover, it is important to note that these high values of the flavonoid content of the variants treated with biostimulants overlap with a significant decrease in the amount of precipitation followed by a sudden rise in temperature (*figure 8*).

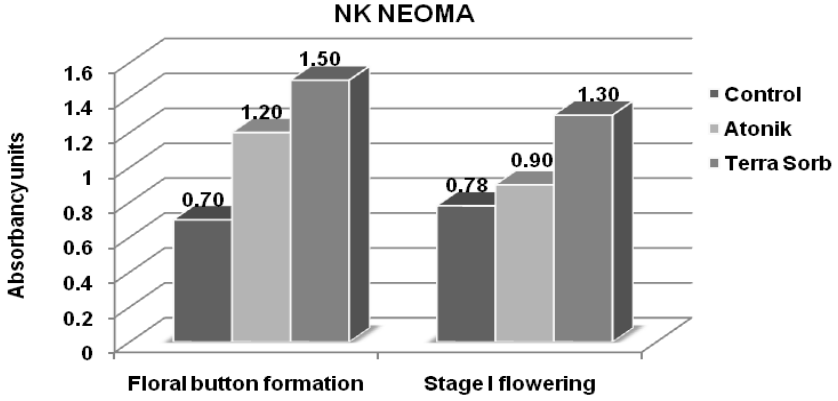



Figure 7 **The effect of biostimulants on flavonoid content**

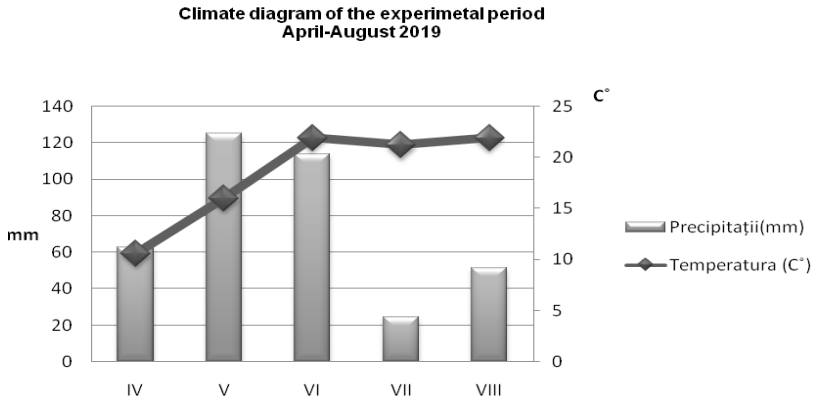



Figure 8 **Climate diagram of the experimental peiod**

## CONCLUSIONS

1. The analyzes related to the foliar system showed a higher number of leaves/plant in the variants treated with the two biostimulants compared to the control group, which denotes not only a faster passage from one phenophase to another, but also an intensification of the process. of photosynthesis.

2. The observations made on the total chlorophyll content, highlighted the variants treated with biostimulants, they recorded the highest values, a result that highlights an intensification of photosynthesis.

3. Studies on the chlorophyll content of *431 nm* and the chlorophyll content of *453 nm*, which make up the light energy absorption center which it transfers to the reaction center (chlorophyll a 662 nm and chlorophyll b 616 nm) have shown that the higher values were recorded in plants treated with the *Terra Sorb* biostimulants, which indicates the intense transport of assimilated substances to the fruiting organs.

4. The content in flavonoid pigments was the highest in the variants treated with biostimulants, but the plants treated with *Terra Sorb* showed the highest values, which shows that this biostimulator has a higher degree of resistance to climatic stress factors.

## REFERENCES

**Akila N., Jeyadoss T., 2010** - *The potential of sea weedliquid fertilizer on the growt hand antioxidant enhancement of Helianthus annuus L*. Oriental Journal of Chemistry, India, 26(4):1353-1360.

**Bîlteanu G., 2001** - *Fitotehnie*, vol. 2. Ed. Ceres, București.

**Dobrek M., Frac M., Cybulska J., 2019** - *Plant Biostimulants: Importance of the Quality andYield of Horticultural Crops and the Improvement of Plant Tolerance to Abiotic Stress*. A Review. Agronomy, Polonia, 4: 20-29.

**El-Nwenhy S.S., El Nasharty A.B., Resk A.I., 2018** - *Enhance sunflower productivity by foliar application of some plant growth bio-stimulants under salinity condition*.Bioscience Research, Egipt, 15 (3):1763-1768.

**Jităreanu C.D., Toma L.D., 2007** - *Fiziologia plantelor*. Ed „Ion Ionescu de la Brad" Iași.

**Jităreanu C.D., 2007** - *Fiziologia plantelor*. Ed „Ion Ionescu de la Brad", Iași.

**Michelle da Silva C., Raisse E.R., Veimar da Silva A., Araújo E.F., 2018** - *Biostimulant Doses X Stress Conditions on the Germinationand Seedling Characteristics of Sunflower Seeds*. Jurnal of Experimental Agriculture International, Brazilia, 26(4):1-11.

**Moța C., Roșu A., Câmpeanu Gh., 2013** - *Compuși bioactivi de origine vegetală.* Abordări biotehnologice. Ed.Ceres București.

**Petcu G., Petcu E., 2008** - *Ghid tehnologic pentru grâu, porumb și floarea soarelui.* Ed. Domino, București.

**Rapacz M., Waligorski P., Janowiak F., 2003** - *ABA and gibberellin-like substances during prehardening, cold acclimation, de- and reacclimation*. Acta Physiologiae Plantarum, 4( 25):151-160.

**Toma L. D., Jităreanu C.D., 2007** - *Fiziologie vegetală*. Ed „Ion Ionescu de la Brad" Iași.

**Vrînceanu A.V., 2000** - *Floarea soarelui hibridă*. Ed. Ceres,București.

# EDAPHIC MESOFAUNA COMMUNITY STRUCTURE IN SOME ECOSYSTEMS AFFECTED BY INVASIVE PLANTS IN THE DANUBE DELTA BIOSPHERE RESERVE

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**Abstract**

Edaphic mesofauna is involved in decomposition and mineralization of organic matter and the regulation of nutrient cycles. These organisms are associated with soil quality and plants diversity. Invasive alien plants into an ecosystem can determine dramatic changes in both the native plant and animal assemblages. Consequently, the purpose of the article is to highlights a potential influence of invasive species (*Elaeagnus angustifolia, Amorpha fruticosa, Ailanthus altissima, Vitis vinifera, Cannabis ruderalis*) on the quantitative and qualitative parameters of the edaphic mesofauna, on the main systematic and trophic groups. Among mites oribatids are predominant in almost of the investigated plots with a maximum of 84% in the plantation with Canada poplar and *A. fruticosa*. Another group of mites, the *Trombidiformes* characterized by a various trophic regime, is also with high densities, the highest one being registered in the ecosystem with *A. altissima* (78%). The ratio between some groups (oribatids/ collembolans, oribatids/ astigmatids) which is considered a good bioindicator of the quality and humification stage of an organic substrate was with high values in all the examined plots. These results have shown that humification is predominant, and the nutrient cycle is slower in all investigated plots. It is remarked a small number of collembolans in all analysed samples and also, an absence of this decomposer group of mesofauna, a group that generally has a high share in the whole fauna of edaphic microarthropods, especially in good humidity conditions.

**Key words**: microarthropods, alien plants, Danube Delta

Nowadays, it is unanimously recognized that invasive plants represent one of the major threats for biodiversity, human health and even for economy. These plants grow spontaneously in the newly occupied territory, rapidly multiply and cause even the extinction of some native species and finally may modify the ecosystem functions as well. At the edaphic level, the invasive plants may change the chemistry, lead to a decreased fertility, may affect mycorrhizal fungi, etc.

In a publication from 2011, Sirbu C. and Oprea A. specify that in Romania 671 non-native species of plants were inventoried, of which 112 species gather the criteria for an invasive status, due to both their spread capacity, as well as the impact they have. In the last hundreds of years, the Danube Delta has been also invaded by many invasive plants, which have a negative influence on this unique ecosystem in Europe. According to Anastasiu P. (Anastasiu P. *et al*, 2014) on the territory of Danube Delta Biosphere Reserve exists 168 non-native plants, of which 35 are considered invasive. Among them *Ailanthus altissima, Amorpha fruticosa* are aggressive having a negative impact on different ecosystems (Anastasiu P. *et al*, 2014). The botanical researches are very numerous, but the same cannot be said about researches of edaphic microarthropods fauna from the perimeters with invasive plants. In Europe, a relevant research has been conducted in Silesian province, south Poland on the influence of the highly productive invasive species *Fallopia sachalinensis* (=*Reynoutria sachalinensis*) on edaphic microarthropods fauna (Skubala P., Mierny A., 2009). Other works are on ccommunities of mites in litter and soil under the invasive red oak (*Quercus rubra* L.) (Kohyt J., Skubala P., 2013) or on the *Collembola* and *Acari* communities under *Impatiens glandulifera* (Rusterholz H.P. *et al*, 2014).

In our country, only one study is dedicated to the fauna of edaphic microarthropods from surfaces covered by invasive plants and is related to the fauna associated with *Reynoutria japonica* from the Maramureș Mountains Natural Park. The respective investigation was carried out in different climatic conditions, but only arachnids and collembola were analysed (Hapca I.A, 2014).

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Therefore, the present article, by the quantitative and qualitative investigation of the fauna of edaphic microarthropods on main systematic and trophic groups from invaded perimeters, compared to the non-invaded ones is a novelty for our country, and the investigation within D.D.B.R. could be a starting point for similar research in other parts of the country.

## MATERIAL AND METHOD

Sampling was performed in June 2019 from eight different plots, six of them with invasive species (*Elaeagnus angustifolia, Amorpha fruticosa, Ailanthus altissima*, *Vitis vinifera, Cannabis ruderalis*) from four localities placed on the D.D.B.R. territory, as follows:

- Pătlăgeanca (1) (45°12′54.6″N 28°41′41.0″E), an area with *E. angustifolia* (E.a.) and one meadow without this invasive plant (mw.);
- Plauru (2) (45°16′31.4″N 29°39′21.8″E) one young plantation (pl.) of *Salix alba* (S.a.), *Populus alba* (P.a.) and *A. fruticosa* (A.f.) and an old plantation (pl.) of *Populus x canadensis* (P.c.) with *A. fruticosa* (A.f.);
- Beștepe (3) (45°05′15″N 29°02′26.76″E) a perimeter with *A. altissima* (A.a.) and an abandoned vineyard (*V. vinifera* – V.v.);
- Sabangia (4) ( 44°58′30″N 28°52′59″E) area with *C. ruderalis* (C.r.) and an adjacent meadow (mw.).

In all these plots there were taken series of five samples. In the plot with *E. angustifolia* and in that with Canada poplar the samplings were collected on two subhorizons – olf (litter and fermentation layer) and ah (humification layer). Each sample had an area of 100 $cm^2$. The edaphic mesofauna was extracted by Tullgren – Berlese method, then it was sorted on groups: *Parasitiformes* (*Mesostigmata*, inclusively *Uropodina*), *Acariformes* (*Trombidiformes* and *Sarcoptiformes* - *Oribatida* subdivision and *Astigmatina* cohort), an order belonging to the class *Entognatha* (*Collembola*) and insects as a whole.

## RESULTS AND DISCUSSIONS

Investigations of the effects of invasive plants on arthropod species richness and abundance yielded conflicting results. Thus, some studies have reported an increased diversity or abundance in invaded habitats (Sax D. F., 2002; Pearson D. E., 2009; Liu W. P. A. *et al.*, 2012), while in others was found a reduced arthropod diversity or abundance (Topp W. *et al*. 2008; Wu Y. T. *et al.* 2009), or even no effect on arthropod abundance (Wardle D. A. *et al*., 1995; John *et al*., 2006) (Rusterholz H.-P. *et al.*, 2014).

An interesting idea, which could be a pertinent explanation of the results obtained in the present study, emerges from the researches contained in a Ph D thesis (Hapca I. A., 2014). In the chapter dedicated to edaphic microarthropods, the author discusses and tries to explain the influence of *R. japonica* on mite and *Collembola* populations. The densities of the mite and *Collembola* populations in the soil of a meadow and that of a perimeter invaded with *R. japonica* in conditions of drought, but also of abundant precipitations were compared. Regarding of the environmental conditions, it was found that the number of the mites increases in the soil covered by *R. japonica*; this is statistically assured in the case of sufficient precipitations. The number of collembolans increases with a significantly positive difference in both analysed perimeters in case of an optimal humidity. In drought conditions, the number of collembolans increases in the area with *R. japonica* by a percentage of over 20% compared to the meadow area (but not statistically assured difference). Therefore, it is considered that if precipitation is lacking, *R. japonica* keeps the soil shady and cold, so that springtails and mites keep their effectives, while in the meadow, the effectives of microarthropods are diminished. On the other hand, in the conditions of a rainy season, the number of collembolans decreases drastically in the perimeter with *R. japonica*, compared to the meadow, the statistical difference being strongly negative. In the present study it can also be observed that it is a higher density in soils with invasive plants compared to the adjacent meadows with no invasive plants (*table 1*). Thus, at Pătlăgeanca, in the perimeter with *E. angustifolia*, the total density of the mesofauna is almost 3 times higher than in the meadow. The same situation was found at Sabangia where in the perimeter invaded by *C. ruderalis* the density of edaphic mesofauna is about 2 times higher compared to the neighbouring meadow (*table 1*). Another possible explanation would be that invasive plants provide an increased intake of necromass, on the basis of which mesofauna groups can develop. In addition a high diversity of litter in different stages of decomposition provides a greater diversity of niches for occupation by soil organisms (Makulec K. I. *et al*., 2006; Morais J. W. *et al*., 2010). Also, it is well known that there are differences in soil fauna abundances between forests of different age classes (Johansson T. *et al*., 2016). Thus, in the case of the plantations from Plauru, both of them invaded by *A. fruticosa*, it was found that the mesofauna abundance is the highest in the soil of the oldest plantation (the poplar Canada one).

Table 1

**Average density (individuals/100cm²) of the edaphic microarthropods from the analyzed agroecosystems**

| Taxa / Locality / Invasive plant/ecosystem | | 1 | | 2 | | 3 | | 4 | |
|---|---|---|---|---|---|---|---|---|---|
| | | E. a. | mw. | pl.+A.f. | | A.a. | V.v. | C.r. | mw. |
| | | | | P.a , S.a. | P.c. | | | | |
| *Mesostigmata* | | 6.4 | 6.8 | 1.2 | 1.4 | 1.8 | 24.4 | 2.2 | 0.8 |
| *Trombidiformes* | | 76.8 | 19.2 | 32.4 | 29.6 | 73.8 | 27.8 | 37.6 | 24.6 |
| *Sarcoptiformes* | *Oribatida* | 48.4 | 25.6 | 82.6 | 169.4 | 18.8 | 36.6 | 22.0 | 8.0 |
| | *Astigmatina* | 1.8 | 0.6 | 6.8 | 0.4 | 0.4 | 2.2 | 5.4 | 5.6 |
| **Total *Acari*** | | **133.4** | **52.2** | **123.0** | **200.8** | **94.8** | **91.0** | **67.2** | **39.0** |
| *Entognatha* (*Collembola*) | | 10.8 | 0.8 | 0.2 | 0.6 | 0.4 | - | 0.6 | - |
| *Insecta* | | 24.4 | 4.0 | 4.0 | 0.4 | 4.6 | 10.2 | 1.0 | 0.6 |
| Other groups | | - | - | - | 0.8 | - | 0.4 | 0.2 | - |
| **Total** | | **168.6** | **57.0** | **127.2** | **202.6** | **99.8** | **101.6** | **69.0** | **39.6** |
| O/C | | 4.48 | 32.0 | 413.0 | 282.33 | 47.0 | - | 36.66 | - |
| O/As | | 26.88 | 42.66 | 12.14 | 423.5 | 47.0 | 16.63 | 4.07 | 1.42 |

Legend: 1-4 sampling localities, see abbreviation in § Material and method

Here the density is 1.6 times higher than that observed in the young plantation with *Populus alba*. At the same time, the largest number of microarthropods in the whole series of considered ecosystems was identified here (*table 1*).

Many studies have shown that *Collembola* and *Acari* are among the most abundant and diverse microarthropods in the litter and soil of numerous ecosystems accounting for about 95% of the total number of arthropods in these strata (Hardings D. J. L., Stuttard R. A., 1974; Maraun M., Scheu S., 2000). According to a review, *Collembola* are the most numerous hexapod arthropods on the planet, including insects; they are particularly sensitive to environmental changes, and therefore thought to be an excellent bioindicator (Hopkin P., 1997). *Collembola* have an important role in plant litter decomposition processes and in forming soil microstructure. They are reported as being dominant in almost kinds of soils (Brahmann P. *et al.*, 2010; Zhu X. *et al.;* Abbas *et al.*, 2012, after Islam S. *et al.*, 2018). Abiotic factors are good predictors of collembolan community structure. The members of these diverse microarthropods group may be affected by changes in soil conditions and vegetation cover (Kaczmarek M., 1975; Hagvar S., 1982; Chauvat M. *et al* 2006 after Islam S. *et al.*, 2018). Their high abundance makes them significant contributors to several processes of soil, such as material and energy cycles, and formation of soil (Vu Q. M., Nguyen T. T., 2000, after Islam S. *et al.*, 2018). Our analysis reveals that collembolans are absent or present, but with a very small representation, being dominated by mites in high rates (79-99%) in both invaded or non-invaded plots. This situation can be explained especially by the dryness of the soil during the sampling period, springtails being very sensitive to this ecological factor.

Analysis of the mites fauna by taxonomic groups led to the finding that the oribatids and trombidiform mites has dominated alternatively (*table 1*).

At Pătlăgeanca, in the ecosystem invaded by *E. angustifolia* trombiforms, are the most abundant group with 46% of total, while in the meadow oribatid mites predominate (49%). At Plauru in both plantations – the young and the old one as well as at Beștepe in *V. vinifera* plot oribatid mites are on the first place with 67.15%, 83.61% respectively 40,2%. Trombidiform mites represent the majority in the rest of the plots, as follows: at Beștepe in the plot invaded by *A. altissima* (77.8%), at Sabangia, in the plot with *C. ruderalis* (55.95) and in the adjacent meadow (63.07%). *Trombidiformes*, a group of mites with a varied food regime (Krantz G. W, Walter D. E., 2009) are with a good representation status in meadows, meanwhile oribatids have the biggest abundance in forest ecosystems. With small percentages (0.59-26.59%) mesostigmatid mites hold third place within the *Acari*, because astigmatid mites have even smaller abundances with only one exception; in the plot invaded by *C. ruderalis* from Sabangia astigmatid mites were identified with a percentage of 8.03% and mesostigmatid with only 3.27%. The mites from *Astigmatina* cohort, is a microphytophagous group (Krantz G. W., Walter D. E., 2009), stimulated by wet and rich in organic matter (Călugăr M. *et al*, 1989). So, this group of mites find more proper condition for developing only in the soil invaded by *C. ruderalis* which is considered to be a eutrophic plant, thus preferring a soil rich in organic matter (Cuharscaia L., 2016).

The ratio between oribatids – O / collembolans – C as well as that of oribatids - O and astigmatids – As, indicates very high values, collembolans and astigmatid mites having sporadic presence and densities much lower than those of the oribatids. These results show the

tendency towards intense humification in both invaded or non-invaded plots.

## CONCLUSIONS

The results of this research are based on only one sequence of time, so the conclusions have just a relative character. For complete conclusions the investigation must be repeated in some other climatic conditions at least. For the moment we can conclude that from a quantitative point of view there are differences between the perimeter invaded by invasive plants and the uninvaded neighbouring area, consisting in higher densities of the edaphic mesofauna in the first ones. From a qualitative point of view there were not detected any differences between them. Both climatic factors and soil properties (generally a sandy loam soil with a fine texture) have a cumulative negative effect on the density of Collembola population. Collembolans are absent or present with small densities in both invaded or uninvaded perimeters. Analysis of mites' fauna on taxonomic groups led to the finding that the oribatids and trombidiform mites have dominated alternatively and they are followed by gamasid mites with one exception when astigmatid mites are on third place. The ratio Oribatida / collembolans is supraunit, as well as the ratio Oribatida / Astigmatina, result which shows the tendency towards intense humification in both invaded or non-invaded plots.

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## REFERENCES

**Anastasiu P., Negrean G., Smarandache D., Liţescu S., Basnou C., 2014 -** *Neophytes in protected areas. Case study: the Danube Delta Biosphere Reserve,* Acta Horti Bot. Bucureşti**,** 41: 41-68

**Călugăr M., Huţu M., Bulimar F., Donose-Pisică A., 1989** - *Aspects of the decomposition process from a grass fertilized with mineral nitrogen* (in Romanian)*,* St. cercet. Biol, ser. Biol. anim., 41(1): 37-47.

**Cuharscaia L., 2016** - *Taxonomic structure, ecology and impact of invasive plant species on the Chișinău ecosystem* (in Romanian)*,* Studia Universitatis Moldaviae, 1(91), 1857-498X, 103-107, available on-line at http://studiamsu.eu/wp-content/uploads/17.p.103-107_91_91.pdf

**Hardings D. J. L., Stuttard, R. A., 1974 -** *Microarthropods*, In Dickinson, C. H. and Pugh, G. J. F. (Eds). *Biology of phi litter decomposition*., Academic Press: London, 489-532 pp.

**Hapca I. A., 2014 -** *Influenţa speciilor de plante invazive asupra biodiversităţii ariilor protejate Studiu de caz: Reynoutria japonica în Parcul Natural Munţii Maramureşului*, PhD thesis abstract, Cluj Napoca, 13 pp.

**Hopkin SP., 1997** - *Biology of the Springtails (Insecta: Collembola)*, Oxford University Press, UK, 330 pp.

**Islam S**., **Hossain M., Hossain M., M Yasmin, 2018** - *Impact of climatic factors and soil quality on the abundance and population density of Collembola in the Rajshahi University Campus, Bangladesh,* Journal of Entomology and Zoology Studies, 6(1): 1119-1125.

**Johansson T, Hjältén J, Olsson J, Dynesius M, oberge J-M, 2016** - *Long-term effects of clear-cutting on epigaeic beetle assemblages in boreal forests.* For Ecol Manag 359: 65–73.

**Kohyt J., Skubała P., 2013** - *Communities of mites (Acari) in litter and soil under the invasive red oak (Quercus rubra L.) and native pedunculate oak (Q. robur L.)* Biological Lett., 50(2): 111–124, available on-line at: https://www.researchgate.net/publication/269474774

**Krantz, G., W., Walter, D., E., 2009** - *A Manual Of Acarology.* third ed., Texas Tech. University Press, 807 pp.

**Makulec, K.I.; Olejniczak, I.; Szanser, M. 2006**- *Response of soil micro and mesofauna to diversity and quality of plant litter,* European Journal of Soil Biology, 42: 244-249.

**Maraun M, Scheu S., 2000** - The structure of oribatid mite communities (Acari, Oribatida): patterns, mechanisms and implications for future, research, Ecography (Cop.), 23: 374–383.

**Morais J.W., Oliveira V.S., Dambros C.S., Tapia-Coral S.C., Acioli A.N.S., 2010** - *Soil mesofauna in different systems of land use soil in upper river Solimões* (in Portuguese, with abstract in English), AM, Brazil. Neotropical Entomology, 39: 145-152.

**Peredo, P., S., F., Parada, Z., E., Vega, C., M., Barrera, S., C., P.**, **2009** - *Edaphic Mesofauna Community Structure In Organic And Conventional Management Of Cranberry (Vaccinium Sp.) Plantations: An Agroecological Approach.*, Rev. Cienc. Suelo Nutr./J. Soil. Sci. PlantNutr., 9(3), 236-244.

**Rusterholz H.-P., Salamon J.-A., Ruckli R., Baur B., 2014** - *Effects of the annual invasive plant Impatiens glandulifera on the Collembola and Acari communities in a deciduous forest*. Pedologia, 57: 285-291.

**Sîrbu C. (coord.), Oprea A., 2011** – *Alien plants in the Romanian flora* (in Romanian)*,* Edit. "Ion Ionescu de la Brad", Iași, 733. pp.

**Skubala P., Mierny A., 2009** - *Invasive Reynoutria taxa as a contaminant of soil. Does it reduce abundance and diversity of microarthropods and damage soil habitat?,* Pestycydy/Pesticides, 1-2, 57-62.

# RESEARCH REGARDING THE INFLUENCE OF GENOTYPE AND EPOCH OF SOWING ON SEEDS YIELD AT RICINUS COMMUNIS L. (CASTOR) IN THE PEDOCLIMATIC CONDITIONS FROM THE CENTRAL OF MOLDOVA

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**Abstract**

The researches were organized in 2018-2019 at the Moldoveni Agricultural Society, Neamt County. In the agricultural year 2018, the genotypes experienced did not show a high adaptability to the pedoclimatic conditions of the area, obtaining yields below 1500 kg/ha. Compared to 2018, the yields obtained in 2019 were higher, this was due to the excess of precipitation registered in May of approximately 30 mm. The yields varied between 1297 kg/ha (Teleorman variety) and 1548 kg/ha (Cristian variety). During in the period under study, the highest yield increases (38 kg/ha, respectively 127 kg/ha), compared to the control (average experience) were obtained for the variants sown in the first and second epochs, which results that the castor being favorable for sowing until the second half of April.

**Key words**: genotype, castor, epoch of sowing

Castor is an important non-edible oil seed crop grown throughout the world (Radhamani T. *et al*, 2012). It is used primarily in traditional medicine but its main interest is for biofuel production to reduce dependency on fossil fuel (Nahar K., 2013).

*Ricinus communis* L. has been a therapeutic agent for 4 000 years, used as a herbal medicine for treating many different diseases, disorders and also many infections. Leaves, root, bark and various parts of the castor have been used for medicinal purposes. It has been used as a laxative for 2 500 years in Greece and Rome (Scarpa A., Guerci A., 1982). Due to the large quantity of oil extracted from *Ricinus communis* L. seeds, it has been known as castor oil plant (Chan A.P. *et al*, 2010). This oil is of great application in various perspectives (Scarpa A. and Guerci A., 1982). The various phytochemicals which are found in castor are steroids, terpenoids, saponins, alkaloids, flavonoids, and glycosides (Alugah C.I. and Ibraheem O., 2014; Vermeer C.P. *et al*, 2003; Jeyam M. *et al*, 2014). Lectins of castor bean are also used prominently in the treatment of some diseases, especially tumour (Ohishi K. *et al*, 2014).

Sowing crop at optimum time along with other agronomic factors is the key feature to get maximum production of any crop. Determining suitable planting date plays an important role in conformation of plant growth stages with desirable environmental conditions which results in maximum yield (Siadata S.A. and Hemayatib S.S., 2009). Scientific works are needed to determine the proper sowing date in a particular zone for optimising the seeds production obtained at castor bean.

## MATERIAL AND METHOD

A factorial experiment was organized in 2018-2019 at the Moldoveni Agricultural Society, Neamt County, using a randomized blocks in three replications. The experiments aimed to identify the genotype with the highest adaptability to climatic conditions in the area of influence and establish the optimal time to sow. In the first experiment, four genotypes were researched, namely: Dragon, Rivlas, Cristian and Teleorman. In the second experience we experimented four sowing epochs:

V1 - Epoch I, sowing in the first decade of April);

V2 - Epoch II, sowing in the second decade of April;

V3 - Epoch III, sowing in the last decade of April;

V4 – sowing in the first decade of May.

The obtained results were processed and interpreted statistically according to the method of analysis of variance.

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## RESULTS AND DISCUSSIONS

In 2018 the experienced genotypes did not show a high adaptability to the pedoclimatic conditions of the area, obtaining yields below 1500 kg/ha. The influence of the genotype on the production of seeds obtained from castor, in 2018, materialized by obtaining fluctuating productions, between 1175 kg/ha (Rivlas) and 1441 kg/ha (Teleorman) (*table 1*).

Comparing the yields obtained with the average experience (control), we notice that the Teleorman variety (142 kg/ha) obtained a statistically assured production increase and interprete positive very significant. The Rivlas variety achieved a production difference (-124 kg/ha) ensured statistically and interpreted as very significant negative (*table 1*).

Compared to 2018, the yields obtained in the agricultural year 2019 were higher, this was due to the excess rainfall recorded in May, which led to a more uniform emergence of castor in the spring. Productions varied between 1297 kg/ha (Teleorman variety) and 1548 kg/ha (Cristian variety) (*table 2*).

Dragon and Cristian varieties stood out with production increases of 44 kg/ha, respectively 70 kg/ha, distinctly significant and very significant compared to the average experience (control). The differences in production recorded by the Rivlas and Teleorman varieties were very significant negative compared to the average experience (control) (*table 2*).

The average of the two years, not very favorable to the castor culture, indicates the fact that the Cristian variety has the greatest adaptability to the conditions of the area. Compared to the control variant (average experience), this variety achieved a distinctly significant increase in production (52 kg/ha) (*table 3*).

Table 1

**The influence of genotype on seed production at *Ricinus communis* L., in 2018**

| Variety | Production (kg/ha) | % compared to control | Diff (kg/ha) | Sign. |
|---|---|---|---|---|
| Dragon | 1274 | 98,07 | -25 | |
| Rivlas | 1175 | 90,45 | -124 | ooo |
| Cristian | 1301 | 100,15 | 2 | |
| Teleorman | 1441 | 110,93 | 142 | *** |
| Average | 1299 | 100 | Ct. | |
| LSD 5%= | | 25,98 kg/ha | | |
| 1%= | | 39,34 kg/ha | | |
| 0,1%= | | 63,19 kg/ha | | |

Table 2

**The influence of genotype on seed production at *Ricinus communis* L., in 2019**

| Variety | Production (kg/ha) | % compared to control | Diff (kg/ha) | Sign. |
|---|---|---|---|---|
| Dragon | 1522 | 102,98 | 44 | ** |
| Rivlas | 1422 | 96,21 | -56 | ooo |
| Cristian | 1548 | 104,74 | 70 | *** |
| Teleorman | 1297 | 87,75 | -181 | ooo |
| Average | 1478 | 100 | Ct. | |
| LSD 5%= | | 22,51 kg/ha | | |
| 1%= | | 34,09 kg/ha | | |
| 0,1%= | | 54,76 kg/ha | | |

Table 3

**The influence of genotype on seed production at *Ricinus communis* L., average years**

| Variety | Production (kg/ha) | % compared to control | Diff (kg/ha) | Sign. |
|---|---|---|---|---|
| Dragon | 1398 | 101,82 | 25 | * |
| Rivlas | 1298 | 94,54 | -75 | ooo |
| Cristian | 1425 | 103,79 | 52 | ** |
| Teleorman | 1370 | 99,78 | -3 | |
| Average | 1373 | 100 | Ct. | |
| LSD 5%= | | 24,24 kg/ha | | |
| 1%= | | 36,71 kg/ha | | |
| 0,1%= | | 58,97 kg/ha | | |

The second sowing season positively influenced the seed production, and its level was influenced by the climatic conditions recorded in the analyzed period. In the agricultural year 2018, the production fluctuations were quite large, the yields obtained varied from 1144 kg/ha (the four epoch of sowing) to 1426 kg/ha (the second epoch of sowing). From a statistical point of view, compared to the control (average of experience) the variant sown in the fourth epoch achieved a very significant negative production difference (-155 kg/ha). However, the variants sown in the first and the second epoch obtained significant and very significant production increases (37 - 127 kg/ha) compared to the control (table 4). In the second year of experimentation (2019), the yields obtained were higher and between 1289 kg/ ha (the four epoch of sowing) and 1699 kg ha (the second epoch of sowing). Compared to the control (average of experience) the variants sown in the second and the four epoch achieved very significant negative production differences (-39 kg/ha, 189 kg/ha), the variant sown in the second epoch achieved a very significant increase in production (221 kg/ha) (*table 5*).

During the study period (2018-2019), the highest production increases (38 kg/ha, respectively 127 kg/ha), compared to the control were obtained for the varieties sown in the first and second epoch, resulting in castor bean responding favorably for sowing by the second half of April. In the variant sown in the four epoch, a very significant production deficit of 158 kg / ha was obtained, compared to the witness of the experience, which we deduce that it is necessary to sow the castor no later than the second decade of April, because the grains do not reach maturity (*table 6*).

Table 4

**The influence of sowing epoch on seed production at *Ricinus communis* L., 2018**

| Epoch of sowing | Production (kg/ha) | % compared to control | Diff (kg/ha) | Sign. |
|---|---|---|---|---|
| 1st epoch | 1336 | 102,85 | 37 | * |
| 2nd epoch | 1426 | 109,78 | 127 | *** |
| 3rd epoch | 1288 | 99,15 | -11 | |
| 4th epoch | 1144 | 88,07 | -155 | ooo |
| Average | 1299 | 100 | Ct. | |
| LSD 5%=<br>1%=<br>0,1%= | | 34,89 kg/ha<br>46,55 kg/ha<br>60,84 kg/ha | | |

Table 5

**The influence of sowing epoch on seed production at *Ricinus communis* L., 2019**

| Epoch of sowing | Production (kg/ha) | % compared to control | Diff (kg/ha) | Sign. |
|---|---|---|---|---|
| 1st epoch | 1485 | 100,47 | 7 | |
| 2nd epoch | 1699 | 114,95 | 221 | *** |
| 3rd epoch | 1439 | 97,36 | -39 | ooo |
| 4th epoch | 1289 | 87,21 | -189 | ooo |
| Average | 1478 | 100 | Mt. | |
| LSD 5%=<br>1%=<br>0,1%= | | 19,62 kg/ha<br>26,09 kg/ha<br>33,94 kg/ha | | |

Table 6

**The influence of sowing epoch on seed production at Ricinus communis L., average years**

| Epoch of sowing | Production (kg/ha) | % compared to control | Diff (kg/ha) | Sign. |
|---|---|---|---|---|
| 1st epoch | 1411 | 102,77 | 38 | ** |
| 2dn epoch | 1500 | 109,25 | 127 | *** |
| 3rd epoch | 1365 | 99,42 | -8 | |
| 4th epoch | 1215 | 88,49 | -158 | ooo |
| Average | 1373 | 100 | Mt. | |
| LSD 5%=<br>1%=<br>0,1%= | | 27,25 kg/ha<br>36,32 kg/ha<br>47,39 kg/ha | | |

## CONCLUSIONS

The natural environment of the Moldoveni Agricultural Society is favorable for field crops, where in normal years as temperatures high yields are obtained for all crops established within the company, the future of which is also the castor crop.

The average of the two years, not very favorable to the castor culture, indicates the fact that the Cristian variety has the greatest adaptability to the conditions of the area.

During the study period (2018-2019), the highest production increases (38 kg/ha, respectively 127 kg/ha), compared to the control were obtained for the varieties sown in the first and second epoch, which means that castor oil is favorable for sowing until the second half of April.

## REFERENCES

**Alugah C.I., Ibraheem O., 2014 -** *Whole plant screenings for flavonoids and tannins contents in castor plant (Ricinus communis L .) and evaluation of their biological activities.* Int. J. Herbal Med, 2(2): 68-76.

**Chan A.P., Crabtree J., Zhao Q., Lorenzi H., Orvis J., Puiu D., 2010 -** *Draft genome sequence of the oilseed species Ricinus communis*. Nat Biotechnol, 28(9): 951-956.

**Jeyam M., Arangaraj M., Ravikumar P., Shalini G., 2014-***Computational analysis of phytocompounds with 1,3- β -D-glucan synthase for antidermatophytic activity*. Sci Rep, 6: 24027.

**Nahar K., 2013 -** *Castor bean (Ricinus communis L.) – a biofuel plant: morphological and physiological parameters propagated from seeds in Bangladesh*. Asian Bus Rev., 2:64-66.

**Ohishi K., Toume K., Arai M.A., Sadhu S.K., Ahmed F., Mizoguchi T., 2014** - *Ricinine: A pyridone alkaloid from Ricinus communis that activates the Wnt signaling pathway through casein kinase 1*. Bioorg Med Chem, 22(17): 4597-4601.

**Radhamani T., Ushakumari R., Amudha R., Anjani K., 2012 -** *Response to water stress in castor (Ricinus communis L.) genotypes under in vitro conditions*. J Cer Oil Seeds, 3:56-58.

**Scarpa A., Guerci A.,1982 -** *Various uses of the castor oil plant (Ricinus communis L.) a review*. J Ethnopharmacol, 5(2): 117-137.

**Siadata S.A. and Hemayatib S.S., 2009** - Effect of sowing date on yield and yield components of three oilseed rape varieties. PlantEcophysiology, 1: 31-35.

**Vermeer C.P., Nastold P., Jetter R., 2003 -** *Homologous very-long-chain 1,3- alkanediols and 3-hydroxyaldehydes in leaf cuticular waxes of Ricinus communis L*. Phytochem, 62(3): 433-438.

# OBTAINED RESULTS REGARDING THE OPTIMIZATION OF GRAIN SORGHUM TECHNOLOGY IN PEDOCLIMATIC CONDITIONS FROM CENTRAL OF MOLDOVA

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**Abstract**

In recent decades in Romania and in many other regions of the world, there is a high frequency of drought years, to three years out of every five. This climate negatively affects the productivity of agricultural crops, and agricultural research must find solutions to diversify the assortment of crops that in tougher environmental conditions guarantee the stability and profitability of agriculture. One of the safest solutions is the cultivation of sorghum, whether for grain or biomass, which due to good drought resistance, the ability to withstand high temperatures and capitalize on poorly fertile land is superior by the yields of all crops and especially, cereals and fodder plants. In the pedoclimatic conditions from the Center of Moldova, starting with 2018 year, were initiated some researches regarding the optimization of the cultivation technology for grain sorghum, in order to create a technology in relation to the new climatic conditions and in relation to the protection of the environment. The results obtained on average over two agricultural years, 2018 and 2019, indicated a very large variation of grain production depending on the sowing density provided and on the applied mineral fertilizers, this being between 4074 kg/ha and 10234 kg/ha. The best results were obtained in the variants sown with 30 g.g./sqm and fertilized with N150P80 with and without the application of the biostimulator Aminosol. From the point of view of economic efficiency, the variant sown with 30 g.g./sqm and fertilized with $N_{150}P_{80}$ was the most profitable.

**Key words**: grain quality, economic efficiency, mineral fertilization, production, sorghum

The phytotechnical group with the largest distribution in the world, and including in Romania, is represented by cereals (Roman Gh. *et al*, 2011). Of these, lately, one of the species that is gaining importance is sorghum. This species is very important, especially in dry areas, where it can be a good alternative to growing corn. This is due to the fact that sorghum is the species that withstands high summer temperatures and achieves high yields even under conditions of water stress. Although sorghum is a plant with a high consumption of nutrients, it does not always react favorably to the application of chemical and organic fertilizers. This is because its root system is extremely effective in extracting nutrients from the soil (Maranville J. *et al*, 1980).

There are many studies on the influence of nitrogen, phosphorus or potassium on grain sorghum productivity (Mamo S. *et al*, 2007), but these refer to each mineral element administered separately and not to the combination of these (Kayuki C. *et al*, 2007).

Mineral fertilizers applied to sorghum grown in different densities positively influence the dry matter, ash and nitrogen content (Drăgici I. *et al*, 1998). In the drier areas of Romania, the fertilization of sorghum crops is of great importance (Rotar and Chircă, 1995), and in the context of sustainable agriculture, establishing the optimal sowing density and optimal fertilizer doses is imperative (Drăghici I., 2003).

Some authors have undertaken important research aimed at establishing the optimal epoch and density for sowing sorghum. Studies abroad have shown that sorghum is grown at a distance between rows of 38 cm and 76 cm between rows (Jones O. and Johnson G., 1997). Plant density greatly influences the dry matter content and has a slight influence on the sugar content of sorghum (Ferraris R., 1986).

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According to data from the literature, a good harvest can be considered at a density at harvest between 100000 and 200000 plants/ha. On fertile lands a density of 150000 - 200000 harvestable plants/ha is recommended, and on lands with low fertility, the recommended density is 100000 harvestable plants/ha.

Taking into account the existing data in the literature, the research conducted at A.R.D.S. Secuieni were to determine the influence of mineral fertilization with the combination of N, P and K on sorghum grown in different densities and to establish the economic efficiency of sorghum according to them.

## MATERIAL AND METHOD

In order to achieve our proposed objectives, in the experimental field of S.C.D.A. A two-factor experience was placed in Secuieni.

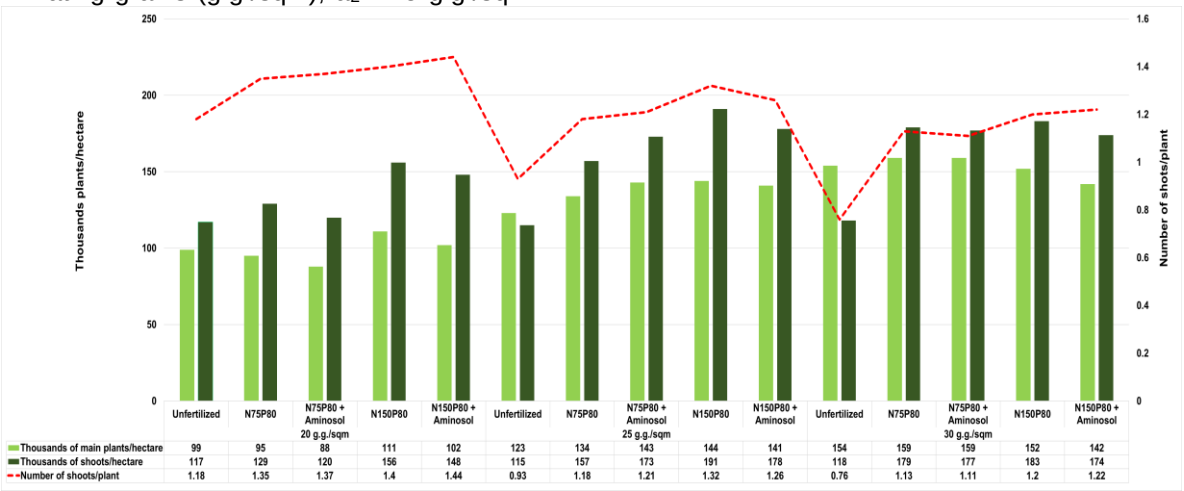
The type of experiment was A x B, and its placement in the field was performed according to the method of subdivided plots with the placement of factor A in strips, in three repetitions. The experiment was performed on the Albanus hybrid (Euralis Seeds), and the factor A was represented by the sowing density with three graduations: $a_1$ - 20 germinating grains (g.g./sqm), $a_2$ - 25 g.g./sqm and $a_3$ - 30 g.g./sqm. Factor B was represented by fertilization with five graduations: $b_1$ - Unfertilized, $b_2$ - $N_{75}P_{80}$, $b_3$ - $N_{75}P_{80}$ + Aminosol, $b_4$ - $N_{150}P_{80}$ and b5 - $N_{150}P_{80}$ + Aminosol. Mineral fertilizers with NP were applied at the preparation of the germination bed, and the biostimulator Aminosol when the sorghum had formed six leaves.

In the laboratory, the starch and protein content was determined using the NIR DA 7250 analyzer, and biometric and specific measurements were performed during the sorghum vegetation period. The samples were taken when the grains reached a humidity of 18 %.

The data obtained were processed and interpreted statistically according to the method of analysis of variance (ANOVA, 2013).

## RESULTS AND DISCUSSIONS

*Figure 1* shows that the factors studied influenced the number of plants harvested, both the main and secondary (shoots). Thus, the number of main plants was higher at the sowing density of 30 g.g./sqm, as is normal, and the number of shoots evolved positively with the increase of the fertilizer dose and negatively with the increase of the sowing density.




| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Thousands of main plants/hectare | 99 | 95 | 88 | 111 | 102 | 123 | 134 | 143 | 144 | 141 | 154 | 159 | 159 | 152 | 142 |
| Thousands of shoots/hectare | 117 | 129 | 120 | 156 | 148 | 115 | 157 | 173 | 191 | 178 | 118 | 179 | 177 | 183 | 174 |
| Number of shoots/plant | 1.18 | 1.35 | 1.37 | 1.4 | 1.44 | 0.93 | 1.18 | 1.21 | 1.32 | 1.26 | 0.76 | 1.13 | 1.11 | 1.2 | 1.22 |

Figure 1 **The number of plants harvest under the A.R.D.S Secuieni pedoclimatic conditions, average 2018 - 2019**

The factors have greatly influenced the grain production achieved, this varying in very wide limits, between 4074 kg/ha (Unfertilized x 20 g.g./sqm) and 10234 kg/ha ($N_{150}P_{80}$ + Aminosol x 30 g.g./sqm). Compared to the control variant (average experience), the variants sown with 30 g.g./sqm achieved the highest production increases, these being between 1240 kg/ha and 2732 kg/ha. The production increases achieved rised with the fertilizer dose, the highest increase (2732 kg/ha) was achieved at the variant fertilized with $N_{150}P_{80}$ + Aminosol. The application of the Aminosol biostimulator broughtproduction increases between 273 kg/ha ($N_{150}P_{80}$ + Aminosol x 30 g.g./sqm) and 1245 kg/ha ($N_{75}P_{80}$ + Aminosol x 30 g.g./sqm).

In conclusion, it is noted that sorghum is a species that prefers large sowing densities of 30 g.g./sqm and is very receptive to mineral fertilization with high doses of nitrogen and phosphorus and the application of biostimulators during the growing season (*table 1*).

From an economic point of view, sorghum is a productive species, with modest needs to soil fertility, drought and involves minimal costs for cultivation.

Table 1

**Results obtained regarding the influence of the interaction between sowing density and fertilization on grain production, average 2018 – 2019**

| Factor A Sowing density (g.g./sqm) | Factor B Fertilization (kg s.a./ha) | Yield | | | The meaning |
|---|---|---|---|---|---|
| | | Kg/ha | Relative (%) | Difference from control kg/ha | |
| 20 | Unfertilized | 4074 | 54 | -3429 | ooo |
| | $N_{75}P_{80}$ | 5881 | 78 | -1622 | ooo |
| | $N_{75}P_{80}$ + Aminosol | 7065 | 94 | -437 | |
| | $N_{150}P_{80}$ | 8020 | 107 | 518 | |
| | $N_{150}P_{80}$ + Aminosol | 8333 | 111 | 831 | * |
| 25 | Unfertilized | 4882 | 65 | -2620 | ooo |
| | $N_{75}P_{80}$ | 6838 | 91 | -664 | |
| | $N_{75}P_{80}$ + Aminosol | 7958 | 106 | 456 | |
| | $N_{150}P_{80}$ | 8580 | 114 | 1078 | ** |
| | $N_{150}P_{80}$ + Aminosol | 9100 | 121 | 1598 | *** |
| 30 | Unfertilized | 5363 | 71 | -2139 | ooo |
| | $N_{75}P_{80}$ | 7497 | 100 | -6 | |
| | $N_{75}P_{80}$ + Aminosol | 8742 | 117 | 1240 | *** |
| | $N_{150}P_{80}$ | 9961 | 133 | 2459 | *** |
| | $N_{150}P_{80}$ + Aminosol | 10234 | 136 | 2732 | *** |
| Average experience (Control) | | 7502 | 100 | Mt. | Mt. |
| LSD 5% (kg/ha) | | 675 | | | |
| LSD 1% (kg/ha) | | 917 | | | |
| LSD 0.1 % (kg/ha) | | 1215 | | | |

*LSD means Least significant difference (For positiv values - Differences larger than LSD 5% level are significant and are indicated with *, differences larger than LSD 1% level are distinctly significant and are indicated with ** and differences larger than LSD 0.1% level are verry significant and are indicated with* *** and for negativ values the *, **, *** is replaced with $^{o, oo, ooo}$.

Analyzing the economic efficiency of the culture calculated taking into account the technological sheet of the culture, we observe a large variation of the net profit depending on the applied technological variant.

We notice from the data in table 2 that all the experienced variants achieved a positive net profit, which emphasizes the fact that sorghum succeeds even in more precarious technological conditions. The most profitable variant proved to be the one sown with 30 g.g./sqm and fertilized with $N_{150}P_{80}$.

The application of the biostimulator Aminosol achieved slight increases of the net profit, the main increases coming from the risIng of the sowing density and from the growing of the doses with mineral fertilizers (*table 2*).

In conclusion, sorghum is a profitable species even in more precarious technological conditions, but the proper application of technological factors leads to significant increases in profit.

Table 2

**Economic efficiency of culture, depending on the factors pursued, average 2018 – 2019**

| Factor A Sowing density (g.g./sqm) | Factor B Fertilization (kg s.a./ha) | Yield kg/ha | Value yield (lei/ha) | Total expenses (lei/ha) | Production cost (lei/kg) | Gross profit (lei/ha) | Net profit (lei/ha) |
|---|---|---|---|---|---|---|---|
| 20 | Unfertilized | 4074 | 3666 | 2470 | 0.61 | 1196 | 1005 |
| | $N_{75}P_{80}$ | 5881 | 5292 | 3090 | 0.53 | 2202 | 1850 |
| | $N_{75}P_{80}$ + Aminosol | 7065 | 6359 | 3318 | 0.47 | 3041 | 2554 |
| | $N_{150}P_{80}$ | 8020 | 7218 | 3350 | 0.42 | 3868 | 3249 |
| | $N_{150}P_{80}$ + Aminosol | 8333 | 7499 | 3610 | 0.43 | 3889 | 3267 |
| 25 | Unfertilized | 4882 | 4394 | 2570 | 0.53 | 1824 | 1532 |
| | $N_{75}P_{80}$ | 6838 | 6154 | 3190 | 0.47 | 2964 | 2490 |
| | $N_{75}P_{80}$ + Aminosol | 7958 | 7162 | 3418 | 0.43 | 3744 | 3145 |
| | $N_{150}P_{80}$ | 8580 | 7722 | 3450 | 0.40 | 4272 | 3588 |
| | $N_{150}P_{80}$ + Aminosol | 9100 | 8190 | 3710 | 0.41 | 4480 | 3763 |
| 30 | Unfertilized | 5363 | 4827 | 2670 | 0.50 | 2157 | 1812 |
| | $N_{75}P_{80}$ | 7497 | 6747 | 3290 | 0.44 | 3457 | 2904 |
| | $N_{75}P_{80}$ + Aminosol | 8742 | 7867 | 3518 | 0.40 | 4349 | 3653 |
| | $N_{150}P_{80}$ | 9961 | 8964 | 3550 | 0.36 | 5414 | 4548 |
| | $N_{150}P_{80}$ + Aminosol | 10234 | 9210 | 3810 | 0.37 | 5400 | 4536 |
| Average | | 7502 | 6751 | 3268 | 0.45 | 3484 | 2926 |
| June sale price 2020: 0.9 lei/kg | | | | | | | |

## CONCLUSIONS

Following the results obtained for grain sorghum experienced in the pedoclimatic conditions in Central Moldova, the following were highlighted:

- the number of shoots evolved positively with the increase of the fertilizer dose and negatively with the increase of the sowing density;
- sorghum is a species that prefers large sowing densities, of 30 b.g./sqm and is very receptive to mineral fertilization with high doses of nitrogen and phosphorus and to the application of biostimulators during the growing season;
- sorghum is a profitable species even in more precarious technological conditions, but the proper application of technological factors leads to significant increases in profit.

## ACKNOWLEGMENTS

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## REFERENCES

**Drăghici I., Drăghici Reta şi Antohe I., 1998** - *Efectul îngrăşămintelor foliare aplicate pe agrofonduri diferite de azot, asupra producţiei de boabe la sorgul cultivat pe solurile nisipoase din Sudul Olteniei*. Lucrări ştiintifice SCCCPN Dăbuleni, Vol. IX

**Drăghici I., 2003** – *Valorificarea nisipurilor şi solurilor nisipoase cu fertilitate naturală redusă (sub 1% humus) prin cultura de sorg pentru boabe în contextul agriculturii private, durabile*. Lucr. şt. SCCCPN Dăbuleni, Vol. XV

**Ferraris R., 1986** - *A comparative analysis of the growth of sweet and forage sorghum crops. II. accumulation of soluble carbohydrates and nitrogen.* Australian Journal of Agricultural Research, Volume: 37, Issue: 5

**Jones O. R. and Johnson G. L., 1997** - *Evaluation of a short-season high-density production strategy for dryland sorghum*. Rep. no. 97-01. USDA-ARS Conservation and Production Research Laboratory, Bushland, TX.

**Kayuki C. K., J. Byalebeka C. S. Wortmann, and Mamo M., 2007**- *Low input approaches for soil fertility management in semiarid Eastern Uganda*. Agron. J. 99:847–853.

**Mamo S., Ayana A. and Tesso T., 2007** - *RADP (random amplified ploymorphyc dna) variation of late – maturing sorghum (Sorghum bicolor L. Moench) landraces from Ethiopia.* Journal ACTA Agronomica Hungarica, Akademiai Kiado

**Maranville J. W., R. B. Clark, and W. M. Ross., 1980** - *Nitrogen efficiency in grain sorghum*. J. plant nutr. 2:577–589

**Roman Gh., Tabără V., Robu T., Pîrşan P., Axinte M., Ştefan M., 2011** - *Fitotehnie. Vol. I – Cereale şi leguminoase pentru boabe*. Editura Universitară, pp 235 – 236

**Rotar I. şi Eugenia Chircă, 1995** - *Cultura pajiştilor şi a plantelor furajere.* Tipo Agronomia, Cluj – Napoca.

# THE INFLUENCE OF TREATMENTS WITH VARIOUS PHYTOSANITARY PRODUCTS (FUNGICIDES) ON THE ATTACK OF SOME PHYTOPATHOGENIC FUNGI ON WHEAT HARVEST - PITAR ROMANIAN VARIETY - IN 2019 PEDOCLIMATIC CONDITIONS OF THE EASTERN BARAGAN

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**Abstract**

This study aims at monitoring the dynamics of the occurrence and evolution of the attack of some pathogenic agents to Romanian wheat variety, Pitar. Among these, we mention: *Puccinia recondita* f. sp. *tritici* (sin. *Puccinia triticina*) which produces wheat's brown rust and *Septoria* spp. which produces wheat's brown leaf spotting (septoriosis). Also, the influence of applying these fungicides on the harvest, as compared to the untreated control variant, was monitored. One experiment with 7 variants (6 variants with phytosanitary treatment, plus one control variant not treated) was taken into consideration for this study, for which the following phytosanitary products were used, as follows: FALCON PRO (prothioconazole 53 g/l + tebuconazole 148 g/l + spiroxamine 224 g/l), MYSTIC 250 EC (tebuconazole 250 g/l) and CAPALO (fenpropimorph 200g/l, epoxiconazole 62.5 g/l, metraphenon 75g/l). The treatment variants were the following: V1 - MYSTIC 250 EC 0.5 L/HA, 1 treatment applied at spike's releasing (17.05.2019); V2 - MYSTIC 250 EC 0.5 L/HA, 1 treatment applied at straw's extension (27.04.2019) + 1 treatment applied at kernel's filling (8.06.2019), V3 - FALCON PRO 0.6 L/HA, 1 treatment applied at spike's releasing (17.05.2019), V4 - FALCON PRO 0.6 L/HA, 1 treatment applied at straw's extension (27.04.2019) + 1 treatment applied at kernel's filling (8.06.2019), V5 - CAPALO 1.0 L/HA, 1 treatment applied at spike's releasing (17.05.2019), V6 - CAPALO 1.0 L/HA, 1 treatment applied at straw's extension (27.04.2019) + 1 treatment applied at kernel's filling (8.06.2019), V7 - Untreated control variant. The experiment was placed in Latin square, the 7 variants being placed in 7 repetitions. Among the pathogenic agents under monitoring, *Puccinia recondita* f.sp. *tritici* fungus producing the brown rust had produced the greatest attacks. The attack of the fungi from *Septoria* sp. variety producing leaf's brown rust (septoriosis) and from *Blumeria* (*Erysiphe*) variety, producing wheat's mildew, was rare. The first two leaves placed under the spike had been analyzed for the above. These observations had led to the conclusion that for all 6 treatment variants, the degree of attack (D.A. %) of *Puccinia recondita* f.sp. *tritici* fungus was more reduced than at the untreated control variant. The harvests of the treated variants were as follows: (V1 – 6989 kg/ha, V2 - 6688 kg/ha, V3 - 6536 kg/ha, V4 - 6828 kg/ha, V5 - 6875 kg/ha, V6 - 6582 kg/ha and V7 (control variant not treated) - 6301 kg/ha.

**Key words**: *Puccinia* spp., *Septoria* spp., latin square

The wheat, *Triticum aestivum*, is attacked by many pathogenic agents, such as: mildew - *Blumeria graminis* f.sp. *tritici*, brown rust - *Puccinia recondita* f. sp. *tritici*, brown leaf spotting - *Septoria tritici*, *Septoria nodorum*, stem's fusariosis and spike's burn *Giberella zeae*, *Giberella avenacea* (Iacob Viorica *et al.,* 1998). The first half of the year 2019 was favorable to wheat, in what concerns the climatic conditions. Rainfalls in large quantities had been registered in this period and the average temperatures had been favorable to wheat. For example, in April, the average temperature registered was 10.4ºC and the rainfalls amounted in total to 60.01 l/m². In May, the average temperature registered was 17.7ºC and the rainfalls amounted in total to 100.6 l/m². In June, the average registered temperature was 22.9ºC and the rainfalls totaled up to 96.8 l/m$^2$. Accordingly, the conditions for the attack of some pathogenic agents specific to wheat were more favorable as compared to previous years. In these conditions, *Puccinia recondita* f. sp. *tritici* fungus (*figure 1*), producing wheat's brown rust (Velichi E., 2012) made known its presence in 2019, in a larger extent as compared to previous years. During vegetation period, this pathogenic agent formed uredospores. In the climatic conditions of the year 2019, teliospores of *Puccinia recondita* f. sp. *tritici* fungus had not been observed during the vegetation period. The other pathogenic agents

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mentioned, dangerous for wheat crop, were signaled sporadically in the climatic conditions of the year 2019. We underline that, as compared to previous years, the attack of *Giberella* spp. fungi producing diseases known under the name of fusarioses (*Fusarium* spp.) was signaled sporadically.

Table 1

**The results of the experiment (the first treatment applied at straw's extension, the second at kernel' filling) with fungicide products (6 variants of treatment + 1 untreated control variant) in what concerns the attack (D.A.%) of *Puccinia recondita* f. sp. *tritici* fungus ("flag" leaf and the next leaf). The observations had been made on 19th June 2019**

| Variant | "Flag" leaf | | | The second leaf | | |
|---|---|---|---|---|---|---|
| | D.A% | Difference as compared to the control variant | Significance | D.A% | Difference as compared to the control variant | Significance |
| **V1**-MYSTIC 250 EC 0.5 L/HA, 1 treatment applied at spike's release (17.05.2019) | 1.47 | 3.43 | ** | 2.87 | 2.37 | ** |
| **V2**-MYSTIC 250 EC 0.5 L/HA, 1 treatment applied at straw's extension (27.04.2019) + 1 treatment applied at kernel's filling (8.06.2019) | 1.91 | 2.99 | ** | 2.54 | 2.70 | ** |
| **V3**–FALCON PRO 0.6 L/HA, 1 treatment applied at spike's release (17.05.2019) | 1.49 | 3.41 | ** | 2.85 | 2.39 | ** |
| **V4**–FALCON PRO 0.6 L/HA, 1 treatment applied at straw's extension (27.04.2019) + 1 treatment applied at kernel's filling (8.06.2019) | 2.01 | 2.89 | ** | 3.07 | 2.17 | ** |
| **V5**–CAPALO 1,0 L/HA, 1 treatment applied at spike's release (17.05.2019) | 1.96 | 2.94 | ** | 3.07 | 2.17 | ** |
| **V6**–CAPALO 1,0 L/HA, 1 treatment treatment applied at straw's extension (27.04.2019) + 1 treatment applied at kernel's filling (8.06.2019) | 1.29 | 3.61 | ** | 2.44 | 2.80 | ** |
| **V7**–Untreated control variant | 4.90 | - | - | 5.24 | - | - |

LD D.A. % for "flag" leaf LD D.A. % for the second leaf
LD 5%= 0.04% LD 5%= 0.61%
LD 1%= 0.22% LD 1%= 0.82%

Table 2

**The results of the experiment (the first treatment applied at straw's extension, the second at kernel' filling) with fungicide products (6 variants of treatment + 1 untreated control variant) in what concerns the harvest (t/ha) obtained at the treated variants, as compared to the untreated control variant**

| Variant | Harvest (t/ha) | Difference as compared to the control variant (t/ha) | Significance |
|---|---|---|---|
| **V1**-MYSTIC 250 EC 0.5 L/HA, 1 treatment applied at spike's release (17.05.2019) | 6989 | 688 | ** |
| **V2**-MYSTIC 250 EC 0.5 L/HA, 1 treatment applied at straw's extension (27.04.2019)+1 treatment applied at kernel's filling (8.06.2019) | 6688 | 387 | ** |
| **V3**-FALCON PRO 0.6 L/HA, 1 treatment applied at spike's release (17.05.2019) | 6536 | 235 | Not significant |
| **V4**-FALCON PRO 0.6 L/HA, 1 treatment applied at straw's extension (27.04.2019)+1 treatment applied at kernel's filling (8.06.2019) | 6828 | 527 | ** |
| **V5**-CAPALO 1.0 L/HA, 1 treatment applied at straw's extension (17.05.2019) | 6875 | 574 | ** |
| **V6**-CAPALO 1.0 L/HA, 1 treatment applied at straw's extension (27.04.2019) +1 treatment applied at kernel's filling (8.06.2019) | 6582 | 281 | * |
| **V7**-Untreated control variant | 6301 | - | - |

LD 5% = 246 kg /ha LD 1% = 330 kg/ha

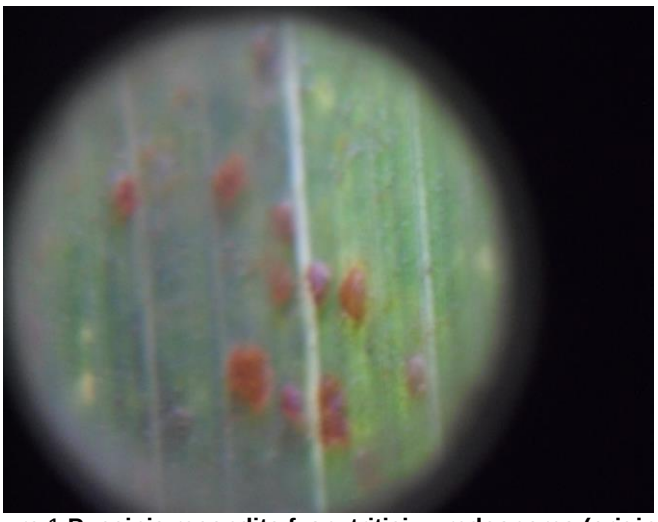


Figure 1 **Puccinia recondita f. sp. tritici - uredospores (original)**



Figure 2 **Aspects from the experimental field (original)**

## MATERIAL AND METHOD

1 experiment with 7 study variants each (*figure 2*) had been conceived for performing the observations. This experiment comprised 6 phytosanitary treatment variants (fungicide products containing various active substances) and one untreated control variant. The variants of the experiment were the following:

-V1-MYSTIC 250 EC 0.5 L/HA, 1 treatment applied at spike's release (17.05.2019):

-V2-MYSTIC 250 EC 0.5 L/HA, 1 treatment applied at straw's extension (27.04.2019) + 1 treatment applied at kernel's filling (8.06.2019);

-V3-FALCON PRO 0.6 L/HA, 1 treatment applied at spike's release (17.05.2019);

-V4-FALCON PRO 0.6 L/HA, 1 treatment applied at straw's extension (27.04.2019) + 1 treatment applied at kernel's filling (8.06.2019);

-V5-CAPALO 1.0 L/HA, 1 treatment applied at spike's release (17.05.2019);

-V6-CAPALO 1.0 L/HA, 1 treatment applied at straw's extension (27.04.2019) + 1 treatment applied at kernel's filling (8.06.2019);

- V7-Untreated control variant.

The experiment was placed in Latin square; the 7 variants being placed in 7 repetitions. Each experimental plot had an area of 15 $m^2$ (5 x 3m). The total number of experimental plots was 49. The surface of an experimental variant was of 15 $m^2$ x 7 repetitions = 105 $m^2$. The total area of the experiment was of 105 $m^2$ x 7 = 735 $m^2$. The treatments had been performed manually, with a "Vermorel" type of equipment. "Trend" adjuvant product, in concentration of 0.03%, was added to the spraying solution. Weeds were fought against with the help of Granstar Super 50 SG herbicide in a dosage of 0.04 l/ha applied, separately, with the Vermorel. An insecticide (Faster 10 CE – 0.15 l/ha) product was also added to the herbicide solution for fighting against cereals' bugs - *Eurygaster* sp. The purpose of the experiment had been the efficiency of the mentioned phytosanitary products, as reported to their price, as well as the efficiency and respectively, the profitability of applying one or two phytosanitary treatments during the wheat's vegetation period in the climatic conditions of the year 2019.

The assessment of the attack's frequency (F %), of attack's intensity (I %) and respectively of the degree of attack (D.A. %) was done separately,

on each and every experimental plot, being analyzed 10 plants / experimental plot. The degree of affectation (attack intensity, I %) of the last two leaves was assessed, especially of the "flag" leaf which has the greatest contribution to the spike's production at strawy cereals. The phytosanitary analyses on the plants' samples had been done with the help of the stereo-microscope and of the optic microscope at the laboratory of Braila's Phytosanitary Office – National Phytosanitary Authority, institution subordinated to the Ministry of Agriculture and Rural Development. These analyses have revealed the presence of *Puccinia recondita f.sp. tritici* fungus which produces wheat's brown rust in the analyzed samples. Other pathogenic agents specific to wheat were signaled totally sporadic. However, in 2019, as compared to previous year, the attack of Giberella fungi which produce diseases known under the name of fusariosis to wheat was signaled sporadically.

For assessing the production of each variant under study, samples of kernels from each experimental plot, 5 samples each / plot, had been analyzed by spot check. Each sample contained 10 plants, so 50 plants had been taken from each experimental plot, for which the harvest was weighted manually. The delimitation of each sample was done with a metric frame with an area of 0.25 $m^2$ (0.5/0.5m). The average of the samples from the experimental plots was used for calculating the harvest of each and every experimental parcel. The statistic interpretation was executed with the help of limit differences (LD %) (Săulescu N., 1967).

The used variety, Pitar, is a Romanian variety of wheat created by the National Agricultural Research and Development Institute Fundulea (I.N.C.D.A. Fundulea). It was registered in 2015. The variety is early-flowering. It is resistant to brown rust *Puccinia recondita* f.sp. *tritici* and to wheat's mildew (*Blumeria graminis* f. sp. *tritici*) and average resistant to septoriosis (*Septoria* sp) and to yellow rust (*Puccinia striiformis*). It has an average resistance level to spike's fusariosis (*Fusarium* spp.) (I.N.C.D.A. Fundulea 2019).

The assessment of the attack of pests can be done with the help of the following values (Methods of Prognosis and Warning 1980):

- Frequency of attack (F %);
- Intensity of attack (I %);
- Degree of attack (D.A %).

- Attack's frequency represents the relative value of the number of plants or organs of the plant under attack (n) reported to the number of observed plants or organs (N). The value of the frequency is established by direct observation on a number of plants or organs, according to the case and to the conditions, existing different methods of sample taking and for performing the observations. In the case of our observations, for the foliar diseases, the number of attacked plant organs out of the total of observed plant organs (leaves) was taken into consideration, being thus established the attack's frequency expressed in percentages %. In the case of blight, it is used the number of attacked wheat spikes, as reported to the total number of observed wheat spikes. The frequency is calculated with the formula F%= nx100/N.

- Attack's intensity represents the degree or percentage in which a plant or a plant's organ is attacked and how much from the surface of the plant or of the organ analyzed (leaf, fruit) is covered by the disease under study.

- The assessment of the surface under attack is done with the naked eye or with the magnifying glass, assessing the percentage occupied by spots or burns caused by the pathogenic agent. The affectation percentages can be noted or grades can be given for each plant or organ attacked by the disease and/or by the pest. The usage of grades can make easier data summarization in a great extent. It can be used a scale with 6 degrees of intensity, as follows:

- Grade 0 no attack
- Grade 1 attack between 1 and 3%
- Grade 2 attack between 3 and 10%
- Grade 3 attack between 11 and 25%
- Grade 4 attack between 26 and 50%
- Grade 5 attack between 51 and 75%
- Grade 6 attack between 76 and 100%

After data's summarization, the attack's intensity is determined by the formula:

$$I\% = \frac{\Sigma (i \times f)}{n}$$

Where:

I% – attack's intensity (in %);

i – intensity according to the grade given to the organ or plant under attack;

f – number of cases (plants, organs) attacked;

n – number of plants attacked.

Grades from 1 to 6, separately, to the "flag" leaf and to the next leaf situated beneath it, had been awarded in our experiment.

- The degree of attack is the expression of the extension of the severity of the attack onto the crop or onto the total number of plants on which we perform the observations. The value expression of DA is given by the relation:

$$D.A\ (\%). = \frac{F \times I}{100}$$

In most cases, there is a negative correlation between the degree of attack of a pathogenic agent or pest and the quantitative and/or qualitative level of the production of a crop.

## RESULTS AND DISCUSSIONS

The 2018 – 2019 agricultural year was more favorable to the occurrence of the attack of the complex of pathogens specific to wheat, as compared to the previous years. In the spring of

2019, rainfalls in large quantities had been registered, and the average temperatures had been favorable to wheat. For example, in April, the average temperature registered was 10.4ºC, and the rainfalls summed up to only 60.0 l/m². In May, the average temperature registered was 17.7 ºC and the rainfalls summed up to 100.6 l/m². In June, the average temperature registered was 22.9ºC and the rainfalls summed up to 96.8 l/m$^2$. However, we underline that the autumn of 2018 was droughty. The first rainfalls useful to wheat's emergence had occurred late, in the second decade of November. Due to this, the plants emerged late, and their density in the spring was reduced. At harvesting, the density of the spikes / m$^2$ was more reduced than the previous years, being of approximately 410-420 spikes/m$^2$. This fact leads to obtaining a smaller production per ha (6400-6500 kg/ha) as compared to previous years, when the harvests exceeded frequently 8000-8200 kg/ha.

In what concerns the dynamics of the occurrence of pathogens to wheat, we mention that the pathogenic agent which occurred in the experiment in the year 2019 was *Puccinia recondita* f.sp. *tritici* fungus producing the wheat's brown rust. Attacks of the fungi variety like *Septoria* sp. producing septoriosis to wheat and *Blumeria* sp. producing diseases known as mildews occurred sporadically. Attacks of the fungi from *Giberella* sp. variety producing diseases known under the name of fusarioses (*Fusarium* sp.) had been also sporadically observed in 2019, as compared to previous years.

When analysing the data from Table 1, we observe that the degree of attack of the pathogens under monitoring, on each variant of treatment, is the following:

- V1-MYSTIC 250 EC 0.5 L/HA, 1 treatment applied at spike's release (17.05.2019) had determined a degree of attack (D.A.%) of *Puccinia recondita* f.sp. *tritici* fungus of 1.47% to "flag" leaf, and 2.87% to the second leaf, although smaller by 3.43% and respectively by 2.37% as compared to the untreated control variant (V7).

- V2-MYSTIC 250 EC 0.5 L/HA, 1 treatment applied at straw's extension (27.04.2019) +1 treatment applied at kernel's filling (8.06.2019), had determined a degree of attack (D.A.%) of *Puccinia recondita* f.sp. *tritici* fungus of 1.91% to the "flag" leaf and 2.54% to the second leaf, so smaller by 2.99% and respectively by 2.70% as compared to the untreated control variant (V7).

- V3-FALCON PRO 0.6 L/HA, 1 treatment applied at spike's release (17.05.2019) had determined a degree of attack (D.A.%) of Puccinia recondita f.sp. tritici fungus of 1.49% to "flag" leaf and 2.85% to the second leaf, so smaller by 3.41% and respectively by 2.39% as compared to the untreated control variant (V7).

- V4-FALCON PRO 0.6 L/HA, 1 treatment applied at straw's extension (27.04.2019) + 1 treatment applied at kernel's filling (8.06.2019) had determined a degree of attack (D.A.%) of *Puccinia recondita* f.sp. *tritici* fungus of 2.01% to the "flag" leaf and 3.07% to the second leaf, so smaller by 2.89% and respectively by 2.17% as compared to the untreated control variant (V7).

- V5-CAPALO 1.0 L/HA, 1 treatment applied at spike's release (17.05.2019 had determined a degree of attack (D.A.%) of *Puccinia recondita* f.sp. *tritici* fungus of 1.96% to the "flag" leaf and 3.07% to the second leaf, so smaller by 2.94% and respectively by 2.17% as compared to the untreated control variant (V7).

- V6-CAPALO 1.0 L/HA, 1 treatment applied at straw's extension (27.04.2019) + 1 treatment applied at kernel's filling (8.06.2019) had determined a degree of attack (D.A.%) of *Puccinia recondita* f.sp. *tritici* de 1.29% to the "flag" leaf and 2.44% to the second leaf, so smaller by 3.61% and respectively by 2.80% as compared to the untreated control variant (V7).

- V7 - The untreated control variety presented a degree of attack of *Puccinia recondita* f.sp. *tritici* fungus of 4.90% to the "flag" leaf and 5.24 to the second leaf.

All differences in what concerns the degree of attack (D.A. %) are statistically assured, according to Table 1.

Out of the analysis of Table 2, the harvest differences as compared to untreated control variant V7 can be also observed, as follows:

- V1-MYSTIC 250 EC 0.5 L/HA, 1 treatment applied at spike's release (17.05.2019) had achieved a harvest of 6989 kg/ha, so larger by 688 kg/ha than that of the untreated control variant.

- V2-MYSTIC 250 EC 0.5 L/HA, 1 treatment applied at straw's extension (27.04.2019) + 1 treatment applied at kernel's filling (8.06.2019) had achieved a harvest of 6688 kg/ha, so larger by 387 kg/ha than that of the untreated control variant.

- V3-FALCON PRO 0.6 L/HA, 1 treatment applied at spike's release (17.05.2019) had achieved a harvest of 6536 kg/ha, so larger by 235 kg/ha than that of the untreated control variant. We underline that this harvest increment, as compared to the untreated control variant, is not statistically assured.

- V4-FALCON PRO 0.6 L/HA, 1 treatment applied at straw's extension (27.04.2019) + 1 treatment applied at kernel's filling (8.06.2019) had achieved a harvest of 6828 kg/ha, so larger by 527 kg/ha than that of the untreated control variant.

- V5-CAPALO 1.0 L/HA, 1 treatment applied at spike's release (17.05.2019) had achieved a harvest of 6875 kg/ha, so larger by 574 kg/ha than that of the untreated control variant.

- V6-CAPALO 1.0 L/HA, 1 treatment applied at straw's extension (27.04.2019) + 1 treatment applied at kernel's filling (8.06.2019) had achieved a harvest of 6852 kg/ha, so larger by 281 kg/ha than that of the untreated control variant.

- V7-The untreated control variant had achieved a harvest of 6301 kg/ha.

The harvest differences as compared to the untreated control variant are statistically assured by it, being distinctly significant (**) in V1, V2, V4 and V5 and significant in (*) V6. The harvest increment of variant V3, as compared to the control variant (+235 kg/ha), is not statistically assured.

## CONCLUSIONS

The 2018 – 2019 agricultural year had been relatively favourable to the wheat harvest. The fall was very poor in rainfalls. The spring and the beginning of the summer were rich in rainfalls, compensating to a certain extent the droughty autumn.

The observations made in the spring of the year 2019 on the wheat experiment – Pitar variety, have led to the following conclusions and recommendations:

1. The attacks of the pathogenic agents were more reduced than in the previous years, even though there had been conditions favourable to their attacks. Among them, the only pathogenic agent which made its presence known was *Puccinia recondita* f.sp. *tritici* fungus which produces the disease known under the name "brown rust" to wheat.

2. For a reliable protection of the wheat crop, in case of using Pitar variety, we recommend in the years with droughty springs the performance of a single treatment with fungicide products, which can contain a single active substance, such as, for example, MYSTIC 250 EC in homologated dosage of 0.5 l/ha. In case the density of plants is reduced, we also recommend the application of a single treatment, even in the years with rainy and cooler springs. In the conditions where a price of approximately 0.75-0.8 lei/ kg of wheat is foreseen in 2020 (Agrointeligența 2020), the selection of the fungicide product is especially important from the point of view of the price. For example, FALCON PRO costs, in the year 2019, approximately 180 lei/l and 0.6-0.8 l/ha is applied. So the cost is approximately of 117 lei/ha/treatment. CAPALO fungicide cost in 2019 approximately 190 lei/l and 1 l/ha is applied, so the cost per ha/treatment is 190 lei. Mystic 250 EC fungicide cost approximately 104 lei/l, 0.5 l/ha is applied, so the cost per ha/treatment is approximately of 52 lei.

The harvest increments as compared to the untreated control variant (V7) were the following:

- V1-MYSTIC 250 EC 0.5 L/HA, 1 treatment applied at spike's release (17.05.2019) was 688 kg/ha, amounting to 550.4 lei. This variant proved to be the most profitable in the climatic conditions of the year 2019, using Pitar variety.

- V2-MYSTIC 250 EC 0.5 L/HA, 1 treatment applied at straw's extension (27.04.2019) + 1 treatment applied at kernel's filling (8.06.2019) was 387 kg/ha, amounting to 309.6 lei/ha.

- V3-FALCON PRO 0.6 L/HA, 1 treatment applied at spike's release (17.05.2019) was 235 kg/ha, amounting to 188 lei/ha.

- V4-FALCON PRO 0.6 L/HA, 1 treatment applied at straw's extension (27.04.2019) + 1 treatment applied at kernel's filling (8.06.2019) was 528 kg/ha, amounting to 422 lei/ha.

- V5-CAPALO 1.0 L/HA, 1 treatment applied at spike's release (17.05.2019) was 574 kg/ha, amounting to 459 de lei/ha.

- V6-CAPALO 1.0 L/HA, 1 treatment applied at straw's extension (27.04.2019) + 1 treatment applied at kernel's filling (8.06.2019) was 281 kg/ha, amounting to 224.8 lei/ha.

The Romanian wheat variety, Pitar, had a very good behavior in what concerns the attack of the pathogenic agents specific to wheat, in the climatic conditions of the year 2019.

The exchange rate Lei/€ for the first 7 months of the year 2020 was 4.8180 lei/1 €, according to the website of the National Bank of Romania.

## REFERENCES

**Iacob V. Hatman M., Ulea E., Puiu I., 1998 -** *Agricultural phytopathology,* "Ion Ionescu de la Brad" Publishing House, p. 16-18, 26-28, 31-33.

**Săulescu N., 1967 -** *Experiment field*, Agro– Sylvan Publishing House, Bucharest, p. 217, 311.

**Velichi E., 2012 -** *General and special phytopathology*, University Publishing House, Bucharest, p. 136-137.

****Agrointeligența,* July 2020 (web page).

******* *The National Bank of Romania* 2020 (web page).

*******1980 *Methods of Prognosis and Warning*, 1980 M.A.I.A., Bucharest, p. 7-9.

******* *Pest – Expert*, Ministry of Agriculture and Rural Development, the National Phytosanitary Authority (web page)

# DATA REGARDING THE MONITORING OF THE SPECIES *DIABROTICA VIRGIFERA VIRGIFERA* LE CONTE SPECIES IN AGRICULTURAL CROPS FROM THE CENTRAL AREA OF MOLDOVA

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**Abstract**

In addition to the 25 species of harmful insects, of economic importance for the maize crops identified in Romania, of which, the corn leaf weevil (*Tanymecus dilaticollis*) and wireworms (*Agriotes* spp.) are very dangerous soil pests, it is added species *Diabrotica virgifera virgifera* Le Conte. The species was identified in Europe in 1992, and in 1996 it spread to Romania. The spreding area of the pest was initially restricted in the south-west and west, in the counties of Arad, Timiș, Caraș-Severin, Mehedinți, Dolj, Hunedoara, then gradually spread to all areas of maize cultivation. In the eastern part of the country, respectively in thearea of influence of the A.R.D.S. Secuieni (Neamț, Bacău and North Vrancea counties area) the insect was reported in 2015, the flight intensity, abundance and frequency of attack increased from year to year, which imposed as a necessity the monitoring of the species and the way of attack. The species *Diabrotica virgifera virgifera* Le Conte causes damage to maize crops both in the larval stage and in the adult stage. Oligophagous larvae feed on the roots of several species of grasses, except sorghum, which they gnaw, cut off, the strongly attacked plants have the slanted stem in the form of a swan's neck, the plants dry prematurely, production losses being 10 - 13%, sometimes higher, up to 55%. Adults are polyphagous, but especially feed on the leaves, silk and corn pollen, but also on the grains at the top of the cobs. The attack reported on the corn leaves is similar to that of the species *Lema menalopa*. Observations and determinations on the appearance and flight of adults were made using yellow glue traps, which have been installed in maize crops since the beginnig of June. The first adults were registered in the first decade of July, the flight continued without interruption until the end of September. During this period July - September, the adults made a single flight curve, the maximum flight peak was recorded in the second decade of August and totaled an average of 470 specimens / trap / decade. Knowing the abundance of *Diabrotica virgifera virgifera* Le Conte in agricultural crops in Central Moldova, it is necessary to continue the research on knowledge of bioecology, factors influencing the emergence, evolution and attack, measures to prevent and control the pest.

**Key words**: maize, pests, attack, crops, flight curve

In addition to the 25 species of harmful insects, of economic importance for the maize crops identified in Romania, of which, the corn leaf weevil (*Tanymecus dilaticollis*) and wireworms (*Agriotes* spp.) are very dangerous soil pests, it is added the species *Diabrotica virgifera virgifera* Le Conte (Trotuș *et al*, 2017; Trotuș *et al*, 2020).

The species entered Europe from North America, in 1992, in Serbia, near Belgrade International Airport, in 1995 it was reported in Croatia and Hungary, and in 1996 it entered Bosnia - Herzegovina and Romania.

In our country, the area of spread of the species was initially restricted in the south - west and west, in the counties of Arad, Timiș, Caraș-Severin, Mehedinți, Dolj, Hunedoara, then gradually expanded in all areas of maize cultivation (Bărbulescu *et al*, 2020; Suciu *et al*, 2019; Bayer Crop Science, 2018).

From 1997 until 2009, at A.R.D.S. Secuieni traps were installed with pheromones and together with the county inspectorates for plant protection Neamț and Bacău we monitored the occurrence of the pest in corn crops. During this period 1997-2009 the species *Diabrotica virgifera virgifera* was not reported in the eastern part of the country.

The pest was registered in the corn crops in the central area of Moldova, starting in 2015. The flight of adults intensified from one year to another, the frequency of attack by adults increased and was recorded in all crops in the eastern part of the country.

The species *Diabrotica virgifera virgifera* Le conte is harmful both in the larval stage and in the adult stage.

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The larvae are oligophages, feed on the roots of several species of grasses, except sorghum, move through the soil until its reach the roots level, which they gnaw, get inside the roots and open gates of pathogens installation that cause their rot, decreases the stability of the plant, strong winds and rains cause the plants to fall. Strongly attacked plants have a sloping stem (swan neck), and dry prematurely, production losses being 10-13% and even higher up to 55% (Horgoș H., Grozea I., 2020).

Adults are polyphagous, but especially feed on leaves, pollen and silk and finally with the grains from the top of corn cobs. The attack on the leaves is identical to that of the *Lema menalopa* species. Adults migrate from corn crops, when pollen and fresh silk disappear in crops sown later, with younger plants. They are also found on different species of the rainbow family, being attracted by the substance cucurbitacin. The damage caused by adults is of secondary importance.

## MATERIAL AND METHOD

The monitoring of the appearance in the corn crops, from the eastern part of the country, was carried out at A.R.D.S. Secuieni starting with 1997, with the help of traps with synthetic sex pheromones, from local origin developed and produced by the „Raluca Rîpan" Institute of Chemistry Cluj-Napoca.

The flight intensified starting with 2018, when the flight monitoring was done with thehelp of yellowgluetraps. The traps were installed in the corn crops of the Plant Protection Laboratory of the A.R.D.S Secuieni - Neamț from June 1st. The readings were made to each 10 days when the number of adults collected was recorded. The traps changed monthly, and when they became clogged with other insect species, dust or plant debris, the traps became decad al

Based on the readings, the appearance, the beginning and the end of the flight, the flight curve and the flight intensity made by the adults of the species *Diabrotica virgifera virgifera* Le Conte were established.

## RESULTS AND DISCUSSIONS

In the observations and determinations made in 2019 regarding the appearance and flight of the species *Diabrotica virgifera virgifera* Le Conte, with the help of two yellow glue traps, we totaled an average of 1537.5 specimens for the period July - September.

In trap no. 1, the total number of adults collected was 1433 specimens, and in the second trap 1642 specimens were registered (*table 1*).

Based on the data recorded on the yellow glue traps, we established the flight curve of the species, which we correlated with the climatic conditions of the agricultural year 2018/2019. The flight of adults began in the first decade of July and continued uninterrupted until the end of September. During this period, July and September, there was a maximum flight peak in the second decade of August, which was 468 specimens / trap 1, 473 specimens / trap 2 and an average of 470.5 specimens on the two traps.

After reaching the maximum peak in the second decade of August, the flight started to decrease, to 13, respectively 25 specimens / trap in the third decade of September (*figure 1*).

From a climatic point of view, the agricultural year 2018/2019 was characterized as hot and dry.

Table 1

***Diabrotica virgifera virgifera Le Conte, adults collected with the help of yellow traps with adhesive glue***

| Installation date / Date of suspension | Date of collection | | Number of specimens collected on traps | | The average of the two traps |
|---|---|---|---|---|---|
| | Month | Decade | Trap 1 | Trap 2 | |
| **01.06.2019** | **June** | **I** | 0 | 0 | 0 |
| | | **II** | 0 | 0 | 0 |
| | | **III** | 0 | 0 | 0 |
| | **July** | **I** | 8 | 13 | 10.5 |
| | | **II** | 180 | 261 | 220.5 |
| | | **III** | 228 | 229 | 228.5 |
| | **august** | **I** | 188 | 248 | 218 |
| | | **II** | 468 | 473 | 470.5 |
| | | **III** | 179 | 211 | 195 |
| | **September** | **I** | 127 | 130 | 128.5 |
| | | **II** | 42 | 52 | 47 |
| **30.09.2019** | | **III** | 13 | 25 | 19 |
| **Total collected** | | | **1433** | **1642** | **1537.5** |

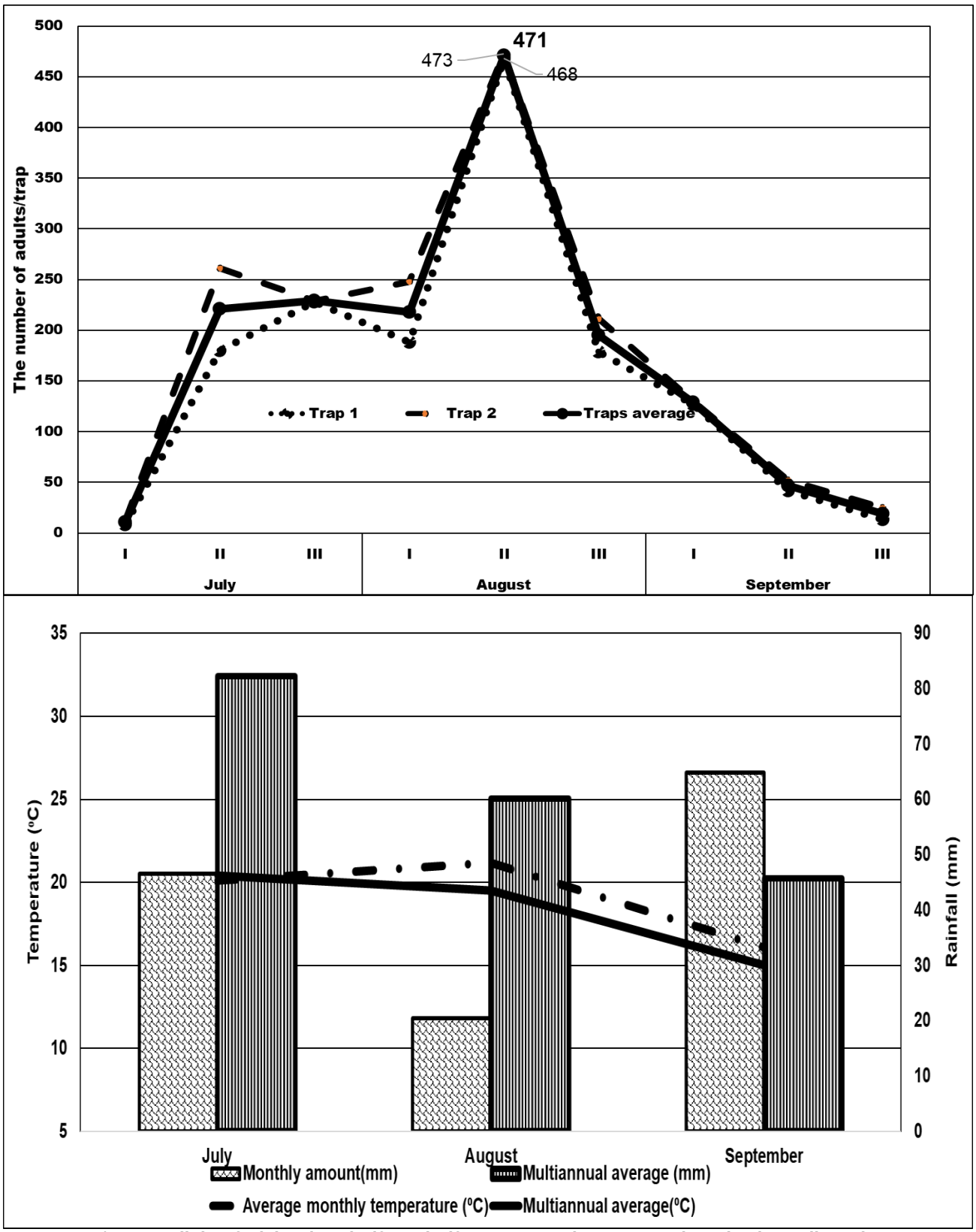



Figure 1. **Flight of *Diabrotica virgifera virgifera* Le Conte in 2019, monitored using yellow glue traps correlated with the climatic conditions for the period July - September**

The average multiannual temperature was 10.0 ºC, 1.1 ºC higher than the multiannual average which is 8.9 ºC, and the annual amount of precipitation was 450.2 mm, 94.1 mm less compared to the average multiannual amount which is 544.3 mm (Table 2).

Between July and September, until the species flew, the monthly temperature deviations were between -0.3 ºC (July) and 1.7ºC (August), and in terms of precipitation, the monthly deviations were negative conditions between -29.2 mm (July) and -39.8 mm (August), due to the

favorable climatic conditions for the appearance, evolution and flight of the species *Diabrotica virgifera virgifera* Le Conte (*figure 1*).

## CONCLUSIONS

The species *Diabrotica virgifera virgifera* has settled and developed an appreciable population in the eastern part of the country.

The species must be considered a dangerous pest of maize crops in the country and in the Central area of Moldova.

It is necessary to approach the different researches, in order to:

- knowledge of bioecology;
- knowledge of the factors that influence the appearance, evolution and attack;
- establishing prevention and control measures;
- improving the technology to control the whole group of soil pests.

## REFERENCES

**Bayer Crop Sciences, 2018,** Catalogul produselor, Protecția plantelor,123 pg.

**Barbulescu Al., 2000,** *Diabrotica virgifera virgifera un dăunător periculos al porumbului în România*, Ed. Geea.

**Suciu L., Mureșanu F., Tărău A., Pacurar A.M., Soptarean L., 2019,** *10 de monitorizare a dăunătorului Diabrotica virgifra virgifera Le conte în cultura de porumb de la SCDA TURDA*, Agricultura transilvaneană, Cultura plantelor de câmp, Buletin informativ , nr 31, Septembrie 2019, pg. 66-72.

**Horgoș H., Grozea I., 2020**, *The current assessment of the structure of Diabrotica virgifera (Coleoptera: Chrysomelidae) populations and the possible correlation of adult coloristic with the type and composition of ingested maize plant*, Romanian Agricultural Research, no. 37,197:210**,** https://www.incda-fundulea.ro/rar/rar37.html.

**Trotuş E., Buburuz A.A., Ursache P.L., 2017** – *Date noi privind protecţia culturilor de porumb împotriva dăunătorilor specifici,55 ani de Cercetare Dezvoltare, S.C.D.A. Secuieni-Neamț, Volum omagial*- Ed. Ion Ionescu de la Brad, Iaşi, pag 115-130.

**Trotuș E., Isticioaia S.F., Mîrzan O., Popa L.D., Naie M., Lupu C., Leonte A., Pintilie P.L., Buburuz A.A., Dobrea I.D.**, **2020**– *Tehnologii de cultivare a unor plante de câmp pentru zona Centrală a Moldovei*, Ed. Ion Ionescu de la Brad, Iași.

# RESEARCHES REGARDING THE INFLUENCE OF THE TECHNOLOGICAL FACTORS ON THE BIOLOGY OF THE SPECIES AND SEED YIELDS AT *CARTHAMUS TINCTORIUS* L. IN A.R.D.S. SECUIENI

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**Abstract**

The paper aims to highlight the influence of technological factors on the biology of the species and seed production at *Carthamus tinctorius* L. (safflower). The research were carried out in 2019, in the experimental field of A.R.D.S. Secuieni. Due to the higher temperatures from the third epoch and the precipitations recorded in the sowing to emergence period, the plants had a faster evolution. It was necessary 117 days from sowing to harvesting the seeds, the sum of the accumulated temperatures was 2241.9 ° C and the precipitation amounted to 230.7 mm. Under the conditions of A.R.D.S. Secuieni, at the first sowing epoch, there was an increase in production of 156 kg/ha compared to the control of the experience. The interaction of the studied factors influenced the seed production, obtaining the highest seed production at the sown variant at 70 cm between rows and 25 cm between plants per row (1688 kg/ha).

**Key words**: seed, safflower, epoch of sowing.

Safflower (*Carthamus tinctorius* L.) is an annual, broadleaf oilseed crop of the family *Asteraceae* adapted chiefly to dryland or irrigated cropping systems (Rohini V.K., Sankara K.R. 2000). It is possible to have originated in southern Asia and is known to have been cultivated in China, India, Persia and Egypt almost from prehistoric times.

Safflower was originally grown for the flowers that were used in making red and yellow dyes for clothing and food preparation (Cho and Tae R.H., 2000). Safflower (*Carthamus tinctorius* L.) is an important oilseed crop with 35-40 % oil (Kolsarici Ö. *et al*, 2005).

Safflower oil is composed of unsaturated fatty acids including linoleic acid (18:2) and oleic acid (18:1), and saturated fatty acids as palmitic acid (16:0) and stearic acid (18:0). It is one of the richest sources of linoleic acid among the commercially available oil (Yeilaghi H *et al*., 2012). Safflower seed oil contains about 71– 75% linoleic acid, 16–20% oleic acid, 6–8% palmitic acid, and 2–3% stearic acid (Velasco L., Fernandez-Martinez J.M., 2001).

Different sowing dates caused flowering and seed development to occur during periods of widely different temperatures, radiation, and day length (Mirshekari M. *et al*, 2013). Sowing date can be a major factor that affects oil content and fatty acid composition at the time of seed development (Yeilaghi H. *et al*, 2012).

## MATERIAL AND METHOD

A factorial experiment was organized in 2019 in the experimental field of Agricultural Research - Development Station Secuieni, Neamt County, using a randomized blocks in three replications.

The trial was conducte on a typical cambic chernozem soil type, middle texture, acid: pH $H_2O$– 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-$NO_3$) and poorly supplied in potassium (124.6 ppm K2O).

In the conditions of A.R.D.S. Secuieni we experimented three sowing epochs:

V1 - Epoch I, sowing in the first emergence (the first decade of April);

V2 - Epoch II, sowing in the second emergence (the second decade of April);

V3- Epoch III, sowing in the last decade of April.

The second experiment was a bifactorial type, placed in the field according to the method of subdivided plots, in three repetitions. Factor A was represented by the distance between rows with graduations: 25 cm, 50 cm and 70 cm and Factor

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B - the distance between plants per row with graduations: continuous row, 15 cm and 25 cm.

The soil work and the preparation of the germination bed consisted in releasing the soil from the plant debris in the pre-planting, stubble-turning and plowing at a depth of 30 cm. In spring, preparation of the germination bed was made with a harrow disc and the sowing was done manually at a depth of 2 cm.

The research was aimed to establish the optimal epoch of sowing for the species *Carthamus tinctorius* L. in order to develop the technology cultivation.

During the vegetation period of plants, phenological observations were made to establish the sum of the thermal degrees and sum of the precipitations needed to grow and develop the plants.

The agricultural year 2018/2019 was characterized as hot in terms of temperatures and dry in terms of the annual amount of rainfall that was unevenly distributed during the vegetation period of the plants. Regarding the temperatures, the multiannual average for the conditions in Secuieni is 8.9ºC, and the average of the agricultural year 2018 - 2019 was 10.0ºC with 1.1ºC higher, the monthly deviations were between -0.9ºC in November and 4.0 ºC in March. The spring was characterized as dry in terms of heat and rainfall, except for May, which was close to normal in terms of temperature and excess in terms of rainfall, with a deviation of 29.3 mm from the multiannual average.

In terms of rainfall, the annual amount recorded was 430 mm by 114.1 mm less than the multiannual average of 544.3 mm agricultural year 2018/2019 being characterized as dry, the monthly deviations from the multiannual average were between - 39.8 mm in August and 29.3 mm in May (*table 1*).

Table 1

**Temperatures and rainfall recorded at A.R.D.S. Secuieni meteorological station**

| Specification | | 2018 | | | 2019 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | X | XI | XII | I | II | III | IV | V | VI | VII | VIII | IX | Media |
| Temperatures °C | Decade I | 11.3 | 8.3 | -4.0 | -4.2 | -0.4 | 6.4 | 9.5 | 11.7 | 19.2 | 20.3 | 20.1 | 18.6 | |
| | Decade II | 11.0 | 2.9 | -2.3 | -3.7 | 2.2 | 6.8 | 7.1 | 15.7 | 23.1 | 18.0 | 21.4 | 15.2 | |
| | Decade III | 11.6 | -3.5 | 0.1 | -3.6 | 0.9 | 7.2 | 12.4 | 18.3 | 21.5 | 21.7 | 22.0 | 14.8 | |
| | Monthly average | 11.3 | 2.6 | -2.0 | -3.8 | 0.9 | 6.8 | 9.7 | 15.3 | 21.3 | 20.1 | 21.2 | 16.2 | 10.0 |
| | Multiannual average | 9.1 | 3.5 | -1.7 | -3.9 | -2.2 | 2.8 | 9.5 | 15.4 | 18.8 | 20.4 | 19.5 | 15.0 | 8.9 |
| | Deviation | 2.2 | -0.9 | -0.3 | 0.1 | 3.1 | 4.0 | 0.2 | -0.1 | 2.5 | -0.3 | 1.7 | 1.2 | 1.1 |
| Precipitations mm | Decade I | 0.4 | 1.2 | 9.4 | 0.2 | 1.8 | 1.6 | 2.2 | 44.2 | 32.2 | 31.4 | 20.0 | 18.4 | |
| | Decade II | 0.0 | 29.8 | 3.0 | 0.2 | 14.8 | 0.6 | 22.8 | 27.0 | 0.4 | 6.0 | 0.4 | 1.0 | |
| | Decade III | 0.2 | 8.6 | 17.0 | 14.4 | 4.4 | 2.0 | 13.0 | 23.8 | 23.2 | 9.2 | 0.0 | 45.4 | |
| | Monthly average | 0.6 | 39.6 | 29.4 | 14.8 | 21.0 | 4.2 | 38.0 | 95.0 | 55.8 | 46.6 | 20.4 | 64.8 | 430.2 |
| | Multiannual average | 38.2 | 28.4 | 25.4 | 20.1 | 19.5 | 26.9 | 46.9 | 65.7 | 85.0 | 82.3 | 60.2 | 45.7 | 544.3 |
| | Deviation | -37.6 | 11.2 | 4.0 | -5.3 | 1.5 | -22.7 | -8.9 | 29.3 | -29.2 | -35.7 | -39.8 | 19.1 | 114.1 |

## RESULTS AND DISCUSSION

The *Carthamus tinctorius* L. species sowing in the first epoch the plants have sprung after 25 days from the sowing, accumulating a sum of the degrees of 316.1°C and 38.2 mm precipitations. From the emergence to the appearance of flowering rods, the sum of accumulated degrees was 521.2° C and 125.2 mm precipitations.

In the case of *Carthamus tinctorius* L. in 2019, from the appearance of the flowering rods until the beginning of blooming passed 23 days, the sum of the thermal degrees recorded for this period was 509.9° C and 25 mm precipitation.

Harvesting the seed was carried out 21 days after the beginning of fructification, accumulating 328.7° C and 27.8 mm of precipitation. Due to higher temperatures from the second epoch of sowing the plants had a faster evolution. From sowing to seed harvesting 128 days were required, the sum of the accumulated temperatures was 2250.7° C and the rainfall amounted to 234 mm.

Due to the high summer temperatures, the plants harvested for seeds from the epoch III of sowing had a vegetation period with 11 days less than the second epoch of sowing. The sum of thermal degrees was 2241.9º C and 230.7 mm precipitation (*table2*).

Table 2

**Phenological observations at *Carthamus tinctorius* L. in 2019**

| Phenological observations | The date from which the phenophase began | Duration in days for seeds | Σ of thermal degrees ($^0$C) | Σ of precipitations (mm) |
|---|---|---|---|---|
| Epoch I | | | | |
| Sowing | 08.04.2019 | - | - | - |
| Emergence | 02.05.2019 | 25 | 316.1 | 38.2 |
| The appearance of flowering rods | 04.06.2019 | 33 | 521.2 | 125.2 |
| The beginning of blooming | 27.06.2019 | 23 | 509.9 | 25.0 |
| The beginning of fructification | 22.07.2019 | 29 | 488.5 | 38.2 |
| Harvesting for seeds | 07.08.2019 | 21 | 328.7 | 27.8 |
| TOTAL | - | 131 | 2164,4 | 254.4 |
| Epoch II | | | | |
| Sowing | 18.04.2019 | - | - | - |
| Emergence | 06.05.2019 | 19 | 277.6 | 49.2 |
| The appearance of flowering rods | 04.06.2019 | 32 | 463.4 | 92.8 |
| The beginning of blooming | 22.06.2019 | 21 | 398.3 | 2.2 |
| The beginning of fructification | 17.07.2019 | 27 | 494.6 | 58.0 |
| Harvesting for seeds | 15.08.2019 | 29 | 616.8 | 32.0 |
| TOTAL | - | 128 | 2250.7 | 234.2 |
| Epoch III | | | | |
| Sowing | 28.04.2019 | - | - | - |
| Emergence | 15.05.2019 | 18 | 279.0 | 65 |
| The appearance of flowering rods | 18.06.2019 | 28 | 664.7 | 75.4 |
| The beginning of blooming | 03.07.2019 | 19 | 329.6 | 53.9 |
| The beginning of fructification | 23.07.2019 | 24 | 376.9 | 15.6 |
| Harvesting for seeds | 20.08.2019 | 28 | 591.7 | 20.8 |
| TOTAL | - | 117 | 2241.9 | 230.7 |

The influence of the sowing epoch on the seed production in safflower was materialized by obtaining productions between 1075 kg/ha (the third epoch) and 1400 kg/ha (the first epoch). From a statistical point of view, compared to the control (average experience), the increase in production (156 kg/ha) statistically ensured was achieved in the variant from the first epoch, this being very significant positive. At the variant sown in the third epoch, was achieved a production difference negative very significant (169 kg/ha) compared to the control (*table 3*).

Table 3

**The influence of the sowing epoch on the production of seeds at *Carthamus tinctorius* L. in 2019**

| Variant | Average production of seeds (kg/ha) | | | |
|---|---|---|---|---|
| | Kg/ha | % | Diff. (Kg/ha) | Significance |
| Epoch I | 1400 | 112.54 | 156 | *** |
| Epoch II | 1257 | 101.04 | 13 | |
| Epoch III | 1075 | 86.41 | -169 | ooo |
| Average | 1244 | 100 | Ct. | |
| | LSD 5%= 70.43 (kg/ha)<br>LSD 1%= 95.95 (kg/ha)<br>LSD 0.1%= 128.96 (kg/ha) | | | |

Table 4

**The influence of interaction from the distance between rows and the distance between plants per row on the average seed production (kg/ha) at *Carthamus tinctorius* L. (safflower) species at A.R.D.S. Secuieni in 2019**

| Distance between rows (A) | Distance between plants per row (B) | Production (kg/ha) | % compared to control | Diff. | Significance |
|---|---|---|---|---|---|
| a1-25 cm | b1- continuous row | 608 | 50.50 | -596 | ooo |
| | b2-15 cm | 679 | 28.48 | -525 | ooo |
| | b3-25 cm | 762 | 18.02 | -442 | ooo |
| a2-50 cm | b1- continuous row | 1094 | 16.38 | -110 | o |
| | b2-15 cm | 1319 | 17.94 | 115 | * |
| | b3-25 cm | 1478 | 22.02 | 274 | *** |
| a3-70 cm | b1- continuous row | 1591 | 29.10 | 387 | *** |
| | b2-15 cm | 1615 | 39.04 | 411 | *** |
| | b3-25 cm | 1688 | 54.73 | 484 | *** |
| Average | | 1204 | 100 | Ct. | |
| LSD 5%= 92.1 kg/ha LSD 1%= 126.9 kg/ha LSD 0.1%= 174.7 kg/ha | | | | | |

Regarding the seed yields, it can be observed that the highest production was obtained at the interaction the distance between rows of 70 cm x 25 cm between plants per row (1688 kg/ha), and the lowest at the interaction of 25 cm x continuous row (608 kg/ha). Very significant positive increases were achieved in the variant sown at 70 cm between rows and at all three distances between plants per row (from 387 kg/ha to 484 kg/ha) compared to the control (average experience) (*table 4*).

## CONCLUSION

The climatic conditions of 2019 influenced the growth and development of the species *Carthamus tinctorius* L. and the seed production obtained. The highest seed production was obtained at the variant sown in the first decade of April (1400 kg/ha). Ensuring the nutrition space is very important for obtaining high productions for safflower.The highest seed production materialized at the variant sown at a distance of 70 cm between rows and 25 cm between plants per row.

## ACKNOWLEGMENTS

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## REFERENCES

**Cho M.H., Tae R.H., 2000 -** *Purification and characterization of Precarthamin Decarboxylase from the Yellow Petals of Carthamus tinctorius L*. Archives of Biochemistry and Biophysics, 382:238-244.

**Kolsarıcı Ö., Alluşoğlu, S. Kaya, M.D., 2005 -** *The Effects of Tillage and Nitrogen Doses on Water Use Efficiency, Soil Moisture and Seed Characters of Safflower (Carthamus tinctorius L.) in Wheat-Safflower Rotation System*. VIth International Safflower Conference, Istanbul, 126-131.

**Mirshekari M., Majnounhosseini N., Amiri R., Moslehi A, Zandvakili O.R., 2013 -** *Effects of Sowing Date and Irrigation Treatment on Safflower Seed Quality*. J. Agr. Sci. Tech.,15: 505-515.

**Rohini V.K., Sankara K.R., 2000 -** *Embryo Transformation, A Practical Approach for realizing Transgenic Plants of Safflower (Carthamus tinctorius L.).* Annals of Botany, 86: 1043-1049.

**Velasco L., Fernandez-Martinez J. M., 2001 -** *Breeding for Oil Quality in Safflower*. In Proceedings of the 5th International Safflower Conference, Williston, North Dakota and Sidney, Montana, USA, 133-137.

**Yeilaghi H., Arzani A., Ghaderian M., Fotovat R., Feizi M., Pourdad S. S., 2012 -** *Effect of Salinity on Seed Oil Content and Fatty Acid Composition of Safflower (Carthamus tinctorius L.) Genotypes.* Food Chem., 130(3): 618-625.

# MONITORING THE TEMPORARY STABILITY OF THE PODIȘU DAM FROM IASI COUNTY BY ADVANCED TOPOGRAPHIC MEASUREMENTS

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**Abstract**

The paper presents elements of analysis of the temporal stability of earth dams by using topographic methods. Structural deformations and displacements are determined and processed by data obtained from advanced topographic studies on the geometry of the dam construction. The studies and researches were carried out for the Podișu earth dam located on the Valea Oii river, Bahlui river basin, Iași county. Special hydrological events recorded in recent years in the Bahlui river basin and especially on the Valea Oii river, have influenced the stability of the earth dams in cascade in this area. Monitoring the structural condition of dams and obtaining stability analysis data were made by topographic surveys in 2006, 2017, 2019. To carry out in accordance with the legislation in force the monitoring of the behavior of constructions, they must be equipped with settlement tracking landmarks but also fixed landmarks. This situation is not fulfilled at most class C and D earth dams. In the absence of tracking marks, in 2019 four landmarks were instaled at the Podișu dam and a local tracking network was created. With the help of topographic measurements, the constructive elements of the earth dam were reconstructed and the analysis base of the stability model was restored (situation plan, longitudinal and transversal profiles, constructive details etc.).

**Key words**: database, deformations, topographic plan, profiles, settlement landmarks

In the last 20 years have produced a number of climate changes in the world, with direct influence on the hydrological cycle. These changes are present in Romania and influence the distribution of annual rainfall and flows in river basins. The high value of the changes creates an important hydroclimatic risk in the evolution of flows and levels on rivers. Hydrological changes influence the behaviour of the river, but also dam construction and existing constructions in the river bad and bank (Luca M. *et al*, 2016).

The safety of hydrotechnical structures is a very important element that must enter the concerns of designers and society in general. In the case of their distruction due to hydrological hazards, other activities from the area, the settlements and human lives may be strongly affected. Braking dams accidents do not occur suddenly but almost always there are signs of danger that would allow preliminary measures to limit or even avoid disasters (Boboc V., Mitroi R., 2016).

From the research carried out until this moment, achieving hydrotechnical objectives involves the use of detalied technical and economic documentation. Various studies are used when making the technical project: topographic studies, geotechnical studies, hydrological studies, hydraulic studies, hydrogeological studies etc. Of all these studies, the topographic documentation, based on topographic measurements, is of particular importance (Luca M. *et al*, 2017).

The methods and technology of data measurement and processing have evolved a lot in recent years, reaching today the real-time monitoring of the deformtions of the constructions subjected to the on-site tracking process by geodetic metods (Onu C., 2011).

Spatial geodetic networks, determined by GNSS technology, have the dominant role in local geodetic network creation nowadays. In the case of the monitoring of some hydrotechnical constructions, these networks are designed so that their geometrical configuration would allow the determination of the coordinates of control points which are located on the construction with high accuracy (Chirilă C., Căsăndrescu I.A., 2015).

The quality of the horizontal coordinates of the points in a local geodetic network is influenced by many factors such as: equipment used for measurement/observation, network geometry, measurement strategy as well as data processing methods (Julianto E.N. *et al*,2018).

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## MATERIAL AND METHOD

The research material is represented by the Podisu earth dam located on the Valea Oii river. From an administrative territorial point of view, the studied massif is located on the territory of Baltati commune in Iasi county. The access to the earh dam is made through an exploatation road that branches from DC 116 in Podisu locality (*figure 1*).

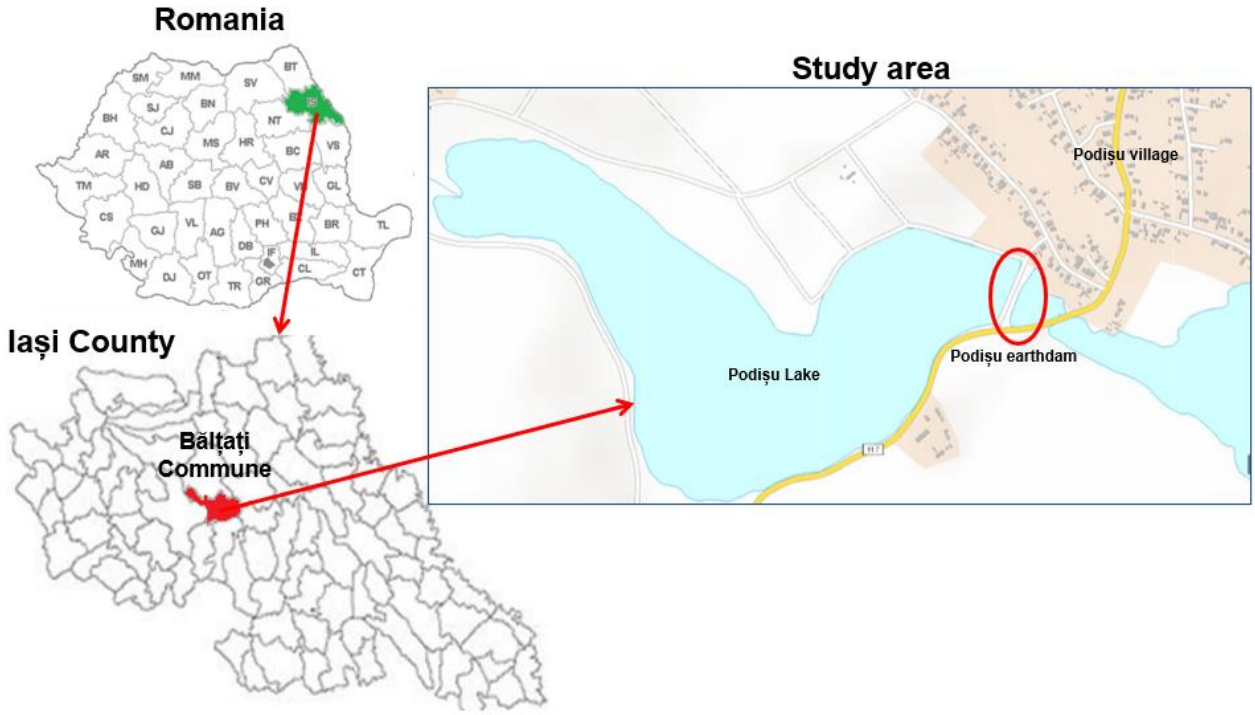



Figure 1 **Representing the study area by framing it on the map of Romania, Iasi county, Podisu locality**

The Podișu reservoir was built between 1961-1962 with an area of 15.63 ha. The accumulation was designed to contribute to flood mitigation on the Valea Oii river and to ensure the flow of servitude downstream to the accumulation Ichim.

The research methodology consists of the following stages:

- Researching the history of the studied objective.
- Analysis of the main technical characteristics of the Podișu earth dam.
- Prezentation of structural aspects.
- Prezentation of the current surveillance system for the studied area.
- Analysis of topographic measurements performed for the dam by comparing the cross-sectional profiles performed in 2006 and 2016.
- Recognizing the objective and performing topographic measurements in order to prepare the situation plan in 2019.
- Design of a local geodetic network for tracking the movements of the earthdam.

The Podișu accumulation is in category C of normal importance and also fulfills the role of a fish pond. The important phenomena that need to be followed are the external stresses and displacements (relative and absolute) that occur during the exploitation period of the earth dam.

## RESULTS AND DISCUSSIONS

The Podișu reservoir was built between 1961-1962 with the main role in flood mitigation on the Valea Oii river, ensuring the flow of servitude downstream. Special events recorded in 1976 when the flood, with a probability of exceeding over 1%, caussed all the cascading dams in this area to be discharged, due to the overtopping of dams. The accumulations located on the Valea Oii river are: Boureni, Bejeneasa, Filiași, Podișu, Ichim and Sârca.

All dams were rebuilt between 1977-1978. Concidering this event and to avoid breaking them, adequate monitoring is very important, to follow external stresses and displacements.

Earth dam Podișu (*figure 2*) is located in the southwest of Podișu village. The Podișu dam is a homogeneous type of earth dam made of local materials with a trapeziodal shape and a circulated crest.



Figure 2 **Overview of the Podișu earthdam**
(photo: Agapie I., 2019)

From a geological point of view, the area of lake Podișu consists of Sarmatian deposits over which are deposited quaternary formations consisting of deluvial and alluvial deposits. Deluvial deposits are represented by clays, sandy clays, dusty-sandy clays and have a maximum thickness of 8-9 m on the left side and over 10 m on the right side (Sbiera I.B., 2006).

The constructive characteristics of the Podișu earth dam are highlighted in *table 1*.

Table 1

**Technical data of the Podișu earth dam**

| Podișu dam (cadastral cod: XIII.1.15.32.12.7) | | |
|---|---|---|
| Dam length | 104 m | |
| Average crest heigh | 87.45 m | |
| Maximum height | 3.9 m | |
| Crest width | 4.5 m | |
| Slope | Upstream | 1:1 (rough stone wall prtection) |
| | Downstream | 1:2 (grass protection) |

In order to transit large and medium waters, the dam is provided with two overflows spillway C1 and C2 located at the ends of the dam.

Spillway C1 (*figure 3*) built of reinforced concrete has a rectangular section of 2.00 x 3.70 m. Its heigh is 3.5 m and the length of the water access front is 1.0 m. Spillway C1 is provided with wooden valves to control the water level in the lake and flows discharged downstream. Spillway C1 is also provided with a window equipped with metal grilles.



**a.**



**b.**

Figure 3 **Photo representing the spillway C1: a – upstream; b – downstream bottom discharge**
(photo: Agapie I., 2019)

Pipe conduit has a legth of 19.50 m and is constructed of reinforced concrete. The pipe shaft is at 82.70 m elevation. Spillway C1 flows into the energy disspation channel made of reinforced concrete.

Spillway C2 (*figure 4*) is made of reinforced concrete, has a rectangular section measuring 3.8 x 5.0 m and a height of 3.5 m. For free access to water the spillway has a window equipped with metal grilles. Also, the presence of wooden valves can be noticed, with the help of which the water level in the lake and the flow discharges downstream can be controlled. The length of the water access front is 2.0 m.

Spillway C2 outlet, of reinforced concrete has a length of 22.0 m and a square section measuring 2.0 x 2.0 m. The pipe shaft is at 83.30 m elevation. Also, in the case of spillway C2, outlet flows into the energy disipating channel.



**a.**



**b.**

Figure 4 **Photo representing the spillway C2: a – upstream; b – downstream bottom discharge**
(photo: Agapie I., 2019)

The Podisu accumulation monitoring system includes visual observations, which take place periodically on the accumulation lake and the earth dam. Thus, it is possible to follow the state of degradation of the banks, their sliding tendencies as well as the tracking of infiltrations in the area of the upstream and downstream slopes. The monitoring of the earth dam takes into account the processes of erosion of the slopes, the appearance of cracks or fissures in the body of the dam, the condition of the slopes in the embedded area of the dam, possible displacements or settlements of the dam and adjacent slopes. The strength of the spillway, the appearance of cracks, the state of integrity of the concrete, the damage of the joints are also checked.

According to the last technical inspection carried out in 2016 (Tănăsescu, 2016), the concrete surfaces of the spillways C1 and C2 were in satisfactory condition with no significant cracks or exfoliations. During the visual inspection of the earth dam, the state of protection of the upstream and downstream slopes was examined. Their condition is satisfactory, without the presence of wetting or infiltration. The analysis shows that the discharge of bottom drain at the spillway C1 requires repair work.

Also, based on the visual observations made during the technical expertise from 2006 and 2016, no landslides of the slopes adjacent to the dam and the lake basin were observed.

The Podisu earth dam is not provided with infiltration monitoring equipment and does not have a drainage system installed. The water level in the accumulation lake is determined following the observations made by the operating personnel at the hydrometric sight drawn on the wall of the spillway C1. The earth dam has no landmarks for tracking settlements or movements. The relative follow of the evolution of these phenomena can be highlighted with the help of the situation plans and the transversal profiles drawn up in 2006, 2016 and 2019.

During the 2006 expertise, following the topographic measurements, the situation plan presented in *figure 5* was drawn up. The cross-sectional profile 1 will be analyzed by comparing it with the results obtained for the same profile following the topographic measurements from 2016.

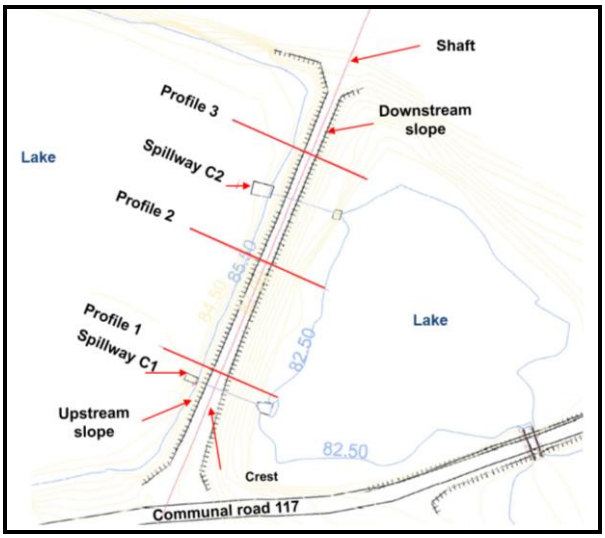



Figure 5 **Situation plan with the representation of the dam components and measured profiles**
(source: Sbiera I. B., 2006)

*Figure 6* shows the two cross-sectional profiles performed in the expertises of 2006 and 2016. In order to draw up the transversal profiles, leveling measurements were performed for 9 points arranged along the line defining profile 1, at the distances mentioned in *figure 6.*

From the analysis of the two transversal profiles it can be observed an elevation of the dam crest by 27 cm in point 4 and by 40 cm in points 5 and 6, respectively. This is due to the works to raise the crest of the dam, the elevation measured in 2016 being 87.79 – 87.92 m compared to the average elevation of 87.45 m measured in 2006.

During the last technical expertise carried out in 2016, it was necessary to install the tracking landmarks on the dam crest and the fixed landmarks at the ends of the dam, with the periodic performance of topo-geodesic measurements.

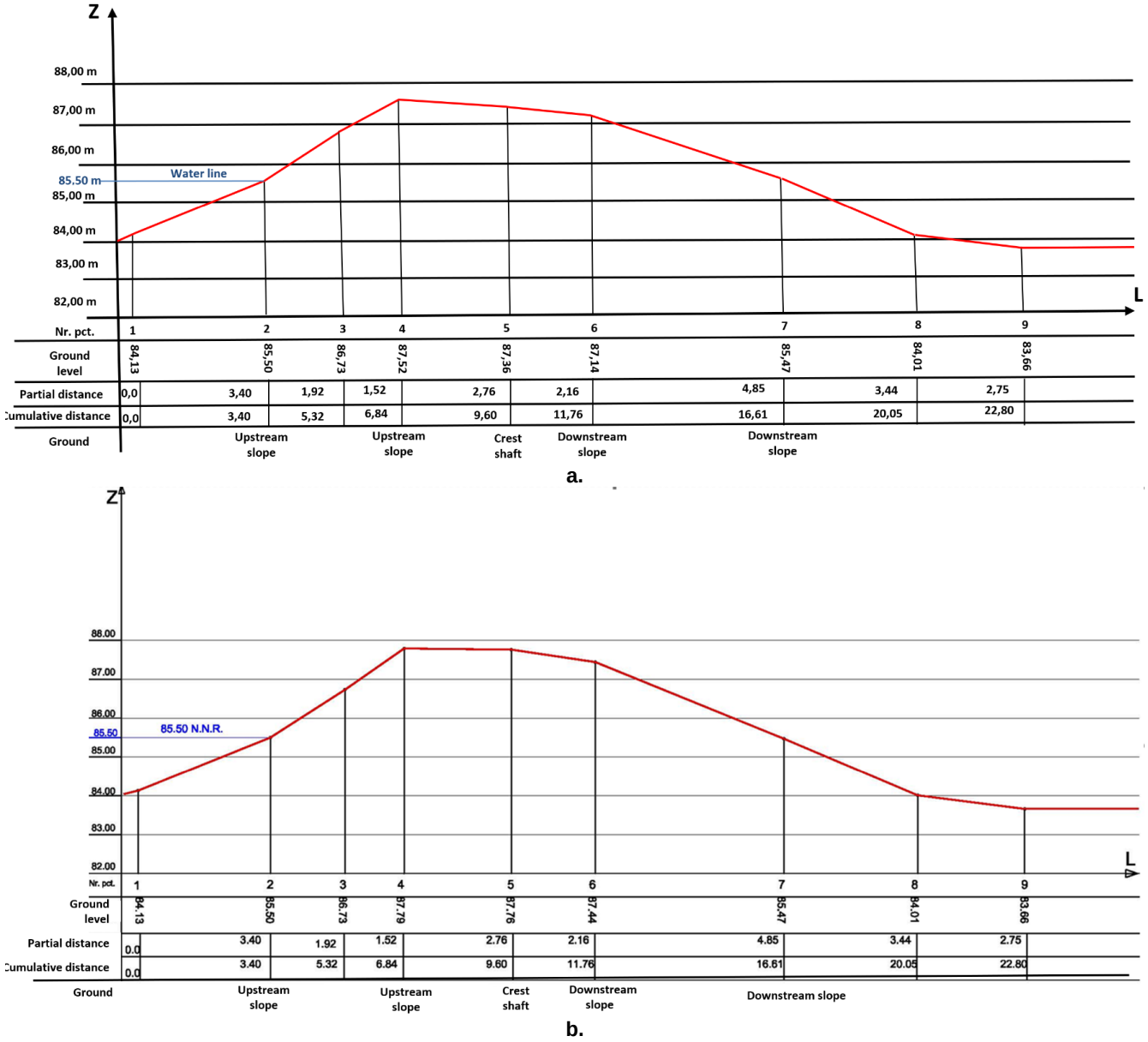
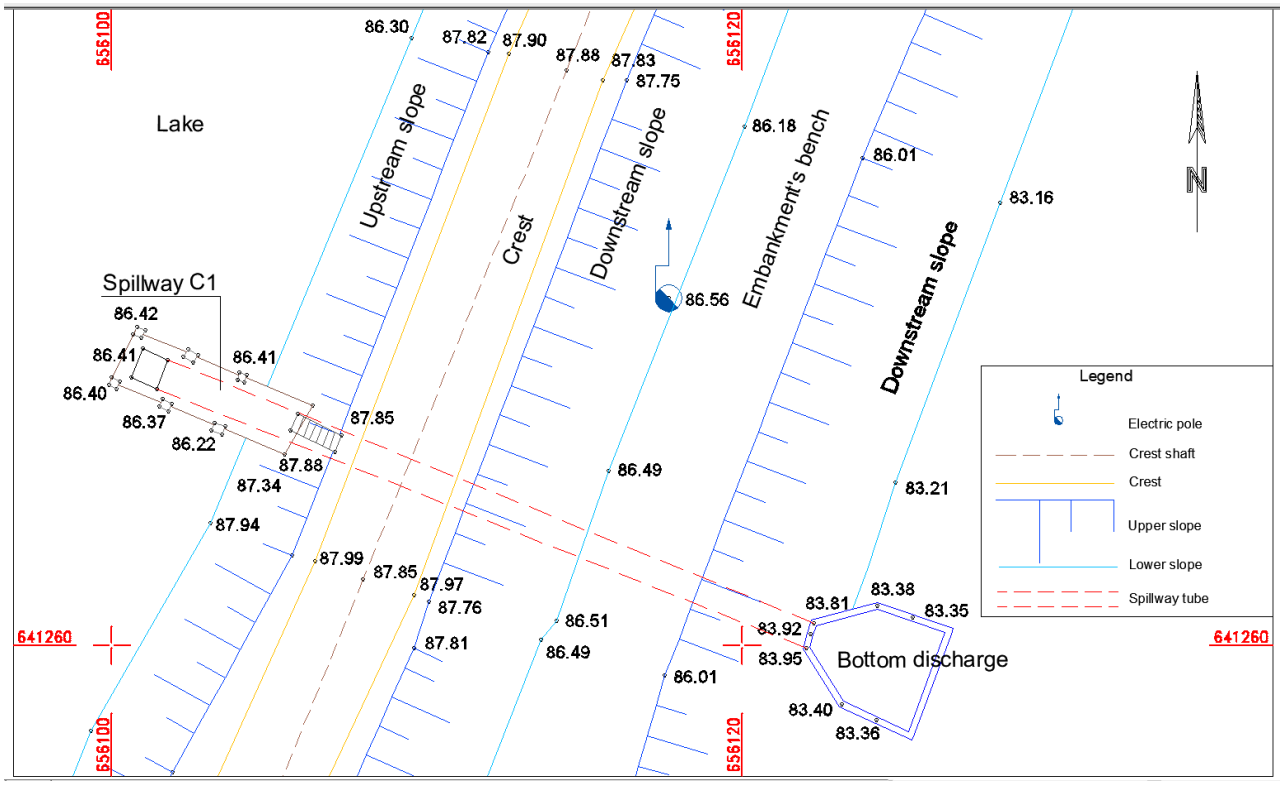



Figure 6 **Representation of the transversal profiles for the analyzed area: a – transversal profile according to the measurements from 2006; b - transversal profile according to the measurements from 2016**
(source: Sbiera I. B., 2006; Tănăsescu M., 2016)

In 2019, a topographic survey was carried out to verify the elevations of the upstream and downstream slopes and the crest. Thus, 10 transversal profiles were made. In *figure 7* the situation plan is represented for two profiles, one of which corresponds to the spillway C1. Compared to the last expertise performed in 2016, there is again an increase in elevations which indicates the realization of the consolidation works of the dam through increased height by about 40 cm.

To made the topographic plan, the geodetic measurements were performed using Trimble equipment. A Trimble R8S fixed receiver (*figure 7.c*) and a Trimble R8S mobile rover (*figure 7.b*) were used. The measurements were performed in real time, in RTK (Real Time Kinematic) mode having a horizontal and vertical positioning accuracy of 8 mm. This method of positioning in real time the coordinates of stationary points is called differential positioning (DGNSS). The situation plan was made in Stereo 70 projection, reference plan for elevation, Black Sea 1975.




a.



b.



c.

Figure 7 **Making the topographic study: a – situation plan in the area of the spillway C1; b – field measurements with the Trimble R8S mobile rover; c – Trimble R8S fixed receiver**

DGNSS positioning is most often used when positioning accuracy is desired. This method involves the use of at least two GNSS receivers: a reference receiver held in a fixed position, at a known coordinate point and another receiver, a rover, whose coordinates must be determined. The fixed receiver determines its own position based on the collected satellite measurements, which it compares to the known position. The difference between the two solutions allows the determination of the measurement errors and the necessary corrections. The corrections are transmitted by the reference station to the mobile receiver to determine its position (Diac M., 2020).

For periodic monitoring of horizontal and vertical movements of the earth dam, in 2019 a tracking network was created consisting of four control points marked with B1, B2, B3, B4, located at the ends od the dam and two reference points S1 and S2, positioned on the slope adjacent to the dam. The stages of the follow-up network were:

- Objective recognition, setting and marking of station points S1 and S2 (*figure 8.a*).
- Establishment and marking of points B1, B2, B3, B4 (*figure 8.b*).
- Determination of station point coordinates by the static GNSS positioning method.
- Performing static measurements and relative positioning of control points B1, B2, B3, B4.




**a.** **b.** **c.**

Figure 8 **Images representing the steps of creation of the geodetic network : a – marking and measuring station points; b – marking control points; c – scheme of the geodetic tracking network**

The static relative method was used to determine the coordinates of the control points. This method involves determining the coordinates of a new point in relation to the coordinates of a known fixed point, by determining the size of the vector between the two points (base-vector), in the reference system WGS 84. Relative static positioning involves simultaneous measurements on the same satellites. Observations recorded by the fixed receiver (S1, S2) are transmitted to mobile receivers (located in the points B1, B2, B3, B4). The observations from both receivers are combined to determine the relative position of the control points in relation to the station point. The accuracy of this positioning method is ± 5 mm ±1 ppm.

The measurements performed resulted in a number of 20 vectors from 10 measurement sessions in relation to the reference station S1 and 10 measurement sessions in relation to the reference station S2.

The measurements were performed using three GNSS receivers at the same time, one Trimble R2 and two Trimble R8S. The observation time was 12 minutes.

Measurement processing was performed in the office with Trimble Business Center software, a application for processing and managing data taken with total station, GNSS receivers or UAV (Unmanned Aerial Vehicle).

The coordinates of the control points are presented in table 2.

Using the same measurement method, the coordinates of the control points can be determined annually or after the occurrence of special events (earthquakes, floods, etc.). The location of the control points, at the ends of the earth dam, allows their subsequent use for determining and following some points located on the crest of the dam or on its slopes. Thus, possible horizontal and vertical displacements that appear during the exploitation period of the dam can be followed. Decisions can also be made on consolidating the dam for its proper functioning.

Table 2

**Coordinates of control points**

| Point | Relative static GNSS measurements | | |
|---|---|---|---|
| | X (m) | Y (m) | Z (m) |
| B1 | 641235.174 | 656114.608 | 87.032 |
| B2 | 641233.023 | 656073.577 | 88.785 |
| B3 | 641362.707 | 656144.724 | 88.478 |
| B4 | 641360.791 | 656156.363 | 88.407 |

The GNSS monitoring method assumes the first measurement as a reference (reference epoch). Future measurements will relate to the first measurement.

The application of GNSS measurement technology has the advantage of not requiring visibility between the points of the geodetic network but from each station a free horizon above the elevation of 15º is necessary. Thus, in order not to create visibility problems for satellites, points stationed with GNSS receivers should not be obstructed by dense vegetation, tall buildings, etc., which may interfere with the received satellite signal. Also, the geometric distribution and the number of satellites in the sky can limit the final accuracy of the measurements even if the individual phase observations from different satellites can be very accurate. This effect is also called dilution of precision (DOP) and its values are increased when parts of the sky are obstructed by artificial structures. All these sources of error must be eliminated in order to obtain millimeter accuracy using GNSS technology. A problem in tracking dams is the location of monitoring points adjacent to the dam walls, thus restricting the visibility of the satellite and the appearance of the multipath effect.

Multipath (*figure 9*) is a disturbance of the satellite signal resulting from the fact that the signal received by the GPS antenna includes both

the direct component and the signals reflected from walls, water surfaces etc.

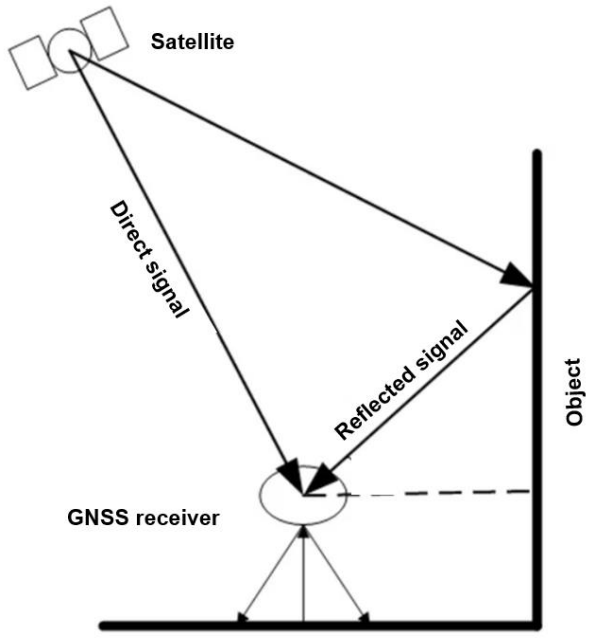



Figure 9 **Schematic representation of the multipath error in the process of performing measurements with GNSS technology** (source: Dai W. *et al*, 2017)

## CONCLUSIONS

As part of the dam monitoring activity, for a good safety in their operation it is necessary to use modern tracking methods, which require the use of high-performance equipment and software to take and process data with high precision.

The local geodetic network created allows the performance of some measurement cycles and their comparison with the measurements from the reference epoch.

Making topographic surveys and drawing up situation plans and cross-sectional profiles allow the detection of trends of loss stability of slopes by traking the level differences recorded .

Making measurements using GNSS technology can highlight the evolution over time of a component element or the entire earth dam.

The relative static measurement method provides higher accuracy in determining the coordinates of the tracked points, compared to the differential RTK method.

## REFERENCES

**Andrei C.O., Cârdei M.**, **2013** - *On the performance of real-time network-based GNSS Positioning*, Revcad, ”1 Decembrie 1918” University, Alba Iulia, 15:13-22, ISSN 2068-5203.

**Boboc V.**, **Mitroi R**., **2016** - *Modeling of earth dams failure*, Revista Lucrări științifice.Seria Agronomie, 59(2):23-28, ISSN 1454-7414.

**Chirilă C., Căsăndrescu I.A.**, **2015** - *Study on application of microtrilateration geodetic network for monitoring of hydrotechnical constructions*, RevCAD, Univ. “1 Decembrie 1918” din Alba Iulia, 19:41-48, ISSN 2068-5203.

**Diac M.**, **2020** - *Poziționare prin metode GNSS*, note de curs.

**Julianto E.N., Safrel I., Taveriyanto A.**, **2018** - *High accuracy geodetic control point measurement using GPS geodetic with static method*, Jurnal Teknik Sipil & Perencanaan, 20 (2), pp. 81-89.

**Luca M., Avram M., Lateș I.**, **2016** - *The influence of hidroclimatic risk factors on the evolution of natural sites*, Revista Lucrări științifice USAMV Iași, seria Horticultură, 59(1):207-212, ISSN 2069-8275.

**Luca M., Luca A.L., Toma D., Tămășanu F.**, **2017** - *Update of the topographic parameters of the structural elements to the pipes network*, RevCAD, Univ. “1 Decembrie 1918” din Alba Iulia, 23:137-144, ISSN 2068-5203.

**Onu C.**, **2011** - *Current trends on monitoring the deformations of studied constructions*, RevCAD, Univ. “1 Decembrie 1918” din Alba Iulia, vol. 11, pp. 169-178 ISSN 2068-5203, ISSN-L 2068-519X.

**Sbiera B.**, **2006** - *Documentație de expertiză privind evaluarea stării de siguranță în exploatare a amenajării piscicole Podișu pe râul Valea Oii, jud. Iași*, pp. 19-50.

**Tănăsescu M.**, **2018** - *Documentație de expertiză privind reevaluarea stării de siguranță în exploatare a acumulării Podișu, jud. Iași*, pp. 1-32.

**Dai W., Shi Q., Cai C., 2017** - *Characteristics of the BDS carrier phase multipath and its mitigation methods in relative positioning,* Sensors, vol. 17(4):2-15.

# SUNFLOWER GENOTYPES FROM NARDI FUNDULEA IN FIELD INFESTATION WITH BROOMRAPE IN BRAILA AREA, IN YEAR 2019

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**Abstract**

In south-east of Romania is present the most dangerous races of parasite *Orobanche cumana* and because of that, who want to cultivated sunflower hybrids, has low seed yield do to broomrape attack. In year 2019, in Braila area, in sunflower fields natural infested with the new races of broomrape from Romania, we tested many sunflower genotypes for resistance/tolerance to this parasite. We want to identifying sunflower genotypes who are resistant/tolerant to broomrape present in Brăila area and from 20 sunflower experimental hybrids tested in natural infested field in three epochs, no one was resistant at broomrape attack. The highest intensity of broomrape attack was in epoch I who was sowing on date May 3, 2019 and sunflower hybrid H2 has 520 broomrape\44 sunflower plants. The lowest intensity of broomrape attack was in epoch II who was sowing on date May 17, 2019 and sunflower hybrid H19 has 40 sunflower plants\13 broomrapes. Sunflower hybrid H17 has a better tolerance at broomrape then other 19 sunflower hybrids tested in field with natural infestation with parasite *Orobanche cumana*, from Brăila area, Romania where is present races G and H. Regarding plant height of sunflower hybrids tested, was between 90 cm (H10) and 135 cm (H6) in first epoch and between 145 cm (H2) and 200 cm (H9) in the second epoch.

**Key words**: broomrape, sunflower, genotypes, infestation

Broomrape (*Orobanche cumana* ) causes a low seed yield of sunflower in fields infested with this parasite (Yang C. *et al*, 2020) and because of that must sowing resistant hybrids who has integrated gene *Or*. Broomrape is present in many countries over the word (Dedić B. *et al*, 2018; Shi B. and Zhao J., 2020) and in other countries just appear (Nabloussi A. *et al*, 2017; González-Cantón E. *et al*, 2019). Parasite *Orobanche cumana* causes low seed yield, small head diameter, small plant height, small hectolitre weight, low one thousand seed yield (TSW) and for they who cultivated sunflower in field infested with this parasite with races G and H is a big problem (Duriez P. *et al*, 2019).

## MATERIAL AND METHOD

We sowing 20 experimental sunflower hybrids, from H1 to H20, created at NARDI Fundulea, on two rows, 4 m long, in field infested natural with broomrape, in Braila area, in year 2019, in three epochs, I, II and III. First epoch was sowing on date 3.05.2019, second was sowing on date 17.05.2019 and third was sowing on date 30.05.2019. In flowering time, we make notation about broomrape attack, head diameter and plant height, of sunflower genotypes tested in natural conditions.

## RESULTS AND DISCUSSIONS

In flowering time, sunflower hybrids from H1 to H20, was tested in epoch I, in a field with high infestation with broomrape (*table 1*).

Head diameter of sunflower hybrids was between 7 cm (H10 and H18) and 15 cm (H11, H13 and H16).

Plant height of sunflower hybrids was between 90 cm (H10) and 135 cm (H6).

Number of broomrape per two rows with sunflower hybrid was between 50 (H17) and 520 (H2).

In flowering time, sunflower hybrids from H1 to H20, was tested in epoch II (*table 2*) and has head diameter between 12 cm (H7) and 23 cm (H9 and H10).

Plant height of sunflower hybrids was between 145 cm (H2) and 200 cm (H9).

Number of broomrape per two rows with sunflower hybrid was between 13 (H19) and 170 (H1).

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In flowering time, sunflower hybrids tested in epoch III (*table 3*), has head diameter between 7 cm (H18) and 15 cm (H3 and H16).

Plant height of sunflower hybrids was between 80 cm (H4) and 135 cm (H6).

Number of broomrape per two rows with sunflower hybrid was between 1 (H19) and 58 (H13).

Sunflower hybrids sowing on date 30.05.2019 in epoch III, has a small number of plants in flowering time.

Sunflower hybrids tested, has a bigger intensity of broomrape attack in epoch I, then second and third epoch, especially at H1 and H2 (*figure 1*).

Sunflower hybrids tested, has a bigger head diameter in epoch II, then first and third epoch, especially H9 and H10 (*figure 2*).

Sunflower hybrids tested has a bigger plant height in epoch II, then first and third epoch, especially at H6, H7, H8, H9 and H17 (*figure 3*).

Table 1

**First epoch with sunflower genotypes tested for resistance\tolerance to broomrape in Braila area, in year 2019**

| Sunflower genotype | Head diameter | Plant height | Sunflower plants\broomrape plants |
|---|---|---|---|
| H1 | 11 cm | 115 cm | 50 sunflower plants\250 broomrape |
| H2 | 10 cm | 105 cm | 44 sunflower plants\520 broomrape |
| H3 | 10 cm | 100 cm | 50 sunflower plants\70 broomrape |
| H4 | 10 cm | 100 cm | 48 sunflower plants\80 broomrape |
| H5 | 12 cm | 105 cm | 49 sunflower plants\90 broomrape |
| H6 | 11 cm | 135 cm | 49 sunflower plants\120 broomrape |
| H7 | 14 cm | 130 cm | 55 sunflower plants\100 broomrape |
| H8 | 11 cm | 125 cm | 50 sunflower plants\80 broomrape |
| H9 | 9 cm | 105 cm | 46 sunflower plants\70 broomrape |
| H10 | 7 cm | 90 cm | 46 sunflower plants\110 broomrape |
| H11 | 15 cm | 120 cm | 44 sunflower plants\70 broomrape |
| H12 | 12 cm | 130 cm | 41 sunflower plants\60 broomrape |
| H13 | 15 cm | 130 cm | 44 sunflower plants\100 broomrape |
| H14 | 13 cm | 125 cm | 47 sunflower plants\120 broomrape |
| H15 | 13 cm | 110 cm | 36 sunflower plants\70 broomrape |
| H16 | 15 cm | 115 cm | 44 sunflower plants\70 broomrape |
| H17 | 12 cm | 115 cm | 52 sunflower plants\50 broomrape |
| H18 | 7 cm | 95 cm | 44 sunflower plants\85 broomrape |
| H19 | 12 cm | 125 cm | 42 sunflower plants\90 broomrape |
| H20 | 13 cm | 115 cm | 44 sunflower plants\70 broomrape |

Table 2

**Second epoch with sunflower genotypes tested for resistance\tolerance to broomrape in Braila area, in year 2019**

| Sunflower genotype | Head diameter | Plant height | Sunflower plants\broomrape plants |
|---|---|---|---|
| H1 | 16 cm | 165 cm | 49 sunflower plants\170 broomrape |
| H2 | 15 cm | 145 cm | 31 sunflower plants\40 broomrape |
| H3 | 16 cm | 170 cm | 40 sunflower plants\48 broomrape |
| H4 | 15 cm | 175 cm | 47 sunflower plants\40 broomrape |
| H5 | 15 cm | 180 cm | 53 sunflower plants\65 broomrape |
| H6 | 17 cm | 195 cm | 45 sunflower plants\70 broomrape |
| H7 | 12 cm | 195 cm | 42 sunflower plants\43 broomrape |
| H8 | 21 cm | 195 cm | 36 sunflower plants\55 broomrape |
| H9 | 23 cm | 200 cm | 42 sunflower plants\45 broomrape |
| H10 | 23 cm | 170 cm | 40 sunflower plants\45 broomrape |
| H11 | 19 cm | 185 cm | 45 sunflower plants\38 broomrape |
| H12 | 18 cm | 175 cm | 44 sunflower plants\25 broomrape |
| H13 | 21 cm | 190 cm | 42 sunflower plants\60 broomrape |
| H14 | 20 cm | 175 cm | 38 sunflower plants\20 broomrape |
| H15 | 15 cm | 180 cm | 40 sunflower plants\48 broomrape |
| H16 | 16 cm | 175 cm | 41 sunflower plants\35 broomrape |
| H17 | 15 cm | 195 cm | 41 sunflower plants\30 broomrape |
| H18 | 17 cm | 170 cm | 42 sunflower plants\43 broomrape |
| H19 | 16 cm | 175 cm | 40 sunflower plants\13 broomrape |
| H20 | 18 cm | 180 cm | 40 sunflower plants\28 broomrape |

Table 3

**Third epoch with sunflower genotypes tested for resistance\tolerance to broomrape in Braila area, in year 2019**

| Sunflower genotype | Head diameter | Plant height | Sunflower plants\broomrape plants |
|---|---|---|---|
| H1 | 10 cm | 130 cm | 17 sunflower plants\3 broomrape |
| H2 | 10 cm | 125 cm | 22 sunflower plants\2 broomrape |
| H3 | 15 cm | 125 cm | 10 sunflower plants\8 broomrape |
| H4 | 9 cm | 80 cm | 12 sunflower plants\2 broomrape |
| H5 | 12 cm | 120 cm | 10 sunflower plants\3 broomrape |
| H6 | 11 cm | 135 cm | 7 sunflower plants\2 broomrape |
| H7 | 14 cm | 130 cm | 15 sunflower plants\25 broomrape |
| H8 | 11 cm | 125 cm | 10 sunflower plants\15 broomrape |
| H9 | 11 cm | 125 cm | 4 sunflower plants\2 broomrape |
| H10 | 12 cm | 125 cm | 14 sunflower plants\19 broomrape |
| H11 | 11 cm | 100 cm | 18 sunflower plants\13 broomrape |
| H12 | 13 cm | 120 cm | 25 sunflower plants\28 broomrape |
| H13 | 13 cm | 120 cm | 23 sunflower plants\58 broomrape |
| H14 | 12 cm | 120 cm | 18 sunflower plants\25 broomrape |
| H15 | 13 cm | 115 cm | 18 sunflower plants\29 broomrape |
| H16 | 15 cm | 110 cm | 8 sunflower plants\13 broomrape |
| H17 | 12 cm | 115 cm | 10sunflower plants\12 broomrape |
| H18 | 7 cm | 95 cm | 10 sunflower plants\17 broomrape |
| H19 | 12 cm | 125 cm | 2 sunflower plants\1 broomrape |
| H20 | 13 cm | 115 cm | 3 sunflower plants\8 broomrape |

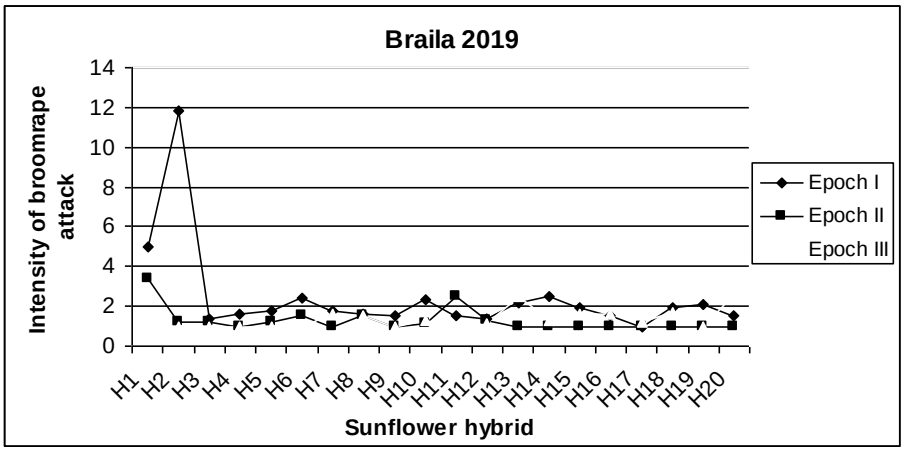



Figure 1 **Intensity of broomrape attack in Braila area, in year 2019**

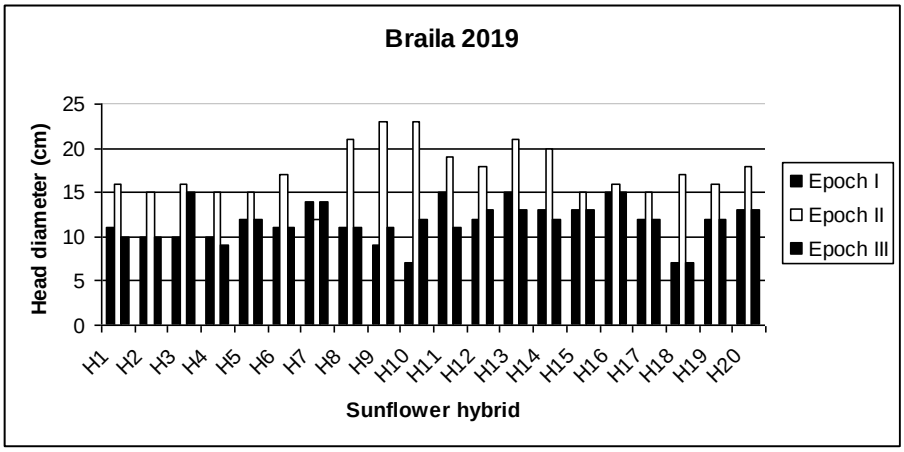



Figure 2 **Head diameter of sunflower hybrids in field infested with broomrape, in Braila area, in year 2019**

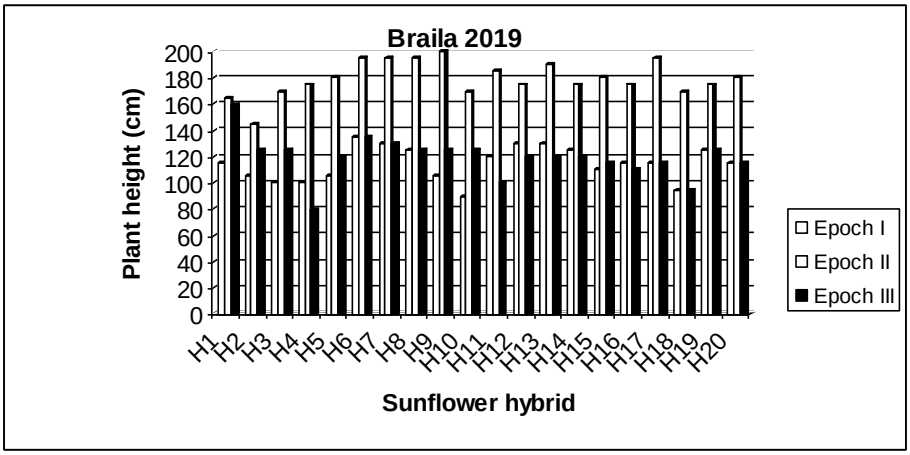



Figure 3 **Plant height of sunflower hybrids in field infested with broomrape, in Braila area, in year 2019**

## CONCLUSIONS

Infestation with broomrape seeds is no uniform distributed in all three epochs, and because of that in epoch I, sunflower hybrids tested, was very small due to a biggest infestation.

It is a big difference between epoch I and epoch II, regarding plant height, head diameter and intensity attack with broomrape, who influence seed yield of sunflower hybrids.

All sunflower hybrids tested, was sensible to races of broomrape present in Braila area, in year 2019.

From all sunflower hybrids tested, H17 has a better tolerance then other, in epochs I, II and III with a lowest intensity of broomrape attack.

## REFERENCES

**Dedić B., Miladinović D., Jocić S., Cvejić S., Jocković M., Miklič V., 2018** - *Increase in virulence of sunflower broomrape in Serbia***. In** Proceedings of 4th International Symposium on Broomrape in Sunflower, Bucharest, Romania, 2-4 July 2018, p. 29-37.

**Duriez P., Vautrin S., Auriac M.C., Bazerque J., Boniface M.C., Callot C., Carrère S., Cauet S., Chabaud M., Gentou F., Lopez-Sendon M., Paris C., Pegot-Espagnet P., Rousseaux J.C., Pérez-Vich B., Velasco L., Bergès H.,l Piquemal J., Muños S., 2019-** *A receptor-like kinase enhances sunflower resistance to Orobanche cumana* | *Request PDF*. Available from: https://www.researchgate.net/publication/337847124_A_receptor-like_kinase_enhances_sunflower_resistance_to_Orobanche_cumana [accessed Nov 03 2020].

**González-Cantón E., Velasco A., Velasco L.,. Pérez-Vich B., Martín-Sanz A., 2019 -** *First report of sunflower broomrape (Orobanche cumana Wallr.) in Portugal.* In Plant Disease. DOI: 10.1094/PDIS-10-18-1723-PDN

**Yang C., Fu F., Zhang N., Wang J., Hu L., Islam F., Bai Q., Yun X., Zhou W., 2020. -** *Transcriptional profiling of underground interaction of two contrasting sunflower cultivars with the root parasitic weed Orobanche cumana*. Plant Soil, from https://doi.org/10.1007/s11104-020-04495-3.

**Nabloussi A., Velasco L., Assissel N., 2017 -** *First report of sunflower broomrape, Orobanche Cumana Wallr in Morocco*. In Plant Diseases, 102:457–457.

**Shi B. and Zhao J., 2020 -** *Recent progress on sunflower broomrape research in China***.** In OCL 2020, 27- 30.

# RESEARCH ON THE PHYSICO – CHEMICAL CHARACTERIZATION OF IMPROVED GENOTYPES FOR *LYCOPERSICON ESCULENTUM* MILL. OBTAINED IN THE ECOLOGICAL SYSTEM

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**Abstract**

Currently, world, horticultural producers and processors are concerned to obtain high quality organic products in conditions of economic profitability. The main aim of the research is to highlight the physico – chemical characteristics of some improved genotypes from the species *Lycopersicon esculentum Mill.* obtained in ecological system in the experimental field within USAMV Iasi in 2019. Thus, the aim was to highlight some qualitative parameters, respectively: titrable acidity, pH value, total dry matter content, soluble dry matter, vitamin c, carotene and lycopene content. The biological material was represented by 37 improved tomato genotypes in order to ensure competitive horticultural techniques. The 37 genotypes of *Lycopersicon esculentum Mill.* showed an average value of the total dry matter content of 7.07 ± 0.5%, showing an oscillating amplitude of the lower delimited values of 4.64% (G223) and 17.9% (G265). The average pH value was 4.4 with limits that fell within the range of variation [4.15 – 4.85]. The content of vitamin C ranged between 14 mg/ 100 g and 29 mg/ 100 g. Other components with antioxidant value that have been shown in important proportions are represented by carotenes (2.36 – 21.22 mg/ 100 g) and lycopene (3.01 – 33.7 mg/ 100 g). This research results strengthens the data in the literature referring to the bioactive compounds of tomatoes emphasizing that the study was conducted for different genotypes grown in organic conditions.

**Key words**: tomatoes, chemical composition, carotenes, lycopene

Current studies investigate how consumers perceive the attributes of organic horticultural products, which in turn contribute to consumer's attitudes and intentions towards this category of products. The improvement of the assortment of tomato hybrids and cultivars is permantely needed, in order to satisfy the market request (Brezeanu P.M. *et al,* 2019).

Specifically, consumer's perceptions of the nutritional contributions (Robu M. *et al,* 2019), ecological well-being and price of organic products (Brezeau P.M. *et al,* 2020) have strong effects on the utilitarian and hedonic attitude towards organic farming on the purchase of organic products from the commercial network (Brezeanu P.M. *et al,* 2016). Through the improvement of characteristics of tomatoes regarding the resistance to diseases, pests and unfavorable environmental factors, the possibility of pollution of the obtained food product and the agricultural ecosystem is strongly diminished (Brezeanu P.M. *et al,* 2019).

Some of the core values of consumers are health and welfare (Predescu C.N. *et al,* 2019, Schiffman and Kanuk, 2010) as evidenced by the growing number of consumer who are concerned about the nutritional (Murariu O.C. *et al,* 2016; 2018) and antioxidant value of the foods they eat (USDA, 2001; 2002), trying to follow a healthy diet, consuming properly preserved foods without toxic residues, that can reduce the risk of obesity and chronic diseases (Miller and Cassady, 2012, Gonciarov M. *et.al,* 2015, Petcu C.D. *et al,* 2014, Petcu C.D. *et al,* 2019). As a result, when consumer decide to buy food, their health – related attributes become important (Petcu CD *et al,* 2020, IFICF, 2020).

This trend may contribute to increased sales of organic products, because organic foods are generally considered to have a higher nutritional content (Lea and Worsley, 2005).

Another reason for the increase in production and demand for organic products would be to prevent negative consequences for the environment. It should be noted that organic products are not grown or processed with conventional pesticides, synthetic fertilizers,

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bioengineering techniques or ionizing radiation (USDA, 2007).

According to national survey conducted by Simmons on consumer awareness of the economic impact, it was concluded that more than a third of consumers indicated that they are willing to pay more for environmental safety or ethical products than for conventional products (Socially Conscious Consumerism, 2007).

Data on some quality indices of organic horticultural products, which could contribute to the formation of an overview of the nutritional and safety properties of these products, appear with a fairly low frequency in the reference literature, especially when the consumer is interested in organic products that could be marked at present in Romania.

Changes in soil microbiota are an early and sensitive indicator of soil pollution being easly to measure accurately across a wide range of soil types and conditions (Ulea E. *et al*., 2017).

To be successful, growers must produce a high yield of high-quality fruit, while holding production costs as low as possible (Brezeanu P.M., *et al.*, 2019). Therefore, many of the breeding goals focus on characteristics that reduce production costs or ensure reliable production of high yields with highquality fruits (Yuling and Lindhout, 2007).

Tomatoes occupy one of the main places amoung the vegetable of horticultural species grown in areas with temperate climates, both in terms of production volume and demand on the markets. These products are foods of plant origin characterized by taste qualities, nutritional value, therapeutic and prophylactic; they can be eaten fresh as well as canned (Murariu O.C. *et al*, 2014;2015).

The main aim of the present research is to highlight the physico – chemical characteristics of fruits from the species *Lycopersicon esculentum*, obtained in ecological system. The main objectives were to highlighting the acidity of the genotypes (titrable and pH value), water content, total dry matter, vitamin C, sugars and pigments for some improved tomato genotypes organically grown.

## MATERIAL AND METHOD

As the research topic includes aspects related to some nutritional, physico – chemical, technological and sensory properties of horticultural products, for obtaining and interpreting scientific data, the research activity was carried out in several laboratories within the University of Agricultural Sciences and Veterinary Medicine of Iași. The practical activities took place between July and September 2019.

The laboratories in which the research was conducted have equipment, glassware, utensils and reagents that have led to conclusive results. The following equipments was used for the physico – chemical analyzed: scale, oven, analytical balance, Zeiss refractometer, hand press, water bath, pH – meter, spectrophotometer UV-1700 and Spekol 1100 spetrophotometer.

The main objective of the research was to monitor the physico – chemical properties of vegetables represented by 37 different genotypes of *Solanoceae* fuits vegetable represented by improved *Lycopersicon esculetum Mill.* tomatoes.

The material studied was cultivated in the experimental fields of USAMV Iași in an ecological system. The genotypes thus cultured were grouped into different experimental categories, coded as follows: G90, G86, G195, G202, G259, G186, G223, G256, G261, G258, G254, G228, G255, G262, G92, G85, G99, G270, G187, G220, G194, G94, G221, G196, G272, G279, samples harvested in august and G84, G184, G198, G200, G222, G263, G264, G265, G267, G271 and blak tomato harvested in September.

The quality of the biological material obtained in the ecological system harvested in August and September by improving some tomato genotypes was evaluated in the research laboratories of the USAMV Iași by determining the main chemical components: total dry matter, soluble dry matter, acidity expressed in predominant acid, pH – value, vitamin C content, β – carotene and lycopene.

The biological material was used for physico – chemical determinations performed in order to argue the nutritional profile rich in antioxidants of improved genotypes grown in ecological conditions.

The soluble dry matter content was determined on the juice extracted from the samples by using the Zeiss refractometer by automatic reading and temperature control at $20^0$C, pH value and titrable acidity were determined by the filtered acid extract of the samples analyzed. The pH value was determined using *Hanna Instruments* device which was previously calibrated in the range of 4.01 – 7.01 – 4.01. The titratable acidity was determined by titration with a 0.1 N NaOH solution in the presence of color indicators, respectively phenophtalein/ thymophthalein, being expressed in the predominant acid (citric acid%). The total dry matter content was determined by drying in an oven at $70^0$C for 20 hours.

The total content of L – ascorbic acid (vitamin C) was determined by extraction with 2% oxalic acid and titration with 2.6 – dichlorphenol indophenol.

The pigments represented by β – carotene and lycopene were evaluated spectrophotometrically. These were extracted with petroleum ether and the quantitative dosing was performed spetrophotometrically UV 1700 against

a blank of petroleum ether at wavelengths of 452 nm for carotene and 472 nm for lycopene.

## RESULTS AND DISCUSSIONS

In Romania, tomatoes are annual plants, although in their areas of origin they behave like perennials. In greenhouse conditions, tomatoes can vegetate for many years (Brezeanu P.M. *et al*, 2020).

Tomatoes are classified according to several criteria: according to the destination of production (for fresh consumption and for industrialization), according to the shape of the fruit (spherical, ribbed, oblong/ elongated, cherry) and according to the color of the fruit (red, pink, orange, yellow).

The fruit is a fleshy berry of different shapes, colors and sizes, depending on the variety of hybrid grown. The shape of the fruit is given by the shape index (IS = h/D, where h = height; D = diameter of the fruit).

If the shape index is equal to or close to 1, the fruits are spherical. If the shape index is less than 1, the fruit is flattened. If the shape index is less than 1, the fruits are elongated.

The color of the fruit can be red, of different shades, orange or yellow, pink. The color of the red and pink fruits is due to the carotenoid pigments contained in the pulp (the lycopene that dominates that β – carotene up to 13 times), over which the epidermis of the fruit, yellow or colorless. When fruits contain more β - carotene than lycopene, they are yellow – orange.

Before ripening, the color of the fruit is light green uniform or green with a darker shade around the stalk. The persistence of the yellow – green area around the peduncle and after ripening is a defect that depreciates the quality of the fruit.

The size of the fruit is most often appreciated by weight and varies within very wide limits, from 30 – 40 g to 300 – 500 g and even 800 g, depending on the variety and cultivation technology (Brezeanu P.M. *et al*, 2020). Cherry tomatoes have small fruits, only a few grams.

Tomatoes are covered with an elastic skin. The pulp is the most valuable part of the fruit, being rich in sugars, vitamins and minerals.

According to data from the literature (Jaramillo *et al*, 2007) tomatoes are rich in vitamins such as A, $B_1$, $B_2$, $B_6$, C, E minerals such as potassium, magnesium, manganese, zinc, copper, sodium, iron and calcium.

Therefore, tomatoes are a very important source for human nutrition because they have many bioactive compounds (Hallmann E. *et al*, 2013). Numerous studies worldwide have indicated that organic tomatoes have a high content of biologically active compounds compared to conventional tomatoes (Juroszc *et al*, 2009; Hallmann E *et al*, 2007; 2013).

A diet rich in vegetables can be associated with a reduced risk of many diseases related to aging and modern life (Marti R. *et al.*, 2016). Many researchers have pointed out the relation between the intake of bioactive compounds present in tomato and a reduced risk of cancer. These bioactive compounds comprise phytochemicals such as carotenoids and polyphenols (Marti R. *et al.*, 2016).

The values of the primary statistical estimators corresponding to the data characterizing the degree of dispersion of the results obtained for water content, total dry matter, soluble dry matter, vitamin C, carotene, lycopene and acidity values for the 37 tomato genotypes (*Lycopersicon esculentum*) were reduced.

Thus, the standard error of the mean was within the limits of 0.02 – 1.51. Analyzing in terms of homogeneity of results for the parameters studied, the results obtained for water content (3.2%) and pH values (4.3%), being below the threshold of 5%, a relative homogeneity for soluble dry matter content values (15,4%) was within the 15% threshold while the results obtained for the other parameters were not not homogenous (*table 1*).

The 37 genotypes of *Lycopersicon esculentum* showed an average value of the total dry matter content of 7.7 ± 0.5%, thus highlighting an oscillating amplitude of the values obtained that were within the minimum value limit of 4.6% (G223) and the maximum of 17.9% for G265 (*table 1*).

The water content was inversely proportional to the total dry matter content, with a range of variation of less than 82.1% for G265 and more than 95.4% for G223. The mean of water content for the 37 genotypes of *Lycopersicon esculentum* is 92.3 ± 0.5%.

Referring to the data presented in the literature, which specifies an average water content of ripe fruit for the tomato species of 94%, it is clear that most genotypes have values that fall around this value, except for genotypes G184, G263, G265 and G267 showing lower values delimited by the range 82.1 – 86.9% (*table 1*).

Table 1

**Estimators of the physico – chemical parameters of the genotypes of *Lycopersicon esculentum* cultivated in ecological system** (TDM – total dry matter, AT – titrable acidity; SDM – soluble dry matter)

| GENNOTIP | $H_2O$,% | TDM, % | pH | AT (citric acid) | SDM, % | Vit. C, mg/100g | Caroten, mg/100g | Licopen, mg/100g |
|---|---|---|---|---|---|---|---|---|
| n | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 |
| Average | 92.3 | 7.70 | 4.4 | 0.4 | 5.6 | 18.7 | 9.12 | 14.1 |
| Variation | 9.07 | 9.07 | 0.04 | 0.01 | 0.75 | 18.44 | 14.60 | 84.16 |
| Standard deviation | 3.01 | 3.01 | 0.19 | 0.12 | 0.87 | 4.29 | 3.82 | 9.17 |
| Mean standard deviation | 0.50 | 0.50 | 0.03 | 0.02 | 0.14 | 0.71 | 0.63 | 1.51 |
| Coefficent of variation | 3.3 | 39.1 | 4.3 | 28.6 | 15.4 | 22.9 | 41.8 | 65.4 |
| Minimum | 82.09 | 4.64 | 4.15 | 0.192 | 4.4 | 14 | 2.36 | 3.01 |
| Maximum | 95.4 | 17.9 | 4.85 | 0.64 | 7.8 | 29 | 21.2 | 33.7 |

The Analyzing the pH values identified for the representative samples of 4.4 ± 0.03 with the limits between the minimum value of 4.15 and the maximum value of 4.85. The mean of soluble dry matter content values defined a delimited range of variation of less than 4.4% (G261, G259 and G94) and more than 7.8% (G92). The identified sugar content values for G92 and G265 genotypes showed dominant superiority.

Vitamin C has values that fall within a range defined by the minimum limit of 14 mg/ 100 g and the maximum of 29 mg/ 100 g with an average of 18.7 mg/ 100 g. Compared to the values presented in the literature, there is a range in the domain of 15 – 30 mg/ 100 g.

It is also possible to analyze the role of tomatoes obtained in the ecological system as a source for natural carotenoids. The average value of carotenoids is 9.15 mg/ 100 g defined by the lower delimited range of 2.36 mg/ 100 g and upper of 21.22 mg/ 100 g. The values obtained for the 37 genotypes studied showed an oscillating trend. The following genotypes are highlighted by superiority in terms of carotene content: G290 with 21.2 mg/ 100 g, G270 with 17.35 mg/ 100 g, G85 with 13.5 mg/100 g, G184 with 13.8 mg/ 100 g, G279 with 12.7 mg/100 g, G228 with 12.06 mg/ 100 g, G271 with 11.3 mg/ 100 g and G187 with 11.2 mg/100 g (*figure 1*).

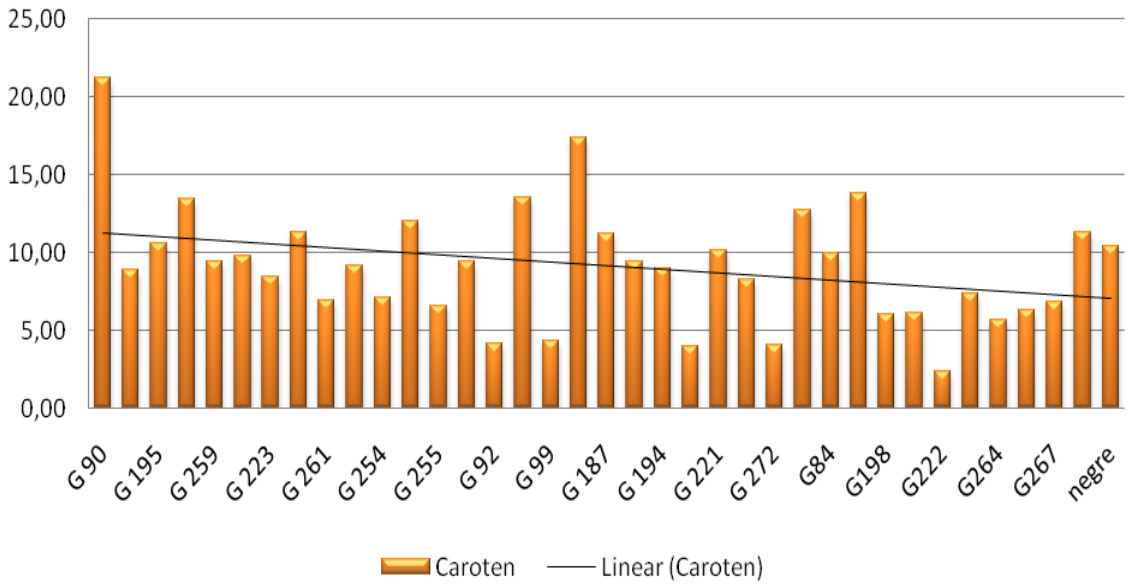



Figure 1 **The carotene content (mg/ 100g) from *Lycopersicon esculentum* genotypes**

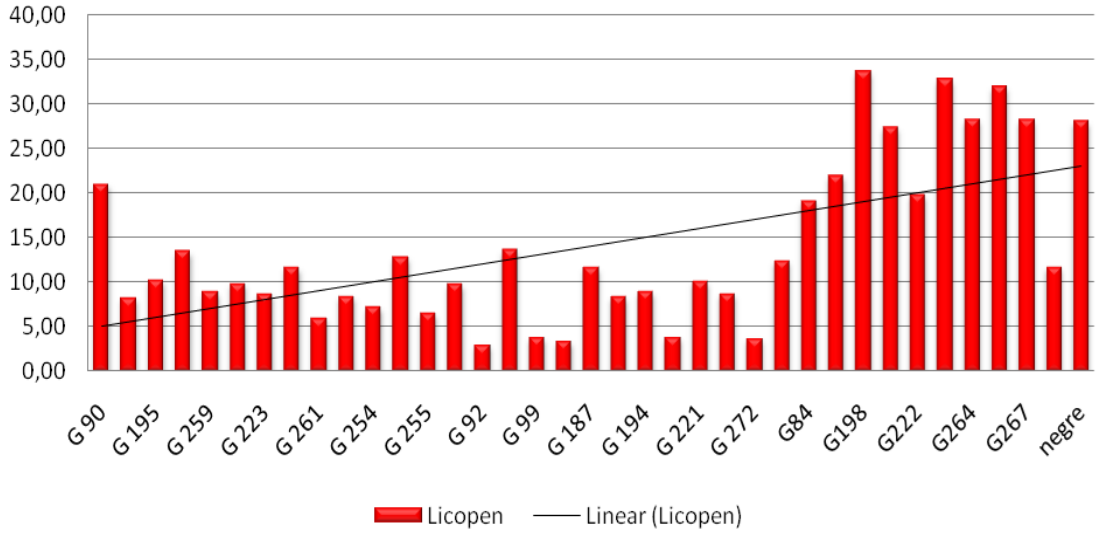



Figure 2 **The lycopene content (mg/ 100g) from Lycopersicon esculentum genotype**

The lycopene content of tomatoes falls within the range defined by 3.01 and 33.7 mg/100 g with a mean value of 14.03 ± 1.51 mg/ 100 g. the

The oscillating amplitude of the lycopene content values for the 37 genotypes determined a lack of homogeneity of the values for this parameter, exceeding the threshold of 15% with a value of the coefficient of variability of 65.4% (*figure 2*).

## CONCLUSIONS

Consequently, tomatoes provide a convient matrix through which nutrients and other components play a beneficial role in consumer health. Tomatoes are rich in vitamin C, lycopene and β – carotene. Compared with phyto – nutrients, the most abundant components in tomatoes are carotenoids.

Lycopene is the most predominant carotenoid, followed by β – carotene. The antioxidant activity of lycopene as well as β – carotene along with the abundance of this in tomatoes make this food a rich source of antioxidant activity.

The remarkable results from the antioxidant point of view of the improved genotypes of tomatoes G198 and G90 are highlighted by the high values in the most important antioxidants, respectively lycopene is presented with a value of 33.8 mg/ 100 g (G198); 32.8 mg/ 100 g (G263); 32.03 mg/ 100 g (G265) and 21.06 mg/ 100 g (G90) and carotene with 21.2 mg/ 100 g (G90); 13.8 mg/ 100 g (G84); 13.4 mg/ 100 g (G202) and vitamin C with 29 mg/ 100 g (G92).

## ACKNOWLEGMENTS

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## REFERENCES

**Brezeanu P.M., Brezeanu C., Ambăruş S., Antal C.A., Calin, M. 2020** - *Effects of limited irrigation on tomato, pepper and mung bean genotypes*, Acta Hortic. 1268: 85-94.

**Brezeanu P.M., Brezeanu C., Ambarus S., Voda A., Robu T., Cristea T.O. and Calin M., 2020 -** *The influence of grafting on yield and quality of peppers, eggplants, tomatoes and melons*, Acta Hortic. 1270: 347-354.

**Brezeanu P.M., Brezeanu C., Silvica Ambăruş, 2019** - *Study of some tomatoes breeding lines for development of new varieties and hybrids*. Studii şi Cercetări Martie 2019 Biologie, Universitatea ”Vasile Alecsandri” din Bacău, 28(1): 51-54.

**Brezeanu P.M., Brezeanu C., Ambarus S., Calin M., Cristea T.O. and Draghici E., 2016** - *Identification and study of useful germplasm resources for tomato breeding*, Acta Hortic., 1127: 331-338.

**Gonciarov M. Neagu I, Ghimpețeanu O.M, Petcu C.D, 2015** - *General principles and regulations on obtaining products from genetically modified organisms*, Journal of Biotechnology, 208 Supplement S: S72.

**Hallmann Ewelina și Rembialkowska E, 2007** – *Estimation of fruits quality of selected tomato cultivars (Lycopersicon esculentul mill) from organic and conventional cultivation with special consideration of bioactive compounds content*, J. Res. Appl. Agric. Engng, 52(2): 55 – 60.

**Hallmann Ewelina, Lipowski J. Marszalek K. și Rembialkowska E., 2013** – *The seasonal variation in bioactive compounds content in juice from organic and non-organic tomatoes*, Plant foods for human nutritions, 68: 171 – 176.

**Jaramilo J., Rodriguez V. Guzman M., Zapata M. and Rengifo T., 2007** – *Technical manual – Good Agricultural practices in the production of tomato under protected conditions*, FAO.

**Juroszc P., Lumkin H., Yang R.Y., Ledesma D.R. Ma C. H. 2009** – *Fruit quality and bioactive compounds with antioxidant activity of tomatoes grown on farm comparison of organic and conventional system*, J. Agric. Food Chem, 57: 1188 – 1194.

**Marti R., Salvador R. and Jaime C.C., 2016** – *Tomato as a Source of carotenoids and polyphenols targeted to cancer prevention,* Cancers (Basel), 8(6): 58.

**Murariu O.C., Murariu F., Velești I., 2014 -** *The effects of processing on the vitamin C in peach compote, preserve and jam destinated for the retail*, Journal of Bioechnology, 185: S80.

**Murariu O.C., 2015** – *Research regarding the influence of storage condition on broccoli vitamin C content*, 58(2): 217 – 220.

**Murariu O.C., Irimia L.M., Diaconu C.M., Murariu F.,** 2016 – *The right of a healthy live provided by a healthy eating support*, Revista Universul Juridic, v. 169.

**Murariu O.C., Irimia L.M., Rbu T., Murariu F. and Arsenoaia V., 2018** – *The influence of storage condition on some bioactive compounds of berrie fruits and those human health promoting*, Lucrări Științifice, Seria Agronomie, 61(2): 222 – 228.

**Petcu C.D. Șulea C. and Mihalache D., 2014** – *Audit of Producers/Users of Compressed Air and Other Industrial Gases used in the Food Industry*, Quality-Access to Success, vol. 15: 138.

**Petcu C.D, Ciobotaru-Pîrvu E. Oprea O.D. and Ghimpețeanu O.M, 2020 -** *Ecological dairy products: healthy or just a trend?*, Scientific Works, series C, Veterinary Medicine, LXVI (1): 87-95.

**Petcu C.D., Georgescu I.M., Zvoristeanu O.V. and Negreanu C.N., 2019** – *Study referring to the appearance of contamination with Deoxynivalenol in grains, grains flour and bakery products on the Romanian market*, Scientific papers – series D – Animal Science, 62(2): 241 - 245.

**Predescu C.N., Ilie L.I., Georgescu M., Raita S., Ghimpețeanu O.M., 2019 -** *The effects of tomato and pepper peel carotenoids on thermal stability of sunflower oil,* J. of Biotechnology, 305, Supplement: S59.

**Robu Maria, Chiran A., Vintu C., Murariu O.C., Robu A.D and Leonte E., 2019** – *Aspects regarding the marketing strategies for small agri-food producers. A case study on Legumele de acasă Târgu Frumos*, Lucrări Științifice Seria Agronomie, 62(2): 51 - 56.

**Ulea E**., Lipșa F.D., Bălău A.M., Filipov F. And Morari E.C., 2017 – Diversity of soil bacteria as indicator of soil pollution in Moldavia region, Romania, Environmental Engineering and Management J., 16(4): 879 – 889.

**Yuling Bai, Lindhout Pim, 2007** – *Domestication and breeding of tomatoes: what have we gained and what can we gain in the future?*, Ann Bot., 100(5): 1085 – 1094.

# CROP SPECIES AND YEAR SEASONS AS DETERMINANTS OF MICROBIOTA STRUCTURE IN CHERNOZEM SOIL IN THE SOUTHEAST REGION OF MOLDAVIA, ROMANIA

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**Abstract**

In this study, we examined the diversity and abundance of microbial communities isolated from chernozem soil type in response to crop species and season from southeast region of Moldavia, Romania. Soil types, plant species, season, human activities and various land management regimes all have great impact on soil biology, but our knowledge of biodiversity of soil microorganisms is still very limited. Therefore, during 2018 we assessed the variation of microbial community in chernozem soil and its response to plant species (rapeseed, sunflower, sugar beet, wheat and maize) and season (spring, autumn). At each site, five replicate bulk samples were taken, consisting of 10 randomly collected sub-samples from the surface soil (10-15 cm horizon). The samples were transported to the laboratory, stored overnight at 4°C, air-dried at room temperature and sieved (2-mm mesh) prior to further use in the experiment. The influence of crop species and season on the total number of microorganisms (CFU $g^{-1}$), relationships between the main groups (bacteria and fungi) and the spectrum of filamentous fungi from our experiment were established. The abundance of the microbial community from all crop species were ranked as follows: wheat (19.2 x $10^6$ CFU $g^{-1}$) > sunflower (1.3 x $10^6$ CFU $g^{-1}$) > maize (1.1 x $10^6$ CFU $g^{-1}$) > sugar beet (0.6 x $10^6$ CFU $g^{-1}$) > rapeseed (0.4 x $10^6$ CFU $g^{-1}$). In case of yearly seasons, the microbial abundance decreased from spring to autumn. Occurrence and distribution of filamentous fungi isolated from soil samples provide new insights into ecology and niche specialization of several soil-borne species. Overall, genera composition of filamentous fungi from chernozem soil cultivated with different crop species was not very heterogeneous and most fungal genera were common to all location. Our results suggest that crop species and yearly seasons have a significant impact on microbial richness and diversity. Extensive use of xenobiotic compounds in agriculture will degrade soil microbial communities, because they affect directly microbial abundance and composition, and indirectly soil texture and fertility.

**Key words**: microbial community structure, chernozem soil, crop species, seasonal variation

Soil represents a habitat for many and various microorganisms that are important in recycling of plant nutrients, maintenance of soil structure, toxin removal, promoting plant growth, and suppressing soilborne plant diseases (Doran J.W. *et al*, 1996; Giller K.E. *et al*, 1998; Filip Z., 2002). Soil fertility is determined by its composition and properties (morphological, physical, chemical and biological), which have a strong impact on a range of processes influencing crop yield, including microbial diversity.

Microbial diversity (community structure) has been recommended as a biological indicator of soil quality, and describes the number of different genera/species and their relative abundance in a given community in a given habitat (Garbeva P. *et al*, 2008). The number and diversity of microbial communities in soil ecosystems have a complex relationship with the intensity of human intervention and are influenced by environmental, edaphic and management factors (Ulea E. *et al*, 2017). Lan G.Y. *et al* (2017) showed that seasonal changes explained the largest part (31.9%) of the total variance of bacterial community composition in soils from tropical region of Hainan (China). Soil bacteria were more sensitive than fungi to the fertilization practices (Ai C. *et al*, 2018). Their results suggest that different response patterns of soil bacteria and fungi to agricultural practices might have consequences for ecosystem function. Microbial community responses to alternative management may be indicative of soil quality change (Schutler M. *et al*, 2001). It is known that agricultural practices cause a loss to microbial biodiversity, and can lead to dramatic changes in bacterial compositions over a relatively short time period (Lan G.Y. *et al*, 2017). Once applied, agricultural chemicals influence directly or indirectly the agroecosystem structure and function (Joergensen R.G and Emmerling C., 2006; Lo C.C,

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2010). In case of soil microbial communities, these chemicals affect their diversity, metabolic activities, reproduction and growth. In general, application of agrochemicals initially decreases the microorganisms number and activity, but as the chemical persists microorganisms develop tolerance/resistance and recolonize the soil.

The main purpose of the present research was to investigate how the structure of microbial communities from chernozem soil type is affected by crop species (rapeseed, sunflower, sugar beet, wheat and maize) and season (spring, autumn).

## MATERIAL AND METHOD

Soils in this study were sampled from southeast region of Moldavia, Romania. Coordinates for the coverage area extended from latitude 44.935 N to 45.282 N and from longitude 27.082 E to 27.322 E. At each site, five replicate bulk samples were taken, consisting of 10 randomly collected sub-samples from the surface soil (10-15 cm horizon). Approximately 1000 g of soil was collected in sterile plastic bags from each site and any organic residue was removed from the surface before sampling.

Soil samples were collected from chernozem soil type cultivated with different plant species (rapeseed, sunflower, sugar beet, wheat and maize) under conventional agricultural conditions (synthetic pesticides and fertilizers were used). Microbial counts in the soil samples were recorded in spring (May) and autumn (September) 2018. The altitude ranges from 25 to 99 meters above sea level.

The samples were transported to the laboratory, stored overnight at 4°C, air-dried at room temperature and sieved (2-mm mesh) prior to further use in the experiment. Soils pH was determined with a glass electrode in a 1:2.5 soil to water ratio and the values covered a range between 8.1 and 8.4.

The total numbers of bacteria of colony forming units (CFUs) were determined by serial dilution and plating into nutritive media. One gram of soil was mixed with 9 mL sterile water (dilution $10^{-1}$) and then 1 mL of the dilution $10^{-1}$ was poured into 9 mL sterile water (dilution $10^{-2}$). After a successive tenfold dilution series, $10^{-2}$ to $10^{-6}$ dilution were prepared. Aliquots (1 mL) of $10^{-2}$ to $10^{-6}$ dilution were spread on nutritive media for assessing the total number of bacteria (Lipsa F.D. and Ulea E., 2018)

Average numbers of colony forming units in 1 g of dry weight soil ($CFU \cdot g^{-1}$) was determined using the plate counting method (Bressan M. *et al*, 2015), on potato dextrose agar medium (PDA) in different compositions: classic, with streptomycin and rose-bengal stain. Streptomycin antibiotic (35 $mg \cdot L^{-1}$) was used to control the reproduction of Gram negative bacteria and rose-bengal stain was used to limit the growth of fast-growing moulds (e.g. *Rhizopus* spp., *Trichoderma* spp.). Czapek-Dox agar media was used for filamentous fungi identification. Light microscopy (1000x magnification) was used to determine the colonial features and the morphological structures of the fungi. The determination of the morphological structures of fungi was carried out on fungal material mounted in lactophenol by slide culture technique. Fungi were identified to genus level based on morphological and physiological characteristics following the works provided by Ellis (1971, 1997), De Hoog et al. (2000), Barnett and Hunter (1999).

The number of bacterial colonies was determined at 24 hours and the fungus colonies at 5 days. The experiment was conducted with a threefold repetition for each microbiological determination and the counts obtained were averaged. Microbiological media plates were prepared using Masterclave 09 plate maker and an aliquot portion of 15mL of media was poured using APS 320 automated Petri plate filler (AES Laboratoire, France).

The data obtained in the experiments were statistically evaluated with SPSS 16.0 for Windows and the results with $p < 0.05$ were considered statistically significant.

## RESULTS AND DISCUSSIONS

Analyzing the ratio between the main groups of microorganisms found in the soil during the observation time, we found differences among seasonal variation and crop species. Bacterial and fungal counts in the soil samples were recorded in spring (May) and autumn (September) 2018. The highest counts of total bacteria were recorded throughout the spring seasons, whereas the lowest count was found throughout the autumn seasons (*figure 1*). The dynamics of the bacterial community from all crop species were ranked as follows: spring (22.6 x 106 CFU $g^{-1}$) > autumn (15.8 x 106 CFU $g^{-1}$). These results are in line with the previous studies and the favourable conditions (temperature, soil moisture) during spring (Bouskill N.J. *et al*, 2013; Francioli D. *et al*, 2014; Valverde A. *et al*, 2014) account for them. The recorded data showed significant seasonal variations (spring vs. autumn) ($p<0.05$).

Our findings about different crop species and season fluctuation showed that the bacterial richness, assessed through the plate counting method, was ranked wheat > sunflower > maize > sugar beet > rapeseed. Application of xenobiotic compounds on soils covered with annual crops determined an increase or a decline in bacterial richness as direct response to the degree of habitat disturbance. Organic fertilization of agricultural soils yielded distinct community structures with

higher richness and diversity (Ge Y. *et al*, 2008). The intensity of human intervention, the environmental and edaphic factors from each location could have a specific impact on the results.

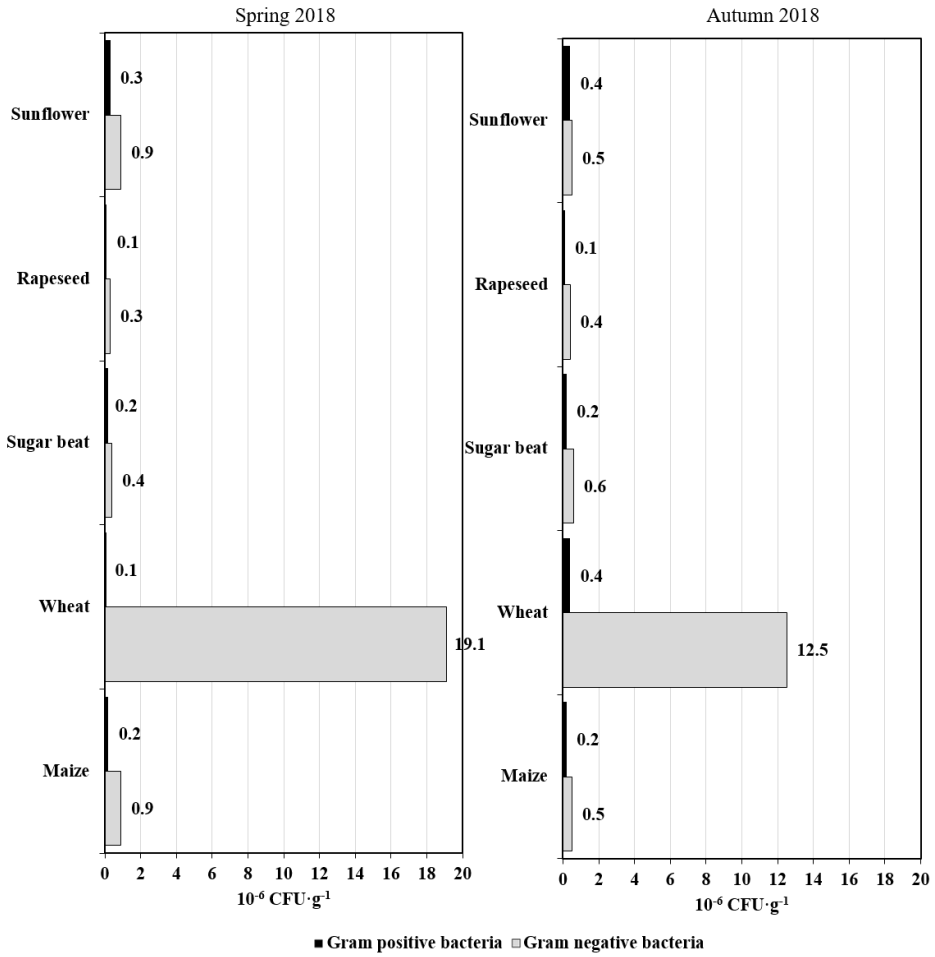



Figure 1 **Evolution of total soil bacteria as influenced by seasonal fluctuations and crop species**

The community structure in 2018 was dominated by Gram-negative bacteria (G-) during both seasons and a possible explanation is the low amount of precipitation recorded in the region of Moldavia. These results show that the environmental factors and physicochemical properties of soil from each location could have a specific impact on soil microbial communities and ecological function (Bissett A. *et al*, 2013).

During spring, in case of wheat, G- bacteria represent 99.4%, while in case of rapeseed G- bacteria represent only 77.0%, from total number of microorganism. The numbers of micromycetes ranged from a minimum value of 0.2 (wheat) to 13.2% (rapeseed). The average amounts of viable Gram-positive bacteria (G+) during the investigation period in the chernozem soil type under cultivation with different crop species varied from 0.4% in case of wheat to 20.5% in case of soil cultivated with sunflower (*figure 2*). These results showed that the environmental factors (yearly seasons) and crop species could have a specific impact on soil microbial communities and ecological functions. Chen J. *et al* (2007) mentioned that the structure of microbial communities exhibited obvious variance after treatment with inorganic fertilizers and pesticides in different types of soils for a long period. Garbeva P. *et al* (2008) showed that in the same soil type the bacterial community depends on land use and management ($p<0.05$). Similarly, Francioli D. *et al* (2014) reported that different land usages and seasons strongly influenced the dynamics and the composition of the bacterial community.

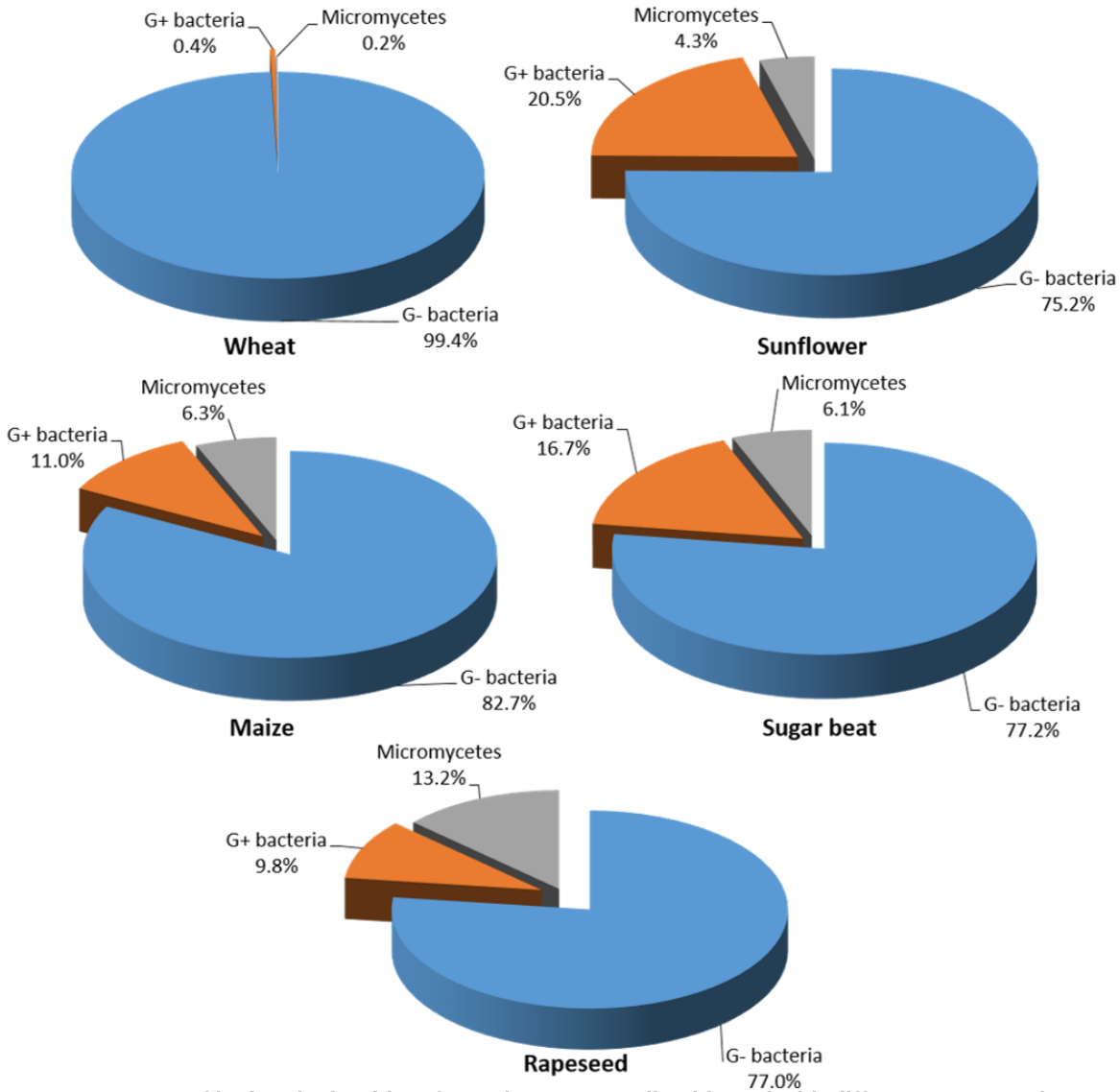



Figure 2 **Frequency of isolated microbiota from chernozem soil cultivated with different crop species**

We noticed that the number of isolated fungus genera in the all observed soil cultivated with different crop species were not identical, but in the same time the differences were not high. In general, soils under integrated management have a significantly reduced fungal richness compared to organic. In our study the fungal community composition was almost similar from spring to autumn and for all crop species cultivated on chernozem soils. The biodiversity of the isolated fungal genera is low, fact which indicated that the usage of inorganic fertilizers and pesticides reduce the microbial community composition. The isolated species belonging to six micromycetes genera: *Penicillium*, *Aspergillus*, *Fusarium Rhizopus*, *Trichoderma* and *Thielaviopsis*, Among the determined micromycetes in all the studied variants, we pointed out *Penicillium* genus, which was isolated at a rate comprised between 60.3 (maize) and 76.7% (wheat) of the total identified genera (*figure 3*).

In the soil sample prevailed from the area cultivated with maize was recorded the filamentous fungi maximum count (6.7 x $10^5$ CFU $g^{-1}$), while the minimum (2.9 x $10^5$ CFU $g^{-1}$) was found in case of wheat under conventional agricultural condition (data not shown).

The investigations conducted on the frequency and spectrum of micromycetes genera shown different values depending of soil types land use and management. The identification of fungi genera which activates in the rhizosphere area of arable land under agricultural rotation shows a relative small number of genera with *Penicillium* and *Aspergillus* as dominant genera in cases of typical chernozem cultivated with wheat, sunflower, maize, sugar beet and rapeseed, with more that 85.0% from all fungi. Highest fungal richness (six genera) was obtained under on the soil cultivated with sunflower (*Helianthus annuus*).

In very small ratio was present *Thielaviopsis* spp. and *Trichoderma* spp. (*figure 3*). Our findings about the influence of crop species on soil microbiota showed that the filamentous fungi richness was ranked maize> sunflower > rapeseed > sugar beet > wheat.

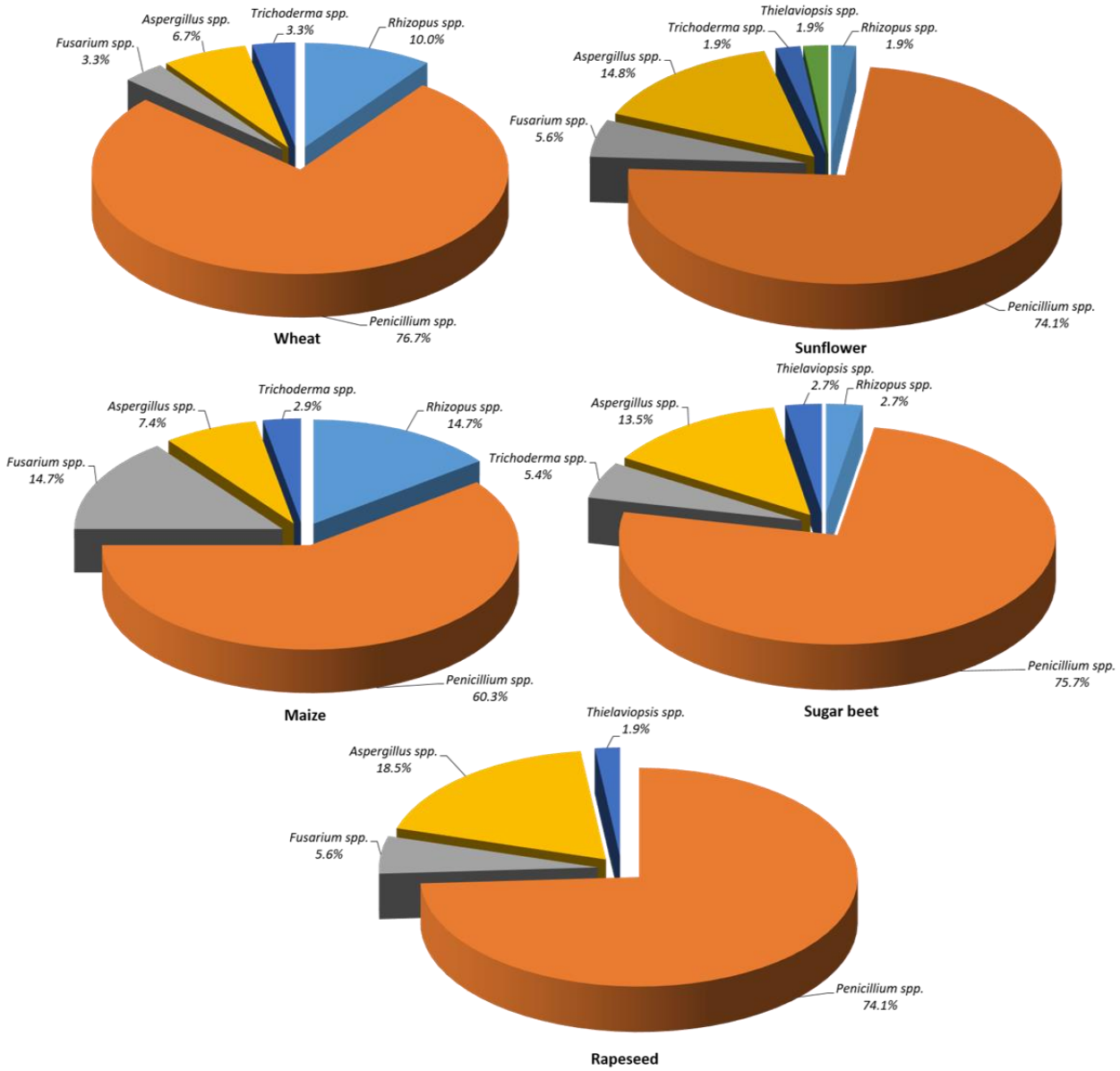



Figure 3 **Taxonomical compositions of filamentous fungi from chernozem soil cultivated with different crop species**

## CONCLUSIONS

All investigated microbial groups were found in all locations and number of the microorganisms was uneven by cultivated crop species. On average, abundance of the most studied microbial groups was the lowest in the chernozem soil cultivated with rapeseed, while the highest abundance was obtained in chernozem cultivated with wheat. In the soil sample prevailed from the area cultivated with maize was recorded the filamentous fungi maximum count, while the minimum was found in case of wheat under conventional agricultural condition.

The investigations conducted on the frequency and diversity of soil microbiota have a complex relationship with the intensity of human intervention and are influenced by environmental, edaphic and management factors.

Intensive and unmannered application of pesticides and inorganic fertilizers in agriculture will pollute the soil, water and air, and cause many human diseases. Also, they affect directly the microbial soil abundance and composition, and indirectly soil texture and fertility. These findings contribute significantly toward an understanding the changes in microbial biomass and structure as response to agricultural management practices.

## REFERENCES


**Ai C., Zhang S., Zhang X., Guo D., Zhou W., Huang S., 2018** - *Distinct responses of soil bacterial and fungal communities to changes in fertilization regime and crop rotation*. Geoderma, 319:156-166.

**Bissett A., Brown M.V., Siciliano S.D., Thrall P.H., 2013** - *Microbial community responses to anthropogenically induced environmental change: towards a systems approach*. Ecology Letters, 16(s1):128-139.

**Bouskill N.J., Lim H.C., Borglin S., Salve R., Wood T.E., Silver W.L., Brodie E.L., 2013** - *Pre-exposure to drought increases the resistance of tropical forest soil bacterial communities to extended drought*. The ISME journal 2:384-394.

**Bressan M., Gattin I.T., Desaire S., Castel L., Gangneux C., Laval K., 2015** - *A rapid flow cytometry method to assess bacterial abundance in agricultural soil*. Applied Soil Ecology 88:60-68.

**Chen J., Zhuang X., Xie H., Bai Z., Qi H., Zhang H., 2007** - *Associated impact of inorganic fertilizers and pesticides on microbial communities in soils*. World Journal of Microbiology and Biotechnology, 1:23-29.

**Doran J.W., Sarrantonio M., Liebig M.A., 1996** - *Soil health and sustainability*. Advances in Agronomy 56:2–54.

**Filip Z., 2002** - *International approach to assessing soil quality by ecologicaly - related biological paarmeters*. Agriculture, Ecosystems & Environment 88:689-712.

**Francioli D., Ascher J., Ceccherini M.T., Pietramellara G., 2014** - *Land use and seasonal effects on a Mediterranean soil bacterial community.* Journal of soil science and plant nutrition 3:710-722.

**Garbeva P. van Elsas J.D. van Veen J. A., 2008** - *Rhizosphere microbial community and its response to plant species and soil history*. Plant and Soil 302(1):19-32.

G**e Y., Zhang J.B., Zhang L.M., Yang M., He J.Z., 2008** - *Long-term fertilization regimes affect bacterial community structure and diversity of an agricultural soil in northern China*. Journal of Soils and Sediments 1:43-50.

**Giller K.E., Witter E., Mcgrath S.P., 1998** - *Toxicity of heavy metals to microorganisms and microbial processes in agricultural soils*. Soil Biology and Biochemistry 30:1389-1414.

**Joergensen R.G., Emmerling C., 2006** - *Methods for evaluating human impact on soil microorganisms based on their activity, biomass, and diversity in agricultural soils.* Journal of Plant Nutrition and Soil Science 169(3):295-309.

**Lan G.Y., Li Y.W., Wu Z.X., Xie G.S., 2017** - *Soil bacterial diversity impacted by conversion of secondary forest to rubber or eucalyptus plantations—a case study of Hainan Island, south China*. Forest Science 6:87-93.

**Lipsa F.D., Ulea E., 2018** - *Practicum de microbiologie alimentară*, Ed. Ion Ionescu de la Brad Iaşi. 163 p., ISBN 978-973-147-275-1.

**Lo C.C., 2010** - *Effect of pesticides on soil microbial community*. Journal of Environmental Science and Health Part B 45(5):348-359.

**Schutter M., Sandeno J., Dick R., 2001** - *Seasonal, soil type, and alternative management influences on microbial communities of vegetable cropping system*. Biology and Fertility of Soils 34:397-410.

**Ulea E., Lipsa F.D, Balau M.A., Filipov F., Morari E.C., 2017** - *Diversity of soil bacteria as indicators of soils pollution in Moldavia region, Romania*. Environmental Engineering and Management Journal 16(4):879-889.

**Valverde A., Makhalanyane P., Cowan D.A., 2014** - *Contrasting assembly processes in a bacterial metacommunity along a desiccation gradient*. Frontiers in microbiology 5:1-8.

# RESEARCH ON THE ACTION OF MINERALIZED WATER ON THE CHARACTERISTICS OF ORDINARY CHERNOZEM

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**Abstract**

The agro-industrial complex of the Republic of Moldova operates in risky conditions. Due to its geographical location, the territory of the republic falls within the area with insufficient and unstable humidity. The annual amount of atmospheric precipitation varies between 380 and 550 mm. Long-term research has established that the main limiting natural factor in obtaining high and stable harvests is the low level of accessibility of plants to accessible water. In the conditions of the republic one of the most effective measures to optimize the soil moisture regime is irrigation. Obviously, it does not exclude the application of agrotechnical processes for storing water in the soil. Soil irrigation as a method of improving water regime has been known since ancient times, but so far there are a number of complicated problems related to the reaction of some soil types to changes in water regime and water quality used for irrigation. Thus, the irrigation of chernozems with mineralized water (> 3000 mg/l) does not cause essential changes in the soil adsorbent complex and does not lead to its secondary salinization. The works carried out aimed at testing and assessing the effectiveness of methods to prevent and combat soil degradation during irrigation. The results of the researches highlight the following: the use of good quality water in the irrigation of chernozems has as a consequence the weak decalcification of the plowed layer, the reduction of the hydrostability of the structure and its compaction; irrigation of chernozemic soils with surface and deep (alkaline) water leads to secondary alkalization and solonization, degradation of the structure, peptization of fine clay, secondary compaction and reduction of water permeability; the degrading effect of chernozems irrigation with water of poor quality can be mitigated by applying organo-calcium amendments or treating the water used with soluble calcium compounds. The experimental polygon from Cozești commune, Singerei district, is located on a straight slope with a south-eastern exposure, with a slope of 2%. The soil is presented by ordinary chernozem strongly deep humic clay-loam. It is irrigated for 9 years. The water used is deep water with an unfavorable chemical composition and a strongly alkaline reaction. The evolution of secondary pedological processes and changes in physical and chemical properties in irrigated soils were established by the method of "pair profiles" (irrigated soil and non-irrigated soil). This method is widely used in pedo-ameliorative study and is considered feasible in the quantitative determination of soil characteristics.

**Key words**: ordinary chernozem, chemical composition, irrigation water, quality indicators

In the Northern part of the Republic the volume of precipitations is attested as below the middle, in the central pedoclimatic zone this indicator appreciated as low, and in the southern one - as very low.

A peculiarity of the republic's climate is the phenomenon of drought. According to the analysis of observational data over the last hundred years, severe and prolonged droughts occur every three years in the northern and central areas and over two years in the southern area (Гаврилица А. 1993). The result of this climatic phenomenon is the reduction or compromise of agricultural production. Long-term research has established that the main limiting natural factor in obtaining high and stable crops is the low level of availability of plants to accessible water (Andrieş S. 2007). In the conditions of the republic one of the most effective measures to optimize the soil moisture regime is irrigation. Obviously, it does not exclude the application of agrotechnical methods for storing water in the soil. Soil irrigation as a method of improving water regime has been known since ancient times, but so far there are a number of complicated problems related to the reaction of some soil types to changes in water regime and water quality used for irrigation. Thus, the irrigation of chernozems with mineralized water (> 3000 mg/l) does not cause essential changes in the soil adsorbent complex and does not lead to its secondary salinization (Ковда В. 1981).

At the same time, the same author points out that the use of water with a degree of mineralization higher than 1000 mg/l on

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chernozemic soils, has as a consequence the secondary salinization and solonization, but also their hydromorphic evolution. As a result of multiannual research, V. A. Covda (Ковда В. 1981) concludes that the development of unified irrigation water quality indicators is practically impossible due to the extremely high diversity of pedological, geomorphological and geochemical conditions of irrigated territories.

In the Republic of Moldova, chernozems make up over 74% of the surface of soils suitable for irrigation (Filipciuc V., 2007). They can be included in the irrigation regime only if the use of water with low soluble salts (up to 1000 mg/l) and favorable chemical composition. Research on different chernozem subtypes shows that changing the natural water regime by irrigation, even when using good quality water, leads to degradation of the structure, compaction of the upper horizon and decalcification (Крупеников И. *et al*, 1978; Подымов Б. 1976). The use of water with a high degree of mineralization or with an inadequate chemical composition for the irrigation of chernozems has as a consequence their salinization and / or secondary solonization (Позняк С. *et al*, 1997; Filipciuc V. *et al*, 1990; Филипчук В. 2014). In this context it is useful to mention that the solonization process severely affects not only the physical and physico-chemical properties of the soil. It also produces degrading effects on the mineralogical composition by increasing the content of swelling material in the smectite and illit-smectite group (Алексеев В. *et at*, 1985). Some secondary pedological processes induced by chernozem irrigation with water of unsatisfactory quality, such as clay, fine clay peptization and ilitization, are irreversible and cannot be restored or restored by amelioration methods. Contrary to these findings, some authors argue that chernozem soils can be irrigated with water in which the soluble salt content is 1500-3000 mg/l (Рабочев И. 1981; Безднина С. 1990; Зимовец Б. *et al*, 1993). V. A. Kovda, by analyzing the global experience of the consequence of irrigation, points out that the unification of water quality indicators for irrigation and the setting of limit values presents great difficulties or is impossible due to the diversity of climatic, geomorphological conditions. For the pedoclimatic conditions of the Republic of Moldova, water quality indicators used for irrigation were established, which regulate the degree of mineralization, reaction, sodium adsorption ratio, magnesium indicator, chlorine and residual sodium carbonate content (Filipciuc V. 2007).

## MATERIAL AND METHOD

In order to establish and evaluate the impact of irrigation of chernozem soils with water of different quality, field, laboratory and office methods were used. The following works were carried out in the field: opening the soil profiles, morphological and morphometric description; collecting soil samples from genetic horizons to determine chemical, physical, water and physico-mechanical properties; collection of water samples for irrigation in order to determine the chemical composition and quality indicators; determination of apparent density and penetration resistance (on genetic horizons); determination of water permeability and water capacity in the field.

In the laboratory it was determined: the hygroscopic water content; density of the solid phase of the soil; granulometric and microaggregatic composition; structural-aggregate composition and hydrostability of the structure; hygroscopicity and wilting coefficients; humus content and composition; calcium and magnesium carbonate content; nutrient content nitric nitrogen, mobile phosphorus and exchangeable potassium; soluble salt content, reaction and ionic composition of the aqueous extract; the content of adsorbed cations; chemical composition and water quality indicators for irrigation. At the office phase, the calculations of the field and laboratory determinations were performed, the results obtained were systematized and analyzed and the report for the current year's stage was elaborated. The works provided by the thematic plan were carried out on selected experimental polygons within the irrigation systems and in their immediate vicinity (non-irrigated soils). The experimental polygon from Cozești commune, Sîngerei district, is located on a straight slope with a south-eastern exposure, with a slope of 2%. The soil is presented by ordinary chernozem strongly deep humic clay-loam. It is irrigated for 9 years. The water used is deep water with an unfavorable chemical composition and a strongly alkaline reaction.

## RESULTS AND DISCUSSIONS

***Hydrochemical characterization of the water source used for irrigation***. The chemical composition and water quality indicators of lakes, reservoirs and ponds are determined by multiple factors, including lithological, geomorphological, hydrogeological and climatic. Hydrochemical research of local water sources shows that their quality depends largely on the power supply. They are very varied, and their mineralization varies in a wide range from 0.5 to 7.0 g/l. On the territory of the Republic there is a zoning of surface waters, including accumulation basins. In the Northern area, non-mineralized lakes with a soluble salt content below 1000 mg/l predominate. In the Central and Southern area, the degree of water

mineralization varies between 1000 and 3000 mg/l. There are hydrochemical districts in which the salt content is 3000 - 5000 mg/l. Such water accumulation basins are concentrated within the Ciuluc - solonetz height. One of the specific characteristics for the water of lakes and ponds in the Republic is the high concentration of magnesium. Previous research has shown that the ratio of bivalent cations (Ca:Mg) is favorable in only 12% of the total number of ponds.

The soil of the Singerei experimental polygon is irrigated for 9 years with water from the pond. Determinations of chemical composition and quality indicators show that the content of soluble salts is very high and varies from 2750 mg/l to 3756 mg/l. This indicates a high danger of soil salinization. The water reaction is estimated to be moderate to strongly alkaline with pH values between 8.70 - 8.90 units. The anionic composition is predominated by $SO_4^{2-}$, the content of which is 23.60 - 33.82 me/l. Chlorine exceeds the maximum allowable limit for irrigation water, with values of 3.73 - 4.41 me/l. $CO_3^{2-}$ is permanently present in the anionic composition in quantities of 2.40-4.80 me/l. $Na^+$ predominates among the cations, the content of which ranges between 27.83 and 39.13 me/l. It is followed by $Mg^{2+}$ with a concentration of 11.66 - 12.60 me/l. In the composition of $Ca^{2+}$ cations it has a subordinate role with a content of only 4.60 - 7.34 me/l. Based on the chemical composition of the water, the SAR, PMg and CSR indicators were calculated. The sodium adsorption ratio is high (9.9 - 11.2) and shows an increased risk of secondary soil solonization. The evolution of this process also indicates the extremely high values of residual sodium carbonate (11.57 - 21.03 me/l). The magnesium index makes up 70 - 72%, so long-term irrigation will lead to the accumulation of magnesium cation in the adsorbent complex of the soil. It is important to emphasize that in the composition of soluble salts of the pond water, sodium sulfate predominates, the content of which varies from 23.60 to 33.92 me/l. Summary Toxic sodium and magnesium compounds have a share of 86-90% of the total soluble salt content.

Irrigation changes of the chemical properties of ordinary chernozem. Due to the humus content, the soil of the Sîngerei experimental polygon falls into the category of moderately humiferous ones (3.15%). On the profile the content of organic matter decreases slowly and obtains values of 0.56 - 0.7% in the solidification rock. Calcium and magnesium carbonates appear in the B1 horizon at a depth of 45 cm in the form of pseudomyceles. Their content increases in depth from 1 to 11%. Irrigation with mineralized water does not produce significant changes in the content of $CaCO_3$ and humus, but has a negative effect on its composition. In the irrigated soil, there was a tendency to decrease the carbon content in the fraction of humic acids. At the same time, a slight increase of this element in the fraction of fulvic acids is observed. The mentioned changes led to the reduction of the CAH: CAF ratio from 3:1 in non-irrigated soil to 2.4:1 in irrigated soil. Other unfavorable changes in the composition of humus relate to the decrease in the content of calcium-bound humic acids and the increase in the content of free humic acids bound to iron and aluminum sesquoxides. In a very short period of time, these changes seem insignificant, but they should not be neglected, because long-term irrigation can substantially increase the mobility of organic matter in the soil. Highly mineralized water has degrading effects on the saline indices of ordinary chernozem and, first of all, on the ionic composition of the aqueous extract. Unirrigated soil is characterized by very low content of soluble salts. The humus-cumulative layer contains only 0.025% salts. In the transition horizons and in the rock the value of the dry residue increases slightly to 0.039 - 0.045%. The current reaction of the first two horizons is neutral with pH values between 7.02 and 7.20. In depth, with the appearance of carbonates, the soil reaction becomes poorly alkalized with variations in pH from 8.05 to 8.30 units.

In the anionic composition of the aqueous extract, the bicarbonate ion predominates, which makes up 0.15 - 0.59 me, and in the cationic one, calcium prevails with a participation of 0.28 - 0.54 me/100 g of soil. The ratio between bivalent and monovalent cations is high and ranges from 6 to 9:1. The use of highly mineralized water for irrigation has the consequence of increasing the content of soluble salts on the entire soil profile. The largest increase was recorded in the humus-cumulative horizon on the thickness of 0-43 cm. Here the value of the dry residue practically doubled from 0.025 - 0.027 to 0.048 - 0.057%. It should be noted, however, that due to the content of soluble salts, the ordinary irrigated chernozem remains in the category of non-saline ones. The reaction of the irrigated soil, through the application of mineralized and alkaline water, registers a significant increase, especially in the upper horizons. On the soil thickness 0 - 43 cm the pH value increased by 1.18 - 1.23 units, reaching sizes of 8.20 - 8.43 units. In the ionic composition of the aqueous extract of the irrigated soil, a significant increase of the $HCO_3$ content and, in particular, of the $Na^+$ content is observed. On the profile of non-irrigated soil, the concentration of

sodium in the soil solution is 0.05-0.11 me, and in the variant with irrigation regime this element reaches values of 0.44 - 0.52 me/100 g of soil, thus registering an increase of 5-9 times. These changes significantly reduced the Ca + Mg: Na ratio from 6 ... 9:1 to 1 ... 2:1. Thus, favorable conditions are created for the evolution of the secondary solonization process.

The use of water of unsatisfactory quality in the irrigation of ordinary chernozem has severe implications on the composition of soluble salts. Calculations show that in the unirrigated chernozem, harmless compounds predominate - calcium bicarbonate and calcium sulfate, which briefly make up 70 - 74% of the total salt content. In irrigated soil toxic compounds of sodium and magnesium [$Mg(HCO_3)_2$; $MgCl_2$; $NaHCO_3$; $Na_2SO_4$; NaCl] are the dominant salts with a weight of 61 - 66%. It is important to note that in the composition of soluble salts of the soil in irrigation appears sodium bicarbonate, a compound that is missing in the solution of unirrigated soil. The impact of alkaline and mineralized irrigation on soil adsorbent complex is sufficiently studied for different soil and climatic conditions. It is unanimously accepted that the use of these waters leads to the emergence and evolution of the process of secondary soil solonization. The effect of using mineralized water was studied on the Sîngerei experimental polygon. The comparative study performed on ordinary chernozem shows that the adsorbent complex of non-irrigated soil is saturated in calcium at 80-87% and in magnesium at 12-18%. The adsorbed sodium is contained in insignificant amounts of 1-2% of the sum of exchangeable cations. From the presented data it can be seen that the $Ca^{2+}$ content decreases in profile from 28.93 me in the humus-cumulative horizon to 20.12 me in the parent rock. Magnesium cation increases from the surface horizon (3.88 me/100 g soil) to the depth (4.58 me). The adsorbed sodium is evenly distributed on the profile, having a content of 0.29-0.37 me/100 g soil.

Irrigation of ordinary chernozem with mineralized water results in a change in the content of exchange bases. For the soil under irrigation, conditions have been created for the appearance and evolution of the decalcification process, diagnosed by the appreciable decrease of the adsorbed calcium content. According to the obtained results, from the humus-cumulative horizon of the irrigated soil $Ca^{2+}$ was substituted in the amount of 2.93 me/100 g soil. It is useful to note that the desorption of this cation is not located only in the surface layer. It is recorded at a depth of 90 cm. Among the effects induced by mineralized water on the soil adsorbent complex is the increase in the magnesium content and, in particular, the adsorbed sodium content. In the colloidal complex of irrigated chernozem $Na^+$ makes up 6% of the sum of exchange bases. Through this indicator the soil is included in the category of moderately alkalized ones. In depth the degree of alkalization is appreciated as weak. Therefore, the use of mineralized water for irrigation generates secondary solonization of the entire soil profile.

***The impact of mineralized water on the physical, hydric and physical-mechanical properties of the soil.*** It has previously been noted that soil texture is a virtually unchangeable property. However, in the literature it is reported that irrigation conditions the claying process and the textural differentiation of the soil profile. Obviously, such changes in particle size composition can occur over a fairly long period of time. The size particle determined on the genetic horizons of the two soil variants require their classification in the class of fine clay-loamy texture. The summary content of coarse and medium sand is very low at 0.1 - 0.2%, and that of fine sand is relatively higher with values between 4.8 and 7.8%. In the dust fraction, coarse dust predominates (27.9 - 33.5%), followed by dust with a participation of 13.0 - 17.5%. The middle dust occupies an intermediate position, this being 7.4 - 10.3%. The amount of fine clay is high (36.6 - 41.9%), slightly lower in irrigated soil. The physical clay content varies between 62.0 and 64.8%. In its composition fine clay has a weight of 61 - 64%. Thus, it can be concluded that during the nine years of irrigation with mineralized water, the texture of ordinary chernozem does not register appreciable changes.

The microaggregate composition represents the totality of aggregates with a diameter of less than 0.25 mm, stable to energetic agitation in water. They highlight a very high content of hydrostable microaggregates with a diameter of 0.05 - 0.01 mm. In both unirrigated and irrigated soil, the content of the fraction equivalent to coarse dust varies in a range of 41.5 - 47.7%. When interpreting the results of soil microaggregate analysis, special attention is paid to the content of fine hydropeptized clay. Multiple publications in the soil physics literature specify the role of the fraction <0.001 mm in the process of potential structuring. Thus, it is considered that at a high content of uncoagulated fine clay, the soil has a very low self-structuring capacity. The peptization process of fine clay depends to a large extent on the composition and content of adsorbed cations. For calcium-saturated soils, a high degree of clay

coagulation is characteristic. The presence of monovalent cations in the adsorbent complex favors the peptization process. A very high peptizing capacity possesses the sodium cation. As a result of the secondary alkalization process, the adsorbed calcium is replaced by sodium in the irrigation water. The accumulation of $Na^+$ in the adsorbent complex increases the degree of peptization of fine clay. This process is observed in irrigated soil. The content of fractions with a diameter below 0.001 mm increased compared to non-irrigated soil, and the dispersion factor, especially in the humus-cumulative horizon, increased from 9 to 16%. The evolution of the degradation processes of the physico-chemical properties under the influence of the mineralized water induces some modifications of the physical, hydric and physico-mechanical properties of the ordinary chernozem. To a lesser extent these changes refer to intrinsic properties, which are difficult to modify, such as the density of the solid phase of the soil. The determinations show that this indicator varies in a range of 2.59 - 2.72 g/cm$^3$, increasing from the humus-cumulative horizon to the parent rock. As the soil profile is texturally and mineralogically homogeneous, the increase in solid phase density is due to the decrease in deep organic matter content.

The apparent density can be modified under the action of the anthropogenic factor, including by the application of irrigation. In the plowed horizon of the unirrigated soil, this indicator makes up 1.24 g/cm$^3$, falling into the large class of values. The surface horizon of irrigated soil is characterized by a high apparent density of 1.38 g/cm$^3$. In depth, it registers an increase up to 1.41 - 1.44 g/cm$^3$, remaining in the same class of values. The total porosity of the unirrigated soil has average values of 52% only in the plowed horizon. In depth this indicator decreases to 47 - 50% and is included in the small class of values. For irrigated soil, the total porosity values vary between 45 and 48%, being appreciated as small. Thus, difficult irrigation conditions are established in the irrigated soil. For the soils in the irrigation arrangements, the aeration porosity is of special importance. On the researched soil profiles, this indicator registers significant changes. In the humus-cumulative horizon of non-irrigated soil, the aeration porosity is medium (18%) and decreases to very low in the transition horizon B1 (10%). Starting with the B2 horizon, this indicator is increasing, reaching a high value of 23% in the parent rock. The aeration porosity in the irrigated soil is very low right from the surface (9%) and up to the B1 horizon. Towards the solidification rock, an increase is observed from 15% in the B2 horizon to 22% in the C horizon, here being appreciated as medium. The settlement status of the common chernozem was assessed by determining the degree of settlement. In non-irrigated soil, the degree of compaction is determined as small (0) in the surface horizon (plowing). On the profile, in the B1 horizon, it is attested as high (+ 12%), and the soil as moderately compacted. In depth, the degree of compaction decreases to +8 ... + 10%, the soil being poorly compacted. The soil in irrigation regime is estimated as poorly compacted from the surface, the values of the degree of compaction oscillating between +8 ... + 10%. The mentioned state of settlement is maintained on the entire soil profile except for the transition horizon B1, in which this indicator makes up + 13%, and the soil is considered moderately compacted.

One of the main mechanical characteristics of the soil is the resistance to penetration. It also presents a simple and quick method of assessing the condition of the soil. From the data presented in table 18 it is observed that the penetration resistance has very low values only in the plowed layer of the non-irrigated chernozem. In depth it increases gradually, indicating values of 12.6 - 23.6 Kgf/cm$^2$, these being appreciated as small. On the chernozem in irrigation, the indicators of penetration resistance are higher. Thus, in the plow layer its value is 16.2 Kgf/cm$^2$ or about 2 times higher compared to non-irrigated soil. On the profile, the penetration resistance registers an increase from 18.3 to 24.5 Kgf/cm$^2$, still remaining in the small class of values. It has previously been reported that irrigation does not essentially influence the hydrophysical indices of the soil. This finding also applies to the use of mineralized water. The hygroscopicity coefficient on both soil variants is high with values between 10.43 and 11.22%. The withering coefficient falls in the large to very high class of values and ranges from 15.6 to 16.8%. The high values of this index are due to the fine texture and high clay content. The water capacity in the field has different sizes on the soil profile. It is estimated as high in the humus-cumulative horizon which includes the plowed and the submerged layer (26.3 - 27.9%). In the transition horizons the field capacity is medium, comprising values of 20.8 - 25.6%, and in the parent rock this index is reduced to 17.8 - 18.5 and is attested as small. The useful water capacity is the range of soil moisture between the wilting coefficient and the water capacity in the field. It is the reserve of water that the soil can give to plants. The calculations show the following: the useful water capacity is medium (11.7 - 11.8%) in the plowed layer; has low values in the transition

horizons B1 and B2 (7.0 - 9.5%); in the BC horizon and in the solidification rock C this index is very small with values between 1.7 and 4.9%. The evolution of the process of secondary solonization of the soil as a result of the use of alkaline and mineralized water has negative effects on the structural-aggregate composition of the ordinary chernozem. Degradation of soil structure during irrigation takes place under the influence of two main causes: decalcification of the upper horizons and accumulation of sodium in the adsorbent complex.

## CONCLUSIONS

The use of Dniester river water to irrigate the carbonate chernozem does not influence the saline indices. The effect of irrigation on physical properties refers to the increase of the hydropeptized fine clay content and the dispersion factor.

Irrigation of ordinary chernozem with mineralized water from local sources results in: - change in the composition of humus and soluble salts; - intensification of the process of decalcification and secondary alkalizing; - increasing the degree of peptization of the fine clay and the dispersion factor; - secondary destructuring and compaction of the soil; - reduction of water permeability.

The application to irrigation of groundwater with inadequate quality indices leads to: - modification of the composition of soluble salts in the soil; - the evolution of the secondary alkalizing process; - increasing the content of peptized clay and the dispersion factor; - secondary soil compaction, increased compaction and penetration resistance; - the appearance of the massive structure with reduced hydrostability; - decrease in the stabilized infiltration rate.

## REFERENCES


**Гаврилица А.О., 1993 -** *Современные проблемы дождевания*. Кишинев: Тип. ГАУМ, 338 с.

**Andrieş S., 2007 -** *Optimizarea regimurilor nutritive a solurilor şi productivitatea plantelor de cultură*. Chişinău: Pontos, 374 p.

**Ковда В.А., 1981 -** *Почвенный покров, его улучшение, использование и охрана*. М.: Наука, 173 с.

**Filipciuc V., 2007 -** *Pretabilitatea solurilor și apelor la irigație*. În: Seceta și metode de minimalizare a consecințelor nefaste. Chișinău, pp. 10-11.

**Крупеников И.А., Подымов Б.П - 1978.** *Диагностика и принципы классификации орошаемых почв*. В сб: Почвенно-мелиоративные проблемы орошаемого земледелия. Кишинев: Штиинца, с. 8-13.

**Подымов Б.П., 1976 -** *Почвы и воды Молдавии в связи с развитием орошения*. В: Сельское хозяйство Молдавии. Кишинев: №5, с. 26-27.

**Позняк С.П., Тортик Н.И., 1997 -** *Орошаемые черноземы юго-запада Украины*. – Львов, ВНТЛ, 239 с.

**Filipciuc V., şi col. 1990 -** *Buletin de monitroring ecopedologic (pedoameliorativ)*. Ediţia I. Chişinău: Agroinformreclama, 50 p.

**Филипчук В.Ф., 2014 -** *Деградация черноземов при орошении и методы восстановления плодородия*. В: Природные и антропогенные факторы воздействия на качество почв и водных ресурсов Республики Молдова. Кишинэу, с. 108-136.

**Алексеев В.Е., Филипчук В.Ф., Арапу К.Г., 1985 -** *Преобразование глинистых минералов и свойств тепличных почв под воздействием поливных вод и химических мелиорантов*. В сб.: Состав, свойства и агроэкологическая оценка почв Молдавии. Кишинев: сс. 80-93.

**Незнаненко С.Н., 1978 -** *Влияния орошения на солевой режим почв.* Тр. Волгоградского с.-х. ин-та, вып. 68, с. 57-63.

**Баскаченко И.Н., 1975 -** *Использование природных минерализованных вод в сельском хозяйстве*. Л.: Колос, 179 с.

**Калашников К.Г., 1963 -** *Применение минерализованных вод для орошения сельскохозяйственных культур*. Кишинев: Штиинца, 131 с.

**Рабочев И.С., 1981 -** *Классификация минерализованных вод по пригодности для орошения*. Тезисы докладов VI делегатскогосъезда всесоюзного общества почвоведов. Тбилиси, т. 5, с. 64-65.

**Безднина С.Я., 1990 -** *Регламентирование и улучшение качества оросительной воды*. В: Повышение качества оросительной воды. Москва: Агропромиздат, с. 4-11.

**Зимовец Б.А. и др., 1993 -** *Методы оценки и изучения пригодности воды для орошения*. Москва: Изд-во ГОСНИТИ, 64 с.

# RESEARCH ON THE QUALITY OF THE SALTY CHEESE OBTAINED IN THE MICROUNIT PRODUCTION FROM UASVM IASI

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**Abstract**

Taking into account the fact that at present the population is in a continuous fight against the food additives, part of the dairy products has started to be indispensable. The quality of the cheeses is mainly outlined by defining the sensory and physical-chemical characteristics, these being the defining ones in the consumers' decision. To obtain superior dairy products we need a very good quality raw milk. Therefore, through this paper we set out to analyze the stages of the technological flow of obtaining salty cheese as well as of the sensory and physico-chemical analyzes on the finished product but also on the raw material. Regarding the quality of the analyzed milk, the average values calculated were 4.01 ± 0.03% for the fat content, and 1.030 ± 0.001g / $cm^3$ for the density. For the final product, salty cheese, sensory analyzes and physico-chemical determination were performed in order to establish the qualitative parameters. Also analyzed were the stages of the technological flow by monitoring the parameters, all of which lead to obtaining a product that can be marketed within USAMV-Iasi.

**Key words**: raw milk, technology, analyzes, quality

According to statistics, the livestock sector together with the agricultural sector, represents a very important branch in the country's economy, managing to provide the raw material for both the feeding of the population and the processing area. For a good development of the agricultural sector, the development of the livestock sector is strictly necessary.

Of all the agricultural products, milk is considered one of the most important products, it occupies the second place, in importance, in the agricultural sector in Romania, after meat.

Milk is considered to be one of the main foods intended for all age groups, but it is also the raw material for a wide range of products, used in the food industry as well as in the industrial one (Bondoc I., 2007).

In terms of production and consumption of milk and dairy products, these have been growing steadily, both globally and at European level. If we refer to the global level, the highest growth was reported in the United States of America, and at the European level, the countries of the European Union have sovereignty.

Quantitatively, world milk production currently reaches about 560 million tones, of which Europe makes approx. quarter.

As a result, in France, in 2000, 22.6 million tons of milk were collected from 4.5 million cows (FAO). In Romania, the annual average in milk production is 5 million tones; for this quantity, cattle participate with about 87% of the total milk production, the average production per animal exceeding 3000 liters per year (Georgescu Gh., 2000).

Regarding milk processing, cheese is considered to be one of the most sought after foods, being found worldwide and in as many forms as possible. Cheeses are produced with very good digestibility, being considered some of the most complex food products. Regarding the sorting range, this differs greatly, especially when we refer to the sensory and physico-chemical factors. From several points of view, cheeses are considered to be the ideal foods, they are very nutritious, flexible in use and application, quite safe, being in a varied assortment range (Angheloiu M., 2015).

As a definition, cheeses are fresh or matured products, obtained from the elimination of whey from the clot formed at the end of milk (whole, partially skimmed or skimmed), cream, whey or a mixture of all these products (Usturoi M.G., 2012).

Whether we talk about cheese made from cow's milk, or from milk obtained from other mammals (sheep, buffalo, goat, reindeer or camel), cheese is an important source of calcium and fat needed for the functioning of the body, as they are

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food. with a very high nutritional value, this is mainly due to the high content of proteins, lipids, mineral salts and vitamins (Usturoi M.G., 2012).

Another advantage conferred by cheeses derives from the rather large storage period, so cheese producers can sell the goods in economic conditions that are favorable to them, in some profile markets the aged cheese assortments are preferred, which have much higher selling prices. , exactly the opposite of the conventional situation registered for other foods, which are desired as fresh as possible.

Cheeses with a lower fat content, such as cow and barley cheese, have a dietary character, and they are especially recommended for people who do not tolerate products with a high fat content. The energy value of cheeses is directly influenced by their fat content.

In addition to proteins, cheeses also contain significant amounts of essential vitamins, such as vitamins A, B2, B12 and D, but also minerals. In the cheese is found synthesized the highest amount of calcium but also high amounts of zinc and phosphorus. Calcium found in cheese is of particular importance in the development of children (Diaconescu A, 2006).

As for the assortments of goat cheese, they are a natural source of vitamin B12 (2 micrograms / 100 grams); a fact that recommends it in the treatment of stress, anxiety, which helps to concentrate better (Usturoi M.G., 2012).

The same source reports that ,,urda" has a great nutritional value, because it incorporates, through heat precipitation, the very valuable serum proteins of milk (lactalbumin and lactoglobulin), which have a high content of amino acids necessary for the human body.

In terms of fat content, cheeses can be fat (contain more than 40% fat), half-fat (between 20-40% fat) and low (less than 20% fat).

Taking into account the factors mentioned above, we can say that cheese can be considered ideal foods, which can be consumed by all age groups.

For these reasons, through the present process we set out to create within the Milk Processing Workshop - USAMV-Iași, an assortment of salty-type cheeses, strictly following the stages of the technological flow, but at the same time the qualitative parameters of milk as well as the finished product.

## MATERIAL AND METHOD

The quantity of milk processed in the processing workshop was 500 L. The raw material milk was brought from the Rediu Farm, in stainless steel containers with a capacity of 100 L.

Regarding the qualitative reception, analyzes were performed on milk of raw material to determine the acidity (˚T) by the Thorner method, the density (g / cm$^3$) by the aerometric method and the fat content (%) by the Gerber method.

200 ml of milk were collected from each container, with an average sample, of which six were made.

The quantitative reception of the milk is performed volumetricly with the help of the galactometer *(figure 1.a)* positioned in the immediate vicinity of the intermediate milk receiving vessel *(figure 1.b)*.




Figure 1 **Milk reception plant**

The operation of cleaning the milk of possible mechanical impurities is carried out by means of the filters mounted at the bottom of the intermediate receiving tank *(figure 1.d)*. The milk is extracted from the stainless steel containers by means of the centrifugal pump *(figure 1.c)*, the milk having to pass through two filters provided with metal screens. The receiving system is provided with an electrical control panel *(figure 1 e)*, through which both the centrifugal pump and the cooling system start / stop.

Temporary storage of raw milk. If the raw milk is not processed immediately, cooling is carried out, by passing the milk through the plate cooler *(figure 2.a)*, up to +4ºC and storing it in a buffer tank, provided with a double jacket. and stirrer for homogenization *(figure 2.b)*.



Figure 2 **Temporary storage of raw milk**

Pasteurization of milk. It is carried out using the plate pasteurizer *(figure 3)*, an operation that requires heating the milk to 74ºC, maintaining it at this temperature for 15 seconds, followed by a sudden cooling to 10oC. The capacity of the plate pasteurizer is 1000 l /h.



Figure 3 **Pasteurizer whith plates**

Fat separation. The result of this operation is sour milk and sweet cream. The centrifugal separator found in the Milk Processing Laboratory is part of the hermetic centrifugal separators category, with milk feedstock being made through the pipe mounted on the top of it *(figure 4).* the separation of the two fractions is achieved by means of two pipes mounted at the top of the separator. The fat separator capacity is 1000 l / h.



Figure 4 **Centrifugal separator**

Homogenization of milk. It is realized with the help of the mechanical pressure homogenizer with two stages of homogenization *(figure 5 a.).*

Homogenization is the operation to stabilize the milk fat emulsion, thus avoiding the separation of milk fat, by passing the milk through 2 homogenization valves, through which the milk under pressure overcomes the resistance of the homogenization valves, thus reducing the fat globules. The homogenizer has the following technical specifications: flow rate - 1500 l / h, maximum pressure - 25 MPa, normal working pressure - 0 ... 20 MPa, engine power - 6 kW. After homogenization, the milk is stored in a buffer tank *(figure 5.b*).



Figure. 5a
**Homogenizer for milk**



Figure 5b **Buffer tank**

Preparation of milk for curing. The homogenized milk is directed to the fitting valve, which is provided with a double jacket (the heating agent is steam) *(figure 6)*. The milk in the pan is heated to 35ºC, at which point the shell (selected cultures) is added. The coagulation process lasts between 50 and 70 minutes, depending on the quality of the milk and that of the selected cultures, until the milk passes into the liquid phase becomes

an elastic, gelled mass.



Figure 6 **Milk closing valve**

Coagulation processing. After the clamping occurs, the processing of the clot is performed in the valve in which the clamping was performed. The processing of the clot involves operations of shredding the coag, by dividing it with the pound *(figure 7)* (mounted inside the closing valve), until a grain of the size of the pea grain (2 - 5 mm) is obtained. During the coagulation processing the temperature in the valve is maintained at 35ºC.

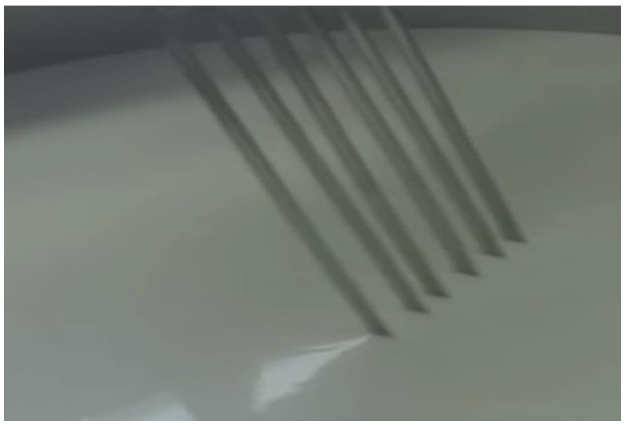


Figure 7 **Splitting the curd with the pound**

Pressing and forming the cheese. After obtaining the grain of cheese, the mass of cheese and whey formed is transferred to the ridge *(figure 8.)*, after which the seat has been previously placed. Coagulation processing requires seat binding and self-pressing operations for 20-30 minutes *(figure. 9).*

The operation of pressing the clot involves the following actions:

- ✓ placing the metal frame over the formed table;
- ✓ loosening the seat and uniformizing the cheese mass;
- ✓ setting the metal frame and pressing for 15 - 20 minutes (20 kgf), then increasing the pressing force.

The duration of the pressing operation is between 130 - 160 minutes, being considered completed when the acidity of the cheese is about 60˚T, and the water content has values between 63 and 65%.



Figure 8 **Transfer of the coagul into the ridge**



Figure 9 **Cheese pasteurization**

Cheese cracking. The cheese thus formed is placed on the ridge, in a single row, for the purpose of breeding. This operation takes 20-30 minutes.

Immersion in brine. Brine is obtained in the installation provided for this purpose, which is provided on the inside with an arm for homogenization (figure 10). The brine has a concentration of 22 - 24% NaCl, 20-30˚T acidity and a temperature of 10-20˚C. From this installation, the brine is sent through the pump and pipes into the wet salt basin *(figure 11).* After winding, the logs are placed in the brine for 16 - 20 hours, and then left to spray on a ridge. Here, the dry salting operation can be carried out, optionally, by pressing over the cheese with coarse salt.



Figure 10 ***Brine production facility***



Figure 11 ***Basin for wet salting of brine***

Salty cheese ripening. The duration of the ripening process is about 40 days in the ripening room, which has a temperature of 12 - 15˚C.

Vacuum packaging. The matured layers of cheese are packed in the packing machine, individually, in special polyethylene bags *(figure 12.).*




Figure 12 **Vacuum packing machine**

After packing, the products are labeled (*figure 13)* and stored in the specially arranged room.




Figure 13 **The label of the finished product realized within USAMV-Iași**

Regarding the quality conditions for the finite product, determinations were made in order to determine the US content (%) and water (%), determining the protein content (%), the fat content (%), the salt content (%) and acidity (˚T).

The water content was made by drying the samples in the oven and the dry one was by difference:

US (%) = 100 - water.

The determination of the protein content was performed by the Kjeldahl method, where the principle of the method consists in the conversion of nitrogen from organic combinations into ammonium sulphate, by heating with concentrated sulfuric acid, in the presence of a catalyst in our case, copper sulphate. By adding a strong base, the ammonia becomes free, and by distillation it is captured in a defined amount of acid with a known normality. The excess acid is titrated with a basic solution having the same normality, the total nitrogen quantity being determined by difference.

The fat determination was performed by the acid-butyrometric method, with the Van-Gulik butyrometer, the principle of the method consists in delimiting the fat from butyrometers, by dissolving the protein substances with sulfuric acid in the presence of isoamyl alcohol followed by centrifugation.

The determination of sodium chloride has as its principle, the precipitation of chlorides in cheese (in this case, salty cheese) with silver nitrate, using as an indicator the potassium chromate.

The acidity determination was performed, as in the case of milk raw material using the Thörner method, where the acids in the cheese composition are neutralized. A sample volume of sodium hydroxide (NaOH) is titrated, in which case a color indicator such as phenolphthalein is also required.

Regarding the physical-chemical examination of the cheeses, five determinations were made for each qualitative parameter.

Also, on the finished product a sensory examination was also carried out, using the points method.

## RESULTS AND DISCUSSION

Regarding the fat content of milk registered in the samples analyzed by us, the average value was 4.01 ± 0.03%, the minimum being 3.90% and the maximum of 4.10%. The studied character presented a very good homogeneity, the value of the coefficient of variation being 1,119 *(table 1).*

Table 1

**Physico-chemical properties for the raw milk**

| Specification | Standard | N | $\bar{X} \pm s_{\bar{X}}$ | CV% | Minimum | Maximum |
|---|---|---|---|---|---|---|
| Fat (%) | min 3 | 6 | 4.01±0,03 | 1.19 | 3.90 | 4.10 |
| Acidity (°T) | 15-19 | 6 | 16.19±0,30 | 3.60 | 15.00 | 17.00 |
| Density (g/cm$^3$) | min 1.029 | 6 | 1.030±0.001 | 0.06 | 1.029 | 1.031 |

Regarding acidity, the values indicated by the standard vary between 15 and 19°T, the average obtained on the milk analyzed by us being 16.19±0.30°T. The studied character also presented a very good homogeneity, the value of the coefficient of variation being 3.60%.

Regarding the density of the raw material milk subjected to the analyzes, the average calculated by us was 1,030±0,001 g/cm$^3$, the minimum being 1,029 g/cm$^3$ and the maximum 1,031 g/cm$^3$. The coefficient of variation obtained was also this time a very small one, of 0.06%, which indicates a very good homogeneity in the analyzed group.

For the finished product, a first parameter analyzed was the water content, where the average value was 56.51±0.05%, the variation limits being between 56.30% and 56.64%, values that have led to a very homogeneous character, the value of the coefficient of variation being 0.08% *(table 2).*

Table 2

**Physico-chemical properties for the salty cheese**

| Specification | Standard | N | $\bar{X} \pm s_{\bar{X}}$ | CV% | Minimum | Maximum |
|---|---|---|---|---|---|---|
| Water (%) | max. 57 | 5 | 56.51±0.05 | 0.08 | 56.30 | 56.64 |
| DM (%) | min. 43 | 5 | 43.49±0.07 | 0.12 | 43.36 | 43.70 |
| Fat/DM (%) | max. 42 | 5 | 40.65±0.02 | 0.20 | 40.52 | 40.76 |
| Protein (%) | min. 16 | 5 | 16.95±0.04 | 0.44 | 16.87 | 17.02 |
| Salt (%) | 2.5 - 4 | 5 | 3.05±0.04 | 3.69 | 2.94 | 3.10 |
| Acidity (°T) | max. 150 | 5 | 132.0 ±0.25 | 1.22 | 145 | 149 |

Regarding the water content, the quality standard indicates a maximum value of 57%, the average value obtained by us being less than 0.49%. The difference up to 100% was represented by the content in dry matter where the minimum value was 43.36% and the maximum reached a level of 43.70%. Regarding the average value, it was 43.49 ± 0.07% *(table 2).*

Another qualitative parameter analyzed was the fat content reported on the dry matter, where the average value was 40.65±0.02%, the minimum being 40.52% and the maximum value reaching the limit of 40.76%. The studied character also presented a very good homogeneity in this case, the value of the coefficient of variation being 0.20%.

Regarding the protein level in salty cheese, the standards indicate a minimum value of 16%, the average value calculated by us being 16.95 ± 0.04, 0.95% higher than the minimum required.

The salt content of salty cheese registered an average level of 3.05±0.04%, the minimum being 2.94% and the maximum value reaching a level of 3.10%. The studied character presented a very good homogeneity, the value of the coefficient of variation being 3.69% *(table 2.).*

For the salt level of the product analyzed by us, the quality standard indicates a minimum value of 2.5% and the maximum allowed is 4%; the salty cheese on which the research was carried out was within these limits, the average being 3.05±0.04%.

A final parameter analyzed was the acidity value, where the calculated average was 132.0±0.25˚T, lower by 18˚T than the maximum indicated in the quality standards. The studied character also presented a very good homogeneity, the value of the coefficient of variation being 1.22%.

For the sectoral examination, the group consisting of the six tasters followed the outward appearance, the color, the appearance in the section, the smell, the taste and the consistency.

For example, in the case of the external aspect, the average score was 4.83 points, five of the six tasters giving a maximum score, namely 5 points, for this feature, and as a result of the weighting, a value of 1.93 points was obtained. In the case of color, the average score obtained was 5 points, all six tasters giving maximum score to this feature, the weighted average score being 2.00 points in this case. The analysis of the aspect in the section led to an average score of 4.66 points and a weighted score of 3.73 points. Another characteristic pursued was consistency, where the tasters gave marks of 5, 4 and 3 points, the average score being 4.5 and the weighted one of 3.6 points.

For the average obtained from the determinations it was 5 points, each one of those who analyzed the product giving a maximum score, which resulted, after the weighting to a value of 2 points.

Table 3

Summary sheet of the results obtained by the scoring method

| No. | The name of the taster | Individual score | | | | | |
|---|---|---|---|---|---|---|---|
| | | Exterior appearance | Color | Appearance in section | Consistency | Smells | Taste |
| 1 | Taster 1 | 5 | 5 | 5 | 5 | 5 | 5 |
| 2 | Taster 2 | 5 | 5 | 5 | 5 | 5 | 5 |
| 3 | Taster 3 | 5 | 5 | 5 | 5 | 5 | 5 |
| 4 | Taster 4 | 5 | 5 | 4 | 3 | 5 | 5 |
| 5 | Taster 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| 6 | Taster 6 | 4 | 5 | 4 | 4 | 5 | 3 |
| Average unweighted score | | 4.83 | 5.00 | 4.66 | 4.5 | 5.00 | 4.66 |
| Weighted average score | | 1.93 | 2.00 | 3.73 | 3.6 | 2.00 | 5.59 |
| Tota weighted score | | **18.85** | | | | | |

The last characteristic analyzed, perhaps the most important, was the taste, where five of the six tasters gave a maximum score, and one granted a 3-point turnaround which led to an average value of 4.66 to obtain it. 5.56 points weighted value.
The summation of the results obtained by weighting led to a final score for salty cheese of 18.85 points, placing the assortment analyzed by us in the "VERY GOOD" category *(table 3).*

## CONCLUSIONS

In order to have a very good quality finished product, it is necessary, in particular, to use a higher quality raw material therefore, the analyzes carried out were also on milk the raw material used in processing.

Regarding the qualitative parameters obtained from the determinations made on the raw material as well as on the finished product, we mention that the results were compared with the values mentioned by the quality standards.

Regarding the unfolding of the technological flow, the temperature parameters as well as the times used in the various operations were taken from the specialized literature, wishing finally to obtain a product with superior sensory and physico-chemical qualities.

➢ *Conclusions drawn from the analysis of milk raw material*

- the fat content of milk registered a higher average value with 0.81% compared to the minimum of 3.2% as stipulated in the standard;
- for acidity, the variation limits indicated in the standard vary between 15°T and 19°T, the average value obtained by us being 16.19±0.30° T;
- milk density, has a minimum value of 1,029 g/cm$^3$ the average obtained by us being 1,030g/cm$^3$.

➢ *Conclusions drawn from the analysis of the flow of technologies*

Being the first batch of processing on the milk micro-production workshop within USAMV-Iași, the good operation of the equipment, the manufacturing recipe as well as the operating parameters were monitored in particular. The temperature was further monitored to determine if the equipment provided was functioning properly, but also the fat content was determined following the separation step to verify that the stored milk reaches a level of 0.1% in terms of fat.

In conclusion, we can say that the equipment works at optimal parameters, thus, in the future, we can try to process new assortments of cheese.

➢ *Conclusions regarding the finished product - salty cheese*

- from the sensory point of view, it was in the category of very good products, the analyzed features receiving scores near the maximum limit;
- from the physical chemically point of view, the first parameter analyzed was the water content, this being 0.49% lower than the maximum indicated by the standard;
- for U.S. content the standard value was min. 43% the average obtained by us being higher by 0.49%;
- the fat / DM content indicated a lower average value by 1.35% than the maximum allowed by the standard;
- for the protein level, the average obtained by us was higher by 3.95% than the minimum limit imposed;
- the salt level of the product registered an average value of 3.05 ± 0.04%, which is within the limits imposed by the standard;
- the acidity registered an average value of 132oT, this being lower by 18$^o$T than the maximum indicated by the standard.

The good functioning of the equipment as well as the high quality of the products that are obtained in the workshop with the help of the students of USAMV Iași obliges us to recommend the processing of a larger quantity of milk and the commercialization of the obtained products.

## REFERENCES

**Angheloiu M., 2015** - *Brânzeturi cu un conţinut redus de sodiu: aspecte ştiinţifice şi tehnologice*", Rezumat

teză de doctorat,Universitatea „Dunărea de Jos” din Galaţi.

**Banu C. și colab. 2009** – *Tehnologii alimentare. Tratat de industrie alimentara, vol. II - Tehnologii alimentare*”, Editura ASAB București.

**Bondoc I., 2007** – *Tehnologia și controlul calității laptelui și produselor lactate*, Volumul I, Editura Ion Ionescu de la Brad, Iași.

**Diaconescu A, 2006** – *Cercetări privind calitatea şi randamentul laptelui utilizat în procesul de obţinere a brânzei Telemea*, Rezumat teză de doctorat USAMV București.

**Georgescu Gh., 2000** - *Laptele şi produsele lactate*, Editura Ceres, Bucureşti;

**Jimborean Mirela Anamaria, 2009** – *Cercetări privind modificările proteolitice care au loc pe timpul maturării brânzeturilor fermentate*, Rezumat teză de doctorat, Universitatea de Ştiinţe Agricole şi Medicină Veterinară Cluj-Napoca.

**Rațu R.N. și Usturoi M.G. 2019** – Aplicații practice în industria laptelui, Editura Pim, Iași.

**Șindilar E. și Bondoc I., 1998** – *Igiena produselor animale,* Manual practic. Centrul de Multiplicare al Universităţii Agronomice “Ion Ionescu de la Brad” din Iaşi.

**Ţibulcă D., Jimborean M.A., 2008** – „*Tehnologia de obţinere a produselor lactate*”, Editura Risoprint, Cluj-Napoca.

**Usturoi M.G., 2012** – Tehnologia laptelui și a produselor derivate, Editura Alfa, Iași.

**Zaharia N.S., 2012** – *Studiul comparativ al metodelor de accelerare a procesului de maturare a brânzeturilor cu pastă filată*, Rezumat teză de doctorat, Universitatea „Dunărea de Jos” din Galați.

http://www.fao.org

# THE INFLUENCE OF THE STORAGE INTERVAL ON QUALITY OF THE APPLE STORED UNDER CONTROLLED STORAGE CONDITION

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**Abstract**

Apples, fruits that are characterized by taste qualities, nutritional, prophylactic and therapeutic value can be consumed in fresh condition for a long time when are stored under suitable conditions. Thus, it was aimed to identify the main organoleptic and phisico-chemical changes on the apples preserved within the *Cerasus Grup* Cotnari deposit by collecting samples represented by six apples varieties (*Golden Reinders, Golden Delicious, Gala, Jonared, Idared și Braeburn)* in two different intervals, respectively: November 2018 and January 2019. In terms of weight losses, it was noted that these ranged between the minimum value of 5,8% for *Gala* variety and maximum of 15% for *Golden Reinders* variety. The value of the firmness decreases, the differences between the two collecting samples periods being between 0,7 kgF/cm$^2$ (for *Jonared* variety) and a significant difference of 1,9 kgF/cm$^2$ for *Braeburn* variety. Compared to the reference values that indicate an adequate storage at the values of firmness between 5 to 7 kgF/cm$^2$, it evidences indicates the urgency of the removal of the *Braeburn* variety from storage to marketing, which has a firmness value of 5,7 kgF/cm$^2$ în January. The pH values were within the reference limits between 3,6 – 5 in both quality control intervals. There was a slight decrease on the pH values for all the varieties analyzed, an aspect closely correlated with the increase of the percentage of sugars by a 1% as a result of the hydrolysis of the starch and its transformation into reducing carbohydrates during storage compared with the values obtain for the sampling from November. The results obtain for the vitamin C content for samples collected in November indicate a fall in the reference values (7 – 12 mg/100 g) for all varieties analyzed excepting the *Golden Reiders* variety which is lower (5,28 mg/100 g). Most varieties evidence a decrease on vitamin C content by 2 mg/100 g in January, excepting the *Golden Reinders* and *Gala* varieties, who maintain their values constant. The results of the organoleptic and phytosanitary evaluation, pH values, iodine tests well as weight losses and firmness values have shown a major importance during the valorification of the stored fruits because they can indicate exactly the optimal moment for marketing in terms of economic efficiency.
drafted in English (10-15 rows, with special reference to research results).

**Key words**: apple quality, controlled storage condition, vitamin C

The group of *Pomaceae,* which also includes the apple, has a good storage capacity compared to the other categories of fruits such us the groups of the *Drupaceus* or the one of fruit bushes (Murariu O. *et al*, 2014; 2017). Their resistence to long term storage is justified by the genetic attribute presented by *Malus domestica* species as well as by the structural, textural, chemical properties and the intensity of physiological process (Murariu O. *et al*, 2018). The *Malus domestica* species has the ability to ripe inclusively after harvesting, which creates the possibility to harvest the fruits designed for longer storage period before reaching the stage of consumption maturation, with maturing during storage. In the literature it is mentioned that the storage life of the different varieties of apples differs according to the difference of the amount of starch that is present in pericarp and mesocarp and also by the storage temperature, which when is optimal increases the storage period (Jamba A. *et al*, 2002, Goncearov *et al*, 2004).

The research results indicate that the influence of ecological factors (temperature, atmospheric precipitation, geographical location of orchards) can contribute to a normal development, an improvement of chemical properties, an increased resistance to diseases during the post – harvest period, and at the same time can improve the quality of the product and the storage capacity of apples (Sumedrea *et al,* 2018), provided that all parameters are observed and monitored (Petcu *et al*, 2007). It has been founded that the autumn – winter apples varieties harvested from the southern part of the country accumulate a higher amount of dry matter and sugars compared to the fruits

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harvested from the orchards located in the northern part where the climatic condition (atmospheric precipitation and air temperature) are more satisfying for fruit growth and development, their resistance to physiological disorders and storage diseases. Also a major factor is the weather conditions of the last weeks until harvest. Thus, in the geographical areas where the temperature during the harvest period reaches below 5°C, it increases the possibility of affecting the fruits of the "cold diseases" during the storage period, and the fruits obtained in the high temperature areas increase the possibility of their attack on the scald.

Jamba A *et al*, (2002) recommends the immersing of the apples harvested in 4% calcium chloride solution, followed by drying and storage in order to provide protection against parasitic diseases. Also, another important factor in the protection of the *Pomacee* is the application of the latest fungicide treatments to combat the diseases caused by the fungi that develop during the period of keeping the fruits fresh. The practice shows that fruits treated with Merpan (50%; 80%), Delan (70%); Ditan (40M) at the end of July or the beginning of the august had a good resistance in storage conditions. Also, it should be noted that in case that some fruits present blows, attack of pests, physiological disorders or diseases are not stored. Also, it should be noted that all diseases can be stopped by a higher $CO_2$ concentration, low of $O_2$ which leads to the storage of fruits in controlled (AC) or modified atmosphere (AM) (Petcu *et al*, 2014). In order to ensure the need of fresh fruits of consumers, regardless of the season, it is resorted to keeping them under specific conditions.

The main purpose of the current research consists in highlighting the conditions of storage in normal atmosphere (3…4°C, Ur = 90 – 95%) on the different varieties of apples stored within the fruit stored at SC Cerasus Group SRL.

## MATERIAL AND METHODS

The objectives of this study consisted in the evaluation of the physico – chemical and phytosanitary characteristics of some varieties of apple kept in the storage with normal atmosphere after one month, respectively 4 months of storage. Thus, there were made the following determinations: - evaluation of physical properties (average weight, diameter and firmness); - evaluation of some chemical constituents (total dry matter content – SUT; $H_2O$; soluble dry matter SUS (sugars); vitamin C; malic acid content (g/100 g – titrable acidity); pH – value and determination of gluco – acidimeters index.

The biological material was represented by six varieties of apples (*Golden Reinders, Golden Delicious, Gala, Jonared, Idared și Braeburn)* harvested from the orchards of Cotnari area, Iasi county, which were kept in the storage of Cerasus Group from Cotnari, Iași.

This deposit was set up by a local producer, being provided with six cells (5 for storage and one for shipping, a conditioning – sorting – packing room, with a storage capacity of 820 tons for apples and 150 – 180 tons of cherries) having as object of activity the commercialization of fruits.

The samples were collected from storage containers by quarters method from the batches of apples that were harvested during the august – september period of 2018 year.

The working methodology complied with the actual standard. The determination of the average weight consisted of weighing the entire sample and the value resulted being divided by the total number of products that make up the sample.

The diameter was determined by measuring the diameter in the equatorial area of the fruits.

The pH value was determined by using the pre-calibrated *Hanna Instruments*.

The content in SUT and $H_2O$ was determined by the classic drying method in the oven and the vitamin C content was determined by extracting it with oxalic acid 2% and volumetric titration with 2,6 – *dichlorophenolindophenol*.

The titrable acidity was determined by titration with 0,1N NaOH in the presence of *phenophthalein*, the results being expressed in g malic acid/ 100 g produce.

The soluble dry matter was determined on the juice extracted from the samples using the hand press and the refractive index readed was expressed as a percentage of sucrose with the Zeiss refractometer.

The gluco – acidimetric ratio was calculated by diveding the SUS value content to the acidity value.

The phyto-sanitary evaluation consisted in the direct observation of the external appearance, of the integrity of the pericarp and mesocarp, on the presence of physiological disorders and diseases by direct comparation with the descriptive sketch.

## RESULTS AND DISCUSSIONS

The average weight values, diameter, firmness and pH-values for all varieties analyzed highlight low values in January vs. November.

The size of the apple fruit is assessed by two different parameters, such as weight and diameter. These indicators are important in order to establish the optimal period of harvest, the mode of transport, the storage period and the type of packaging.

The average weight of the 6 varieties analyzed in November showed values that fell within the delimited range of variation lower of

176 g (for the *Braeburn* variety) and higher of 279,8 g for the *Ionared* variety.

Depending on the specific weight, apples are grouped as follows: large fruits 180 – 220 g (*Golden Reinders, Golden Delicious* in november, *Gala, Jonagored, Idared*), medium to large fruits 170 – 190 g (*Braeburn* in January) and medium fruits 130 – 160 g (*Golden Delicious* in January, *Braeburn* in January). The values obtained were correleted with the data from the literature and it was observed that only some varieties, such as *Braeburn* fall within the limits of standard values; and in this case of *Gala* and *Jonagored* varieties, surplus values were registered, compared to the standard values. In the case of *Golden delicious* variety, the reduced weight (161 g) can be determined by the poor management system of fruit crops, as well as by non – compliance with the optimal storage parameters (*Table 1*).

The values obtained in January for the average weight ranged between the minimum limit of 155.3 g (*Braeburn* variety) and the maximum limit of 254,2 g (*Ionagored*). The resulting weight losses between the two different analysis intervals ranged from a minimum of 6% for the *Gala* variety to a maximum of 12; 12,3 and 15% for *Braeburn*, *Golden Delicious* and *Golden Reiders* varieties.

In *table 1* is presented the diameters of the apples varieties investigated in the two intervals of storage, with values between 65 mm for Braeburn variety and 84 mm for the Idared variety. All varieties analyzed correspond to the calibration requirements (minimum 60 mm) (*table 1*).

Weight and diameter losses, respectively, may be due to metabolic processes during storage.

The firmness value decreases, the differences between the two harvesting periods being between 0.7 kgF/ $cm^2$ (*Jonared*) and a significant difference of 1.9 kgF/ $cm^2$ for *Braeburn*. Compared to the reference values that highlight an appropriate retention for firmness values between 5 – 7 kgF/ $cm^2$, it is imperative to expedite the removal from the storage the *Braeburn* variety, which has a firm value of 5.7 kgF/ $cm^2$ in January. Therefore, analyzing the results of the apples firmness, it is found that in both intervals of analysis the apples were still suitable for storage and transport, with the exception of the *Idared* variety (in January) which have to be given for consumption or processing.

The acidity provides information on the degree of ripeness and quality of the fruit.

The pH values were within the reference limits between 3.6 to 5 in both quality control intervals. There is a slight decrease in pH for all varieties analyzed, which is closely correlated with an increase in the percentage of sugars of 1% due to the hydrolysis of the starh and its transformation into reducing carbohydrates during storage compared to the values obtained in November.

Table1

**Results regarding the physical parameters of apples varieties during storage analysed in November and January**

| Varieties | Average weight (g) | | Horizontal fruit Diameter (mm) | | Firmness (kgF/ $cm^2$) | | pH value | |
|---|---|---|---|---|---|---|---|---|
| | N | I | N | I | N | I | N | I |
| *Golden Reinders* | 224.4 | 190.2 | 76 | 69 | 7.8 | 6.7 | 3.9 | 3.9 |
| *Golden Delicious* | 183.4 | 161 | 72 | 65 | 7.1 | 5.6 | 4.3 | 4.2 |
| *Gala* | 210.8 | 198.4 | 77 | 74 | 7.3 | 6.2 | 4.29 | 4.18 |
| *Jonagored* | 279.8 | 254.2 | 82 | 78 | 7.1 | 6.5 | 4.6 | 3.9 |
| *Idared* | 242 | 219.5 | 84 | 72 | 6.4 | 4.8 | 3.8 | 3.6 |
| *Braeburn* | 176 | 155.3 | 70 | 65 | 7.5 | 5.7 | 3.9 | 3.8 |

The titrable acidity provides information of the freshness, ripeness and health of the fruit. The indicator may be in surplus during the leverage period and deficient at oversaturation.

The titrable acidity varies between the minimum limit of 0.4 g malic acid/ 100 g apple for the *Golden Reiders*, *Golden Delicious* and *Gala* varieties *in* January and the maximum 0.8 g malic acid/ 100 g for the *Idared* variety in november. All the results obtained fall within the limits of the reference values established by the literature (0.27 – 1.02 malic acid/ 100 g apple) (*table 2*).

The titrable acidity values recorded in January are lower compared to the results obtained in november. This decrease in acidity may be due to the early harvest of the fruit, as well as to the unsuitable atmospheric composition, the high storage temperature and the long shel life.

The vitamin C content varies depending on the variety and the way that products are harness; fresh fruits having a maximum content in vitamin

C at harvest (Irimia L., 2013; Murariu O.C. *et al* 2014; 2017; 2018). The results obtained for the vitamin C content in November indicate a fit in the reference values (2 – 10 mg/ 100 g)(Davey *et al*, 2000) for all varieties analyzed except the Golden Reiders variety which is lower (5.28 mg/ 100 g). Most varieties show a decrease in vitamin C content of 2 mg/ 100 g in january, with the exception of *Golden Reiders* variety which keep their values constant losses that may be due to the long storage period and the evolution of the maturation process (*table 2*)..

Tabelul 2

**Results regarding the chemical characteristics apples varieties during storage analysed in November and January**

| Varieties | Vitamin C (mg/100 g) | | Titrable acidity (g malic acid/ 100 g) | | Soluble dry matter (%) | | Gluco – acidimetric index | | Total dry matter (%) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | N | I | N | I | N | I | N | I | N | I |
| *Golden Reinders* | 5.6 | 5.3 | 0.6 | 0.4 | 12.0 | 12.8 | 20.0 | 32.0 | 13.4 | 15.2 |
| *Golden Delicious* | 7.0 | 5.4 | 0.5 | 0.4 | 13.4 | 14.2 | 26.8 | 35.5 | 11.6 | 13.4 |
| *Gala* | 7.1 | 7.0 | 0.5 | 0.4 | 10.5 | 12.8 | 21.0 | 32.0 | 13.4 | 13.6 |
| *Jonagored* | 7.1 | 5.3 | 0.7 | 0.6 | 12.4 | 13 | 17.7 | 21.6 | 13.1 | 13.7 |
| *Idared* | 7.0 | 5.5 | 0.8 | 0.7 | 11.6 | 12.4 | 14.5 | 17.7 | 15.0 | 15.4 |
| *Braeburn* | 8.8 | 7.0 | 0.7 | 0.6 | 11.0 | 12.2 | 15.7 | 20.3 | 12.8 | 13.1 |

Table3

**Results regarding the quality and disease presence of apples varieties during storage analysed in November and January**

| Varieties | Storage period | Extra | Cal I | Cal II | *Venturia inequalis* | *Monilinia fructigena* | *Botrytis cinerea* | *Alternaria* | Bitter stain | Internal crash | Pericarpal defects |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Golden Reinders* | N | 97.5 | - | - | - | - | - | - | - | - | P |
| | I | 96.8 | - | - | - | - | - | - | - | - | P |
| *Golden Delicious* | N | - | 87.3 | - | - | - | - | - | - | - | - |
| | I | - | 87 | - | - | - | - | - | - | p | - |
| *Gala* | N | - | 88.9 | - | - | - | - | - | - | - | - |
| | I | - | 89.7 | - | - | - | - | - | p | - | - |
| *Jonagored* | N | 98 | - | - | - | - | - | - | - | - | - |
| | I | 97.2 | - | - | - | - | - | - | - | - | p |
| *Idared* | N | 90.7 | - | - | - | - | - | - | - | - | - |
| | I | 91.7 | - | - | - | - | - | - | - | - | - |
| *Braeburn* | N | | 86.4 | - | - | - | p | - | - | - | - |
| | I | | 88.2 | - | - | - | - | - | - | - | - |

Literature indicates that the dynamically controlled atmosphere maintains the post-harvest quality of apple by reducing the rate of respiration and ethylene production. The physiological disorders produced by ethylene, such as scalding, are completely suppressed. Also, the resistance and color of apple are higher due to storage in the controlled atmosphere. In conclusion, the controlled atmosphere maintains the physico – chemical and organoleptic quality of apples, but the high concentration of $CO_2$ and low concentration of $O_2$ causes damage to the fruit.

Soluble dry matter content is most higher with the degree of ripening of the apples is more advanced. In table 2 it is showed the results obtained in the two periods on the soluble dry matter content. The analyzed varieties registered values between 10.5% for *Gala* variety in November and 14.2 for *Golden delicious* in January. All values obtained for soluble dry matter was higher in January. The increase of soluble dry matter content is due to the ripening of the fruit. During the ripening process the sugar content increases and the taste of apple was sweeter.

Apples are in optimal taste balance and can be eaten fresh at a certain value of soluble dry

matter/ acidity ratio. The value of the index is characteristic of each astringent, swet and sour variety (*table 2*). The gluco – acidimetric index values show values between the minimum of 14,5 (*Idared* in november) and the maximum of 35.5 (*Golden delicious* in January). This values indicate that apples have a sweet taste. It should be noted that the results recorded in January are higher compared to those recorded in November, due to the maturation process which is characterized by increased sugar content and decreased acidity.

In *table* 2 are presented the values of total dry matter obtained for the samples analyzed in November and January. The total dry matter content varied between the minimum of 11.6% for the *Golden delicious* in November and the maximum of 15.4% for *Idared* in January. It is observed that almost all the values obtained in November and January respectively are lower than the rerference value (15%) (Moțoc D. *et al*, 1971) excepting the *Golden Reiders* variety and the *Idared* variety in both ranges which showed values close to the reference values.

The results regarding the disease presence on apples was followed by visual examination of the apples, which consisted of direct observation of the integrity of the pulp, the external appearance. The presence of gray rot (*Botrytis cinerea*), stings caused by various insects, internal crash and post – harvested physiological disorders were observed (*table 3*). Consequently, after the visual assessment, the presence of gray rot (*Botrytis cinerea*) in the *Braeburn* variety in November, physiological disorders, namely, bitter spot in the *Gala* variety in January, stings in the varieties *Golden Reinders* (samples from November and January) and *Jonagored* (in January).

Depending on the total score of organoleptic evaluation, the apples are classified by quality, as follows: Extra quality: 90 – 100 points; First quality: 65 – 90 points; Second quality: 31 – 65 points and Lower quality: less than 30 points.

In the case of the organoleptic examination carried out in November, the total score varies between 86.4 points for the *Braeburn* variety and 98 points for the *Jonagored* variety and in January the score varies between 87 points for the *Golden delicious* variety and 97.2 points for the *Jonagored* variety. Analyzing the obtained results, it is observed that the *Jonagored* variety registered the highest score, both in November (98 points) and in January (97.2 points).

## CONCLUSIONS

Consequently, apples provide a convenient matrix through which nutrients and other health – related food components can be provided to humans. Apples are a good source of vitamin C.

Results indicates that the normal atmosphere with controlled condition from deposit maintains the post – harvest quality of apples by reducing the rate of respiration and ethylene production. The physiological disorders produced by ethylene, such as scalding, are completely suppressed. Also, the resistance and color of apple are higher due to storage in the controlled conditions.

In conclusion, the controlled conditions maintain the physico – chemical and organoleptic quality of apples, but the high concentration of CO2 and low concentration of O2 causes demage to the fruits. Thus, further research is needed to improve the technology of the dynamically controlled atmosphere, to minimize the level of $CO_2$ and $O_2$, as well as the injuries produced during long – term storage.

## ACKNOWLEGMENTS

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## REFERENCES

**Davey M.W., Montagu M., Inze D., Sanmartin M., Kanellis A., Smirnoff N., Benzie J., Strain J., Favell D., Fletcher J., 2000 –** *Plant L – acorbic acid: chemistry, function, metabolism, bioavailability and effects of processing*, Journal of the Science of Food and Agriculture, 80:825 – 860.

**Goncearov M., Petcu C., Antoniu S., 2004 -** *Hazard analysis critical control points - a modern concept regarding food quality and safety*, Scientific Papers: Veterinary Medicine, Timişoara, 37:868-872.

**Irimia L.M., 2013 -** *Cotrolul și expertiza calității legumelor, fructelor și produselor derivate*, Ed. I.I. de la Brad Iași.

**Jamba A., Carabulea B., 2002 –** *Tehnologia păstrării și industrializării produselor horticole*, Editura Cartea Moldovei, Chișinău.

**Moțoc Dumitru, Dimitriu M., 1971 –** *Biochimia produselor alimentare*, Ed. Didactică și Pedagogică București.

**Murariu O.C., Irimia L.M., Robu T., 2017-** *Analiza și controlul calității produselor din fructe și legume – Îndrumător de lucrări practice*, Ed. I.I. de la Brad Iași.

**Murariu O.C., Irimia L.M., Robu T., Murariu F., Arsenoaia V., 2018 –** *The influence of storage condition on some bioactive compounds of berrie fruits and those human health promoting,* Lucrări Științifice.Seria Horticultură, 61 (2):222 – 228.

**Murariu O.C., Irimia L.M., Robu T., 2017-** *Analiza și controlul calității produselor din fructe și legume – Îndrumător de lucrări practice*, Ed. I.I. de la Brad Iași.

**Murariu O.C., Șan E., Robu T., Irimia L.M., Ratu R.N., Murariu F.,** 2018 – *Evaluation of the presence nof the pesticides residues and it's metabolites from raw materials used as sources for ensuring a healthy nutritions for athlets*, Proceeding of ICU, 185 – 191.

**Murariu O.C., Irimia L.M., Anghel R., Murariu F.,** 2014 – *Research on the apples quality marked in the Moldova area from the physico – chemical and sensorial point of view*, Lucrări Științifice. Seria Horticultură, 57(1):195 – 198.

**Petcu C.D., Savu C., Mitrănescu E., Chirilă S., 2007 -** The *implementation of the integrated quality and food safety management system in the food industry units*, Lucrări Ştiințifice Medicină Veterinară, Timișoara, vol. XL, pg. 545-51.

**Petcu C.D., Şulea C., Dumitrache M., 2014 -** *Audit of Producers/Users of Compressed Air and other Industrial Gases used in the Food Industry, Quality*-Access to Success, 15 (130).

**Ranganna S., 2008 –** *Handbook of analysis and quality control of fruits and vegetable products*, by Tata McgRaw – Hill Publishing.

**Sumedrea D., Florea A., Sumedrea A., Asănică A., Coman R., Militaru M., Chițu E., Butac F., Marin FC., Calinescu M, 2018 –** *Influence of different storage methods on apples chemical proprieties*, Agriculture for Life – Life for Agriculture, Bucharest, 1(1):316-321.

# YIELD AT 75 EUROPEAN SOYBEAN VARIETIES FROM DIFFERENT MATURITY GROUPS IN THE CLIMATIC CONDITIONS OF THE TRANSYLVANIAN PLAIN

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**Abstract**

Soybean being the most important legume plant for grains, the high protein and oil content determines many uses, which leads to expansion of soybean crop areas. The experiment was conducted at Agricultural Research and Development Station Turda (ARDS Turda) in the climatic conditions of the 2018 and 2019. Biological material included 75 Romanian varieties (12) and foreign genotypes (63), from different maturity groups (000 - II). The rainfall and temperature varied in the two-year study which determined differences on average yield obtained for each maturity group. The highest average yield for the maturity groups 00, 0, I, II was obtained in the climatic conditions of the year 2019, instead the behavior of the very early genotypes (000) was different, the year 2018 being more favorable. The maturity group recommended till now for the Transylvanian Plain was very early (000) and early (00), but from the data presented the highest yields were obtained by the maturity groups 0 (2719 kg/ha), I (2895 kg/ha) and I + II (2732 kg/ha). A continuation of the study is required, to establish the suitable maturity group for the new conditions of Transylvanian Plain.

**Key words**: soybean, maturity group, yield, climatic conditions

Soybean is the most important legume plant for grains, and one of the most important protein crops in the world. Its great economic importance leads from its many uses, but also from the chemical composition of the grains: approximately 40% protein, 20% lipids, 17% cellulose and hemicelluloses, 7% sugars and about 6% ash (Pratap A. *et al*, 2011).

These qualitative traits corroborated with the special role it plays in crop rotation and atmospheric nitrogen fixation determined the increased of the areas with soybean crop worldwide. The process of plant growth and development is important to the successful adaptation of a species to its geographic and climatic environment. Adaptation of a species to the growing season of a region ensures the species' reproductive success. The breeding process can also be important in improving a crop's yield potential (Guriqbal S., 2009). Genotype × environment interactions (G × E) induce differential response of soybean in variable environmental conditions (Carrera C. et al, 2011).

High temperature and water deficit are the major abiotic factors that restrict plant growth (Jumrani K. and Bhatia V.S., 2018).

In Europe, about 40 million tons of soybeans are consumed annually, most of them coming from imports (Dima D.C., 2015). Europe has great potential for soybean cultivation in the Danube region, Romania being one of the countries with high potential for soybean cultivation. By establishing the Donau Soja Association, various programs for farmers, consumers and research programs have been developed. With a lack of information on the favorable conditions for each maturity group in the Danube region, following the Friesing researchers meeting, the European trials soybean varieties was initiated.

Several European countries, such as Romania, Croatia, Austria, Switzerland, Italy, Serbia, Slovakia, France, Germany, Poland, the Czech Republic and the Netherlands, took part in this study. Each country participating in this study had several test centers, their total number was 34 centers.

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## MATERIAL AND METHOD

The biological material studied included 75 soybean genotypes, of foreign and Romanian origin, from different maturity groups (000 - II). The genotypes studied were representative of each country, so from Romania there were 12 varieties from maturity groups very early, early, medium, tardive and very tardive. The biological material of foreign origin represented 63 genotypes from maturity groups 000, 00, 0, I and II, from countries such as: Croatia (11), Austria (13), Switzerland (9), Italy (17), Serbia (6) and France (7).

The experience was carried out for a period of 6 years (2014 - 2019) in the Soybean Breeding Laboratory at ARDS Turda. In 2014, the experience was performed respecting the established protocol as three-meter row in two randomized repetitions for each maturity group. The observations were made according to Fehr and Caviness (American rating scales). From 2015 the genotypes were analyzed also from yield point of view, each variety was mechanized sown on 2 rows with a length of 12 m, the distance between rows of 50 cm the harvestable surface being 10 $m^2$. The present paper is a review of the yield data obtained and the behavior of each maturity group in climatic condition of ARDS Turda in the years 2018 and 2019.

## RESULTS AND DISCUSSION

The climatic conditions during vegetation season can have either negative or positive impact on soybean plant development and also crop yield.

The impact of climate variability on soybean yield is very important not only at national but also at global scales. The vegetation stages and grain yield of the studied soybean genotypes were influenced by atypical climatic conditions of the experimental years.

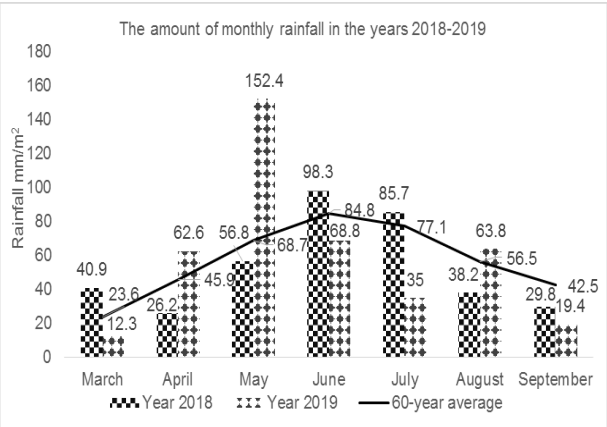



Figure 1 **The amount of monthly rainfall in the years 2018 – 2019**

Average monthly rainfall at Turda during the cropping periods (March to September) was lower than average over the last 60 years in the first experimental year, and higher in the second year (*figure 1*).

With respect to monthly temperature for two years during the experimental periods in 2018 and 2019 we notice a general tendency of warming of the weather, the months of June and August being not only droughts but also very warm (*figure 2*).

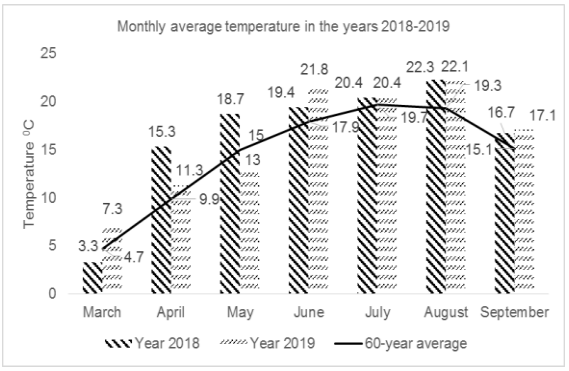



Figure 2 **Monthly average temperature in the years 2018 – 2019**

The experimental data are summarized in *table 1*, *table 2*, *table 3*, *table 4* and *table 5* highlighting genotypes from each maturity group with the maximum values for grain yield: Diamant (MG 000) with 3059 kg/ha in 2019 year; Flavia (MG 00) with 3257 kg/ha in 2019; Valjevka (MG 0) with 3691 kg/ha in 2018; Astafor (MG I) with 3693 kg/ ha in 2018; Ecudor (MG II) with 3598 kg/ha in 2018.

The highest average yield for the maturity groups 00, 0, I and II was obtained in the climatic conditions of 2019, instead the behavior of the very early genotypes (000) was different, the year 2018 being favorable. Although the highest yields were registered for maturity groups 0, I, and II, they did not significantly exceed the average yield of the 00 (early) the maturity group recommended for the Transylvanian Plain.

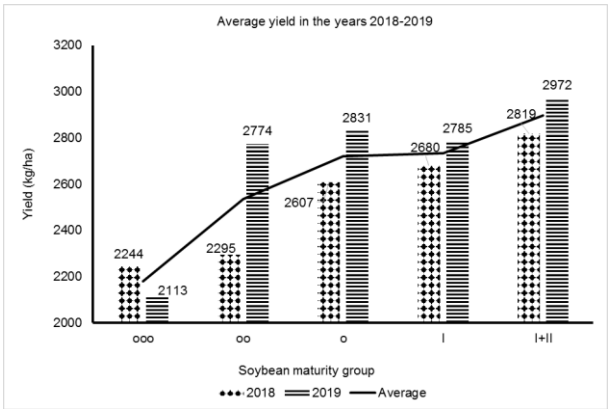



Figure 3: **Average yield in the years 2018 – 2019**

The yield of soybean genotypes from MG 000 (*table 1*) varied in the first experimental year

between 1460 kg/ha (Sultana) and 2716 kg/ha (Tourmeline) and between 1355 kg/ha (Amandine) and 3059 kg/ha (Diamant) in 2019. The average yield in the experimental years of the 15 very early soybean genotypes was 2179 kg/ha.

The obtained data for the MG 00 (*table 2*) reveals varieties yield with higher than 3 t/ha like: Cristina TD, Flavia, Christine with: 3035 kg/ha (2018 year), 3257 kg/ha (2019 year) respectively 3023 kg/ha (2019 year).

The highest yielding MG were 0, I and II with an average production of: 2719 kg/ha, 2732 kg/ha and 2895 kg/ha (*table 3, 4, 5*). According to the climatic conditions for the experimental years, the yield obtained for the tardy maturity groups (0, I and II) was higher than the results for maturity groups recommended for the Transylvania Plain (00 and 000) but the difference was small and nonsignificant (*figure 3*).

Table 1

**Average of the obtained yields for the maturity group 000 in the years 2018 – 2019**

| No. | Variety | Yield kg/ha 2018 | Yield kg/ha 2019 | Average yield kg/ha |
|---|---|---|---|---|
| 1 | SULTANA | 1460 | 1913 | 1687 |
| 2 | PERLA | 2320 | 2752 | 2536 |
| 3 | AMANDINE | 1875 | 1355 | 1615 |
| 4 | MERLIN | 2475 | 2141 | 2308 |
| 5 | LISSABON | 2599 | 2068 | 2334 |
| 6 | GALLEC | 2301 | 1895 | 2098 |
| 7 | TOURMELINE | 2716 | 2532 | 2624 |
| 8 | CH 22/174 | 2581 | 2081 | 2331 |
| 9 | MALAGA | 2288 | 2001 | 2145 |
| 10 | CH 21414 | 2200 | 2046 | 2123 |
| 11 | CAPNOR | 2239 | 2056 | 2148 |
| 12 | ABELINA | 2339 | 1529 | 1934 |
| 13 | CH 22/172 | 2088 | 1833 | 1961 |
| 14 | ES SENATOR | 2204 | 2439 | 2322 |
| 15 | DIAMANT | 1971 | 3059 | 2515 |
| Average | | 2244 | 2113 | 2179 |

Table 2

**Average of the obtained yields for the maturity group 00 in the years 2018 – 2019**

| No. | Variety | Yield kg/ha 2018 | Yield kg/ha 2019 | Average yield kg/ha |
|---|---|---|---|---|
| 1 | CARLA TD | 2181 | 2659 | 2420 |
| 2 | FORTUNA | 1853 | 2664 | 2259 |
| 3 | SIGALIA | 1918 | 2763 | 2341 |
| 4 | FELIX | 2412 | 2954 | 2683 |
| 5 | EUGEN | 2684 | 2902 | 2793 |
| 6 | KORANA | 2550 | 2984 | 2767 |
| 7 | OANA F | 1922 | 2848 | 2385 |
| 8 | ES MENTOR | 2187 | 2797 | 2492 |
| 9 | CRISTINA TD | 3035 | 2946 | 2991 |
| 10 | FLAVIA | 2945 | 3257 | 3101 |
| 11 | CHRISTINE | 1843 | 3023 | 2433 |
| 12 | ONIX | 2738 | 2716 | 2727 |
| 13 | PROTEIX | 2150 | 2128 | 2139 |
| 14 | AMPHOR | 2323 | 2905 | 2614 |
| 15 | JOSEFINE | 1689 | 2070 | 1880 |
| Average | | 2295 | 2774 | 2535 |

Table 3

**Average of the obtained yields for the maturity group 0 in the years 2018 – 2019**

| No. | Variety | Yield kg/ha 2018 | Yield kg/ha 2019 | Average yield kg/ha |
|---|---|---|---|---|
| 1 | BAHIA | 3249 | 3404 | 3327 |
| 2 | ESG 121 | 2772 | 3118 | 2945 |
| 3 | TERRAPRO | 3595 | 3517 | 3556 |
| 4 | AIRES | 1665 | 2264 | 1965 |
| 5 | HILARIO | 2828 | 2698 | 2763 |
| 6 | LUCIJA | 2950 | 3026 | 2988 |
| 7 | DACIANA | 2291 | 2843 | 2567 |
| 8 | PICOR | 2444 | 2796 | 2620 |
| 9 | PEPITA | 2448 | 2472 | 2460 |
| 10 | BUGA | 2709 | 2443 | 2576 |
| 11 | GALINA | 2174 | 2958 | 2566 |
| 12 | PEDOR | 1892 | 2668 | 2280 |
| 13 | COLUMNA | 2011 | 2702 | 2357 |
| 14 | VALJEVKA | 3691 | 3126 | 3409 |
| 15 | ANA | 2393 | 2432 | 2413 |
| Average | | 2607 | 2831 | 2719 |

Table 4

**Average of the obtained yields for the maturity group I in the years 2018 – 2019**

| No. | Variety | Yield kg/ha 2018 | Yield kg/ha 2019 | Average yield kg/ha |
|---|---|---|---|---|
| 1 | ZLATA | 2718 | 2710 | 2714 |
| 2 | SAVA | 2707 | 3048 | 2878 |
| 3 | CASTETIS | 2448 | 2148 | 2298 |
| 4 | SG EIDER | 2025 | 2616 | 2321 |
| 5 | ADONAI | 3350 | 2583 | 2967 |
| 6 | IKA | 2628 | 2705 | 2667 |
| 7 | ZORA | 3114 | 2975 | 3045 |
| 8 | TRIUMF | 2096 | 2927 | 2512 |
| 9 | ASTAFOR | 3693 | 2825 | 3259 |
| 10 | ISIDOR | 3268 | 2324 | 2796 |
| 11 | ZAGREPCANKA | 2343 | 2926 | 2635 |
| 12 | RUZICA | 2317 | 3208 | 2763 |
| 13 | CRINA F | 2087 | 2961 | 2524 |
| 14 | SANSA | 2276 | 3564 | 2920 |
| 15 | OPTIMUS | 3128 | 2252 | 2690 |
| Average | | 2680 | 2785 | 2732 |

Table 5

**Average of the obtained yields for the maturity group I + II in the years 2018 – 2019**

| No | Variety | Yield kg/ha 2018 | Yield kg/ha 2019 | Average yield kg/ha |
|---|---|---|---|---|
| 1 | ASCASUBI | 2714 | 2640 | 2677 |
| 2 | TENA | 2877 | 2858 | 2868 |
| 3 | BLANCAS | 2974 | 2716 | 2845 |
| 4 | EIKO | 3231 | 3014 | 3123 |
| 5 | VENERA | 3136 | 3204 | 3170 |
| 6 | PACO | 1976 | 2451 | 2214 |
| 7 | SPONSOR | 2624 | 2837 | 2731 |
| 8 | PACIFIC | 2451 | 2832 | 2642 |
| 9 | MITSUKO | 2691 | 3271 | 2981 |
| 10 | BUENOS | 2984 | 3029 | 3007 |
| 11 | HIROKO | 2406 | 3068 | 2737 |
| 12 | ECUDOR | 3598 | 2980 | 3289 |
| 13 | DEKABIG OPT | 2527 | 3169 | 2848 |
| 14 | LUNA | 3124 | 3285 | 3205 |
| 15 | CELINA PZO | 2968 | 3229 | 3099 |
| Average | | 2819 | 2972 | 2895 |

## CONCLUSION

In the climatic conditions from ARDS Turda in the years 2018-2019 the average yields obtained were between 2179 kg/ha (000) and 2895 kg/ha (I + II).

The highest average yield for the maturity groups 00, 0, I, II was obtained in the climatic conditions of the year 2019, instead the behavior of the very early genotypes (000) was different, the year 2018 being more favorable.

Although the highest yields were registered for maturity groups 0, I, and II, they did not significantly exceed the average yield of the 00 (early) the maturity group recommended for the Transylvanian Plain.

The conditions of the experimental years 2018 and 2019 are favorable for maturity groups 0, I and II, but there is a risk that the material will not reach maturity when the amount of degrees useful for plant development is not reached.As the climate is in a continuous process of change and the years are more difficult, with uneven amount of rainfall, high temperatures that influence the development of plants, a continuation of the study is required, to establish the suitable maturity group for the new conditions of Transylvanian Plain.

## REFERENCES

**Carrera C., Martínez M. J., Dardanelli J., Balzarini M. 2011.** *Environmental Variation and Correlation of Seed Components in Nontransgenic Soybeans: Protein, Oil, Unsaturated Fatty Acids, Tocopherols, and Isoflavones.* Crop Science, 51(2),800.

**Dima D.C., 2015**. *Soybean Crop in Romania, Bulgaria and the Republic of Moldova: Current Situation and Perspectives.* Agriculture and Agricultural Science Procedia*, 6,*

**Guriqbal Singh, 2009**.*The Soybean Botany, Production and Uses, Department of Plant Breeding and Genetics Punjab Agricultural University Ludhiana, India*, available on-line at: https://epdf.pub/the-soybean-botany-production-and-uses.html.

**Jumrani K., Bhati, V.S., 2018**: *Impact of combined stress of high temperature and water deficit on growth and seed yield of soybean*. – Physiol Mol Biol Plants 24(1): 37- 50.

**Pratap A., Gupta S.K., Kumar, J., Solanki R.K., 2011.** *Soybean. Technological Innovations in Major World Oil Crops,* Volume 1, *293–321.*

# RESEARCH REGARDING THE INFLUENCE OF CONSERVATION BY USING DEEP – FROZEN METHODOLOGY OVER THE QUALITY OF SOME HORTICULTURE PRODUCTS

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**Abstract**

Vegetables improve human life by means of the many nutrients they contain. The nutritional quality of frozen products is intensified by the quality of the raw material, which uses correct manufacturing practices in the preservation process, while horticultural products are stored at the appropriate temperature. Competing with new minimum food processing technologies, industrial freezing is the most satisfactory method for maintaining quality for long storage periods. The main purpose of this study is to determine the influence of a preservation process based on the use of the cold, of cryoanabiosis, respectively on fresh vegetables frozen using a domestic and industrial method. We monitored the possible qualitative changes after the storage of the frozen biological material and the difference between the application of a home preservation technology, respectively the application of an industrial preservation technology on the products under analysis. The main objectives of the study are to examine the quality of frozen vegetables by determining the sensory and physical-chemical characteristics of cold-preserved products. The study material to be analysed is represented by three species of vegetables, as follows: carrot (*Daucus carota*), root parsley (*Petroselium crispum*), respectively broccoli (*Brassica oleracea*). The sensory evaluation of the products studied showed that frozen products using the industrial system had superior characteristics compared to those frozen at home. It is found that after the freezing of horticultural products using a domestic and industrial method there were no significant differences in the results of physical and chemical tests, as these kept their nutritional value high. Regarding the pH results, the biggest differences were identified in the case of broccoli. Thus, as the frozen broccoli in the industrial system registered a value of 5.7, and the frozen broccoli in the domestic system a value of 6.58. Acidification of the product may occur due to the freezing of water in the cells, followed by an increasingly concentrated accumulation of cell fluid containing diluents and colloidal substances. The water content increased in the case of products frozen by using a domestic system, presenting higher values as compared to the humidity of industrial frozen products, but also compared to the reference values as follows: carrots and parsley registered a humidity of 90% and 86%, respectively. The higher value in the case of the humidity parameter is caused by a higher amount of released cell juice, due to a slow freezing which led to the formation of ice crystals or to the occurrence of the plasmolysis phenomenon. The soluble dry matter shows several differences. Products frozen at home have higher values compared to industrially frozen products. The most significant difference appears in the case of root parsley frozen at home with a value of 11%. Therefore, freezing showed the following advantages: the lowering of the temperature of the product below 0℃ ensured the keeping of the plant product longer, and most of the biochemical reactions were stopped during freezing and also the blocking of the multiplication of microorganisms took place.

**Key words:** freezing, horticultural products, vitamin C

Carrot (*Daucus carota*) is an edible root especially popular among vegetables due to its versatility in culinary use and its healthy composition enriched with phytonutrients, fibre and minerals (Lascu D., 2008).

Carrots are sensitive to heat, temperatures higher than 30℃ cause lower quality and poor production, those higher than 24℃ lead to thick and short roots, rich in carotene, and those lower than 13℃ result in thin and long roots, faintly coloured (Ciofu R., 2004). Carrots are stored by silage in the furrow, in bulk, in ditches by sand stratification or stored in warehouses with natural ventilation. The optimum temperature is of 0.5… 30℃, at the relative humidity of 90 - 95%.

Although carrots have the ability to resist long periods in a fresh condition, they are very suitable for freezing, and therefore they are processed in industrial quantities. Economic considerations determine the preservation of this

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vegetable in different sizes, taking into account the influence of the freezing process on total costs. Therefore, small carrots (babycarrot) are frozen as a whole, and large ones take various shapes (cubes, slices).

The flow of technological operations begins with the *calibration, washing, removal* of the package and cleaning of the *shell*. The most efficient method of removing any mineral residue is steam cleaning, on the other hand it leads to the realization of a finished product of very good quality. This stage takes place at a pressure of 7 kg/cm3, 35 seconds (Mihalca G., 1980).

In case of carrots, strong cooling results in better quality. Moreover, without being previously scalded frozen carrots show better results than carrots that have been scalded and then frozen, because the blanching operation can cause the product to lose its consistency and vitamin content (Murariu O.C. *et al*, 2014; 2015). Through the power of separation of the oscillating mass, the removal of the undersized fractions of the carrot takes place. This operation takes place before freezing.

The most efficient method for maintaining the best possible quality of the carrot is represented by the scraped freezing, which uses fluidized layer installations (Murariu F. *et al*, 2019). This may be due to the rapid freezing time, so that both large and irregular ice crystals do not form on the surface of the product and inside it. The freezing time for the whole carrot is 25 minutes, and for the sliced carrot a maximum of 5-6 minutes.

Parsley under the scientific name of *Petroselinum hortense* is part of the *Umbeliferae* family and is widely cultivated as a medicinal plant, a spice and a vegetable.

The root must have the following characteristics in order to be considered suitable for freezing: white, dense, juicy pulp. Parsley from the autumn harvest is preferred.

To obtain a consistent colour and increase the storage period, parsley is scalded for one minute for slices and cubes and 5 minutes for the whole root. In the presence of air there are oxidation reactions that result in the degradation of parsley, especially of unripened parsley, and to avoid this situation it should be kept in cold water with 0.5% salt.

Broccoli is becoming increasingly popular as a fresh vegetable and is a significant source of nutritious antioxidants, such as vitamins and carotenoids. Broccoli is distinguished by the amount of vitamin C it contains, folic acid, beta-carotene and dietary fibre (Tian D., 2016).

Special importance will be given to the preservation of broccoli because it has a high degree of perishability. When kept fresh at a temperature of 10℃, it does not undergo major changes, while at a temperature of 15 - 20℃, broccoli can be affected from a qualitative point of view. Broccoli can be stored for a maximum of 2 - 3 weeks, even in warehouses with a controlled atmosphere the temperature of which is less than 5℃. Research into food preservation technologies usually focuses on one of two aspects: selecting process conditions to minimize product quality loss or developing engineering design methodologies to ensure that the required process can be performed at low cost (Petcu C. *et al*, 2014).

In the latter aspect, heat transfer is usually a major concern. The heat must be removed from the product by cooling or freezing and subsequently the product must be kept at a constant temperature in storage. There are also important effects of moisture transfer, especially evaporation from the product surface. Therefore, the main purpose of the research is to determine the influence of a preservation process based on the use of that cold, cryoanabiosis, on fresh vegetables frozen by a domestic and industrial method.

## MATERIAL AND METHODS

The variation of the qualitative parameters following the technological process of preservation by freezing and the difference between the freezing using an industrial system and a domestic system on the vegetables studied was analysed.

The products of household origin were packed in plastic bags with closing system having dimensions of 20 x 13 cm and a capacity of 1 litre. They were subjected to a heat freezing treatment at a temperature of -18 ℃ for 7 days. The samples frozen using an industrial system were purchased from the Iași commercial network, being packed in polyethylene bags.

In order to determine the quality of the products studied, the following determinations were performed: sensory evaluation and physical-chemical evaluation of horticultural products by determining the physical-chemical parameters: vitamin C (mg/100 g product); humidity (%); pH, soluble dry matter (%).

To perform all the analyses listed above, a suitable instrument is required, as follows: pH meter, Zeiss refractometer, thermostat oven, various reagents that will highlight the desired component (oxalic acid, phenolphthalein, sodium hydroxide), refrigerator (Danivelici C. *et al,* 2006).

The sensory analysis of the vegetables in question was performed by the students of the University of Agricultural Sciences and Veterinary Medicine, Iași, being considered non-specialized tasters and involved the individual filling in of a questionnaire. The evaluation of the defrosted vegetables consisted in the award of grades from 1

to 10, grade 1 representing the most non-compliant condition of the product in question, and grade 10 places the defrosted product in the best quality standard.

The sensory analysis was completed by the centralization of the grades obtained, calculating the arithmetic mean of each property found in the questionnaire and classifying the evaluated horticultural products in a quality category.

Determination of vitamin C is based on the property of ascorbic acid to produce an oxidative-reducing reaction in the presence of 2 - 6 *dichlorphenolindophenol* (Murariu *et al,* 2014; 2017; 2018).

Grind 10 g of vegetable product in a mortar, transfer everything to a 100 ml Berzelius beaker, add 50 ml of distilled water and let it boil in a water bath at 70 ℃ for 20 minutes. After boiling and cooling the sample to 20 ℃, the contents shall be poured into a 100 ml volumetric flask, is brought to the mark and filtered using filter paper into an Erlenmayer flask. From the filtrate take 10 ml over which add 2-3 drops of phenolphthalein and titrate the sample with NaOH, until the colour turns pale pink. When establishing the pH value of the vegetables, a portable pH meter was used, the electrode of which is detachable, with a measurement accuracy of 0.2. Before performing the readings, the pH-adjustment operation will be carried out, using the solutions of electrode calibration buffer and cleaning with distilled water. The pH values of the vegetables will be read from the LCD screen of the pH meter.

The determination of the soluble dry matter is carried out using a Zeiss hand-held refractometer. The preparation of the refractometer consists in wiping the prism and the movable plate using an alcohol-soaked gauze, calibrating the device by putting 2-3 drops of distilled water (20℃) on the movable plate and the closing thereof. Take the refractometer to the eye and adjust the eyepiece, checking that the total reflection limit is 0. If it is not at 0 then it is considered that the device is not calibrated and a correction will be made to the adjusting screw with a screwdriver.

The actual analysis consists in preparing the sample, weighing 50 grams of frozen vegetable product and defrosting it in an Erlenmeyer flask, covering it with a watch glass. The contents are homogenized, a few drops are taken with the help of a stick and placed on the prism of the refractometer.

The determination of the total humidity is based on the weight loss of the biological material analysed using the oven drying method, at a temperature of 70℃, 10 hours. Before being placed in the oven, the samples of each biological material studied are weighed and placed in previously weighted numbered glass or metal ampoules. Drying is considered complete when the difference between two weighings does not exceed 0.005 g. To cool the samples, they are placed in a desiccator, then a new weighing will take place.

## RESULT AND DISCUTIONS

Following the sensory analysis, the suitability of the broccoli and carrot product for preservation with the help of low temperatures was highlighted. The frozen broccoli and carrot product in the industrial system were evaluated with maximum score presenting a colour characteristic to the defrosted product, an odour and a taste specific to the vegetable variety.

At the same time, the industrial freezing results in the preservation of the external properties due to a well-developed system of control of the environment, of the freezing speed and of the air circulation inside the freezing installation.

At the opposite side, the parsley root product stands out for its inferior value due to the following quality parameters: texture, degree of oxidation, degree of hydration, taste and smell.

The amount of vitamin C varies in horticultural products depending on their variety, species and time of harvest. Therefore, vitamin C is found in an amount of 5 mg/100 g fresh carrot product, 150 mg/100 g fresh product represented by parsley root, and in broccoli this content varies between 110 - 113 mg /100 g fresh product (*Lascu D., 2008*).

Defrosted products (in the household) recorded a significant loss of vitamin C. In the case of broccoli, it decreased by approximately 28%, registering an amount of 31.68 mg/100 g of product. Significant losses were recorded in the parsley root, reaching 26.4 mg/100 g of product. For carrots, the freezing process resulted in a decrease of up to 50% of vitamin C. In case of products frozen by using an industrial system, the values are slightly higher, as follows: 37.84 mg/100 g broccoli product, 27.28 mg/100 g parsley root product and 3.52 mg/100 g carrot product.

It can be seen that vegetables frozen by using an industrial technological system obtained better values than vegetables frozen using a domestic system. The most relevant difference is in the case of industrial frozen broccoli, which recorded 6 units more vitamin C. For parsley root and carrot, the differences are of one unit. In the case of carrots, the amount of vitamin C decreases between 0.1 - 0.2% per day, according to specialized reports. The main causes of damage to ascorbic acid are: long storage time, poor storage, all associated with high storage temperatures.

In case of freezing using a domestic system, the losses of vitamin C are higher compared to products frozen by using an industrial system, because the temperature that provides good stability of ascorbic acid is reached over a longer period of time. According to detailed studies, the

degradation appears easier and faster at -18 ℃, instead with an adequate conservation at -25 ℃ it remains unchanged.

The way the product is packaged reduces the ascorbic acid content. Although the products were packed in polyethylene bags with a closure system, the penetration of oxygen was not completely stopped.

The most significant pH difference is in case of broccoli, the one frozen at home has a value of 5.7, and the broccoli frozen at industrial level has a pH of 6.58. Both values fall within the reference values. Differences of two units are found in the case of both root parsley and carrot. Homemade root parsley (P2) has a pH of 5.8 while C2 has a value of 6.07. Homemade frozen carrot P3 has a value of 5.58 and C3 5.72.

Among the most well-known reasons for the change in pH we list:

- in the constitution of the cellular liquid there are substances of dilution and in suspension, which determine the increase of its concentration at the moment of the decrease of the temperature and the initiation of the freezing process, and thus the acidification of the cell takes place;

-phosphates are very insoluble in cell juice and precipitate more slowly, which causes a change in pH by more than one unit.

The relation of the values obtained to those in the research literature highlights the fact that the carrot frozen both in a domestic and in an industrial system has a superior value [90% - 88.42%], along with the parsley root with a water content that has inferior value that falls within the range of variation [82.8% - 82%] (Lascu D., 2008).

The increase in the humidity of the products may be due to temperature fluctuations, thus ice crystals being formed in the tissues, destroying the cells. At the same time, improper storage of the raw material, a slow freezing speed and the degree of maturation can justify a higher humidity.

In the case of products frozen at home, the values of soluble dry matter are represented by the following values: 6.3% for broccoli, 11% for root parsley and 9.8% for carrots. The results of the analysis for industrially preserved products are lower as follows: for broccoli there was a percentage of 5.9%, parsley root 9.6% and carrot 8%. This difference can be explained by the higher degree of maturation of products frozen using the industrial system.

The decrease of the soluble dry matter is caused by the increase of the temperature, which determines the increase of the respiration rate, as the carrot and parsley root have an average respiration rate (5 - 10 $cm^3$/kgh); and to support it, complex carbohydrates are converted to glucose. In this case, the increase in the temperature of the products is given by their preparation for the carrying out of the analysis and removal from the cold room.

## CONCLUSIONS

Following the sensory examination, products frozen by using the industrial system showed better characteristics than those frozen using a domestic system.

The organoleptic analysis of the vegetables resulted in the following things: a decrease in their characteristics after freezing; among vegetables, broccoli and carrots best retain their properties as compared to parsley root.

Both freezing systems have reduced ascorbic acid content by up to 50%.

It is found that after the freezing of horticultural products using a domestic and industrial there were no significant differences in terms of the results of physical and chemical analysis, which kept their nutritional value high.

## REFERENCES

**Ciofu R., 2004 -** *Tratat de legumicultură*. Editura Ceres, București.

**Denivelici C., Nita M., 2006 -** *Controlul conservelor vegetale prin analize senzoriale și fizico-chimice*. Editura Valahia University Press, Târgoviște.

**Gonçalvesa E. M., Pinheiroa J., Abreua M., 2010 -** *Carrot (Daucus carota L.) peroxidase inactivation, phenolic content and physical changes kinetics due to blanching*. Revista Journal of food engineering, volumul 97, pag. 574-581.

**Lascu D., 2008 -** *Enciclopedia alimentelor*. Editura All, București.

**Mihalca Gh., 1980 -** *Congelarea produselor horticole și prepararea lor pentru consum*. Editura Tehnică, București.

**Mihalca V., Mihalca Gh., 1992 -** *Păstrarea alimentelor în gospodărie prin congelare*. Editura Ceres, București.

**Murariu O.C., Irimia L., Robu T., 2017 -** *Analiza și controlul calității produselor din fructe și legume* Editura „Ion Ionescu de la Brad", Iași

**Murariu F., Voda A.D., Murariu O.C., 2019 –** *Researches on food safety assessment – supporting a healthy life style for the population from NE of Romania*, Journal of Biotechnology, vol. 305, S68.

**Petcu C.D., Şulea C., Dumitrache M., 2014 -** *Audit of Producers/Users of Compressed Air and other Industrial Gases used in the Food Industry, Quality-Access to Success*, 15 (130).

**Tian D., Fen L., Jiangang L., Mengli K., Jingfen Y., 2016 -** *Comparison of different cooling methods for extending shelf life of postharvest broccoli*. Zhejiang University, Hangzhou Zhejiang 310058, China.

# THE STUDY OF BROOMRAPE DIVERSITY IN DIFFERENT SUNFLOWER CULTIVATING COUNTRIES BASED ON MORPHOLOGICAL ARAMETERS OF PARASITE SEEDS

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**Abstract**

The root holoparasite *Orobanche cumana* Wallr. produces a very high number of extremely small seeds, which remain viable in the soil for decades and could be easily disseminated through the use of machinery or contaminated seeds. Due this fact and considering the global scale of sunflower seeds exchange, the control of parasite is extremely difficult. Currently broomrape is present in the majority of sunflower cultivation countries and spreads very quickly to new areas. In this context, it is of interest to analyze and highlight distinctive morphological features of *O. cumana* seeds collected from different European and Asian countries, such as the Republic of Moldova, Romania, Bulgaria, Ukraine, Serbia, Spain, Turkey and China. The morphometric analysis (seed length, width and length/width ratio) of broomrape samples did not show significant differences in their size. *O. cumana* seeds ranged between 0.316-0.393 mm x 0.148-0.176 mm, with a L/W ratio of 2.022-2,596. A moderate positive correlation ($r$=0.485) between length and width of broomrape seeds has been revealed. The mean value of L/W ratio in all investigated populations (38) was around 2.3, being in agreement with the results obtained by other authors and showing that *O. cumana* has preferentially elongated shape of seeds comparative to other broomrape species. Comparing to other studies, the mean value of L/W ratio was higher than 2.0 (2.18) even in Chinese populations. The coefficients of variation indicated low values, especially in the case of seed length (6.73-19.56%), which suggests a moderate level of intrapopulational variability, all studied populations being relative homogenous. The analysis of Euclidean distance showed small distances (0.001-0.577) between broomrape populations, the most distant being those collected from Seville (Spain), Tulcea (Romania), Xin Jiang (China), ORSR11 (Serbia), Popeasca and Sarata Mereseni (Republic of Moldova) and Edirne, Kesar (Turkey) in different combinations.

**Key words:** broomrape, *Orobanche cumana*, populations

The root, holoparasite *Orobanche cumana* Wallr. is one of the most important constraint for sunflower production in cultivating countries, which can cause from 20 to 100% yield decreasing (Domínguez J., 1996). The most affected traits are seed yield production, lipid and protein content in the seeds and oil content (Gisca I. *et al*, 2017; Duca M. *et al*, 2013).

Actually broomrape infests 16 million hectares of crop land worldwide and affects around 50% of the world's sunflower crops (*https://www3.nuseed.com*). The high price of oil, as well as the increasing market demand for sunflower seeds, contributes to the continuous growth of the areas cultivated with this culture. Excessive expansion of cultivated areas leads to irrational use of soils, failure of crop rotation, which causes the accumulation of pathogens in the soil.

Broomrape produces a huge number (around 500000 per plant) of extremely small seeds (between 200 and 300 μm), which remain viable in soil for decades (Plaza L. *et al*, 2004). Due to this fact, new infestations can easily occur through the use of machinery or contaminated seeds and the eradication/ prevention of parasitic weed is very difficult, especially considering the global scale of sunflower seeds exchange (Joel D. *et al*, 1987; Dongo A. *et al*, 2012). Breeding for crop resistance remains to be the most effective approach to control the parasite control. However, as response to continuous introduction of new resistant sunflower genotypes, broomrape evaluates, developing another virulent race, which overcomes the resistance (Pérez-Vich B. *et al*, 2013; Vrânceanu A. *et al*, 1980). Thus, during last two decades, highly virulent races of broomrape appeared and spread very quickly to new areas in Turkey (Kaya Y., 2014), Spain (Martin-Sanz A. *et al*, 2016), Bulgaria (Shindrova P., 2006), Romania (Pacureanu M. *et al*, 2009), Moldova (Duca M. *et*

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*al*, 2017b), Ukraine (Burlov B. *et al*, 2006), Russia (Antonova T. *et al*, 2013).

According to recent studies, high genetic diversity and frequency of mutation in relatively homogeneous populations of *O. cumana*, as well as genetic recombination, may be important driving forces of race evolution (Pineda-Martos R. *et al*, 2013; Martín-Sanz A. *et al*, 2016). Thus, in order to propose effective strategies for parasite control and reduction of productivity losses not only breeding efforts, but also better understanding of parasite biology and diversity are required.

Even genetic diversity within and between *O. cumana* populations has been successfully studied using different molecular tools, such as RAPD, ISSR and SSR (Benharrat *et al*, 2002; Duca M. *et al*, 2017c, 2019; Gagne *et al*, 1998; Bilgen *et al*, 2019; Guchetl *et al*, 2014; Pineda-Martos *et al*, 2013) the studies aimed to emphasis diversity within and among populations based on seed morphology, as well as to differentiate sunflower broomrape from different origins and races are still actual (Duca *et al*, 2017a; Krupp A. *et al*, 2014; Plaza L. *et al*, 2004). The usefulness of micromorphological traits of *Orobanche* seeds in differentiation of species or groups of species has been demonstrated by various authors (Abu Sbaih H. *et al*, 1994; Joel D., 1987; Plaza L. *et al*, 2004; Musselman L. *et al*, 1976). The high production of seeds per broomrape shoots, their size and shape, facilitates soil penetration and seed dissemination and are considered important factors in parasite adaptation and evolution (Piwowarczyk K., 2013; Plaza L. *et al*, 2004).

The main objective of this study was to evaluate the morphometric parameters (length, width and the ratio l/w) of broomrape seeds belonging to eight different European and Asian countries, such as the Republic of Moldova, Romania, Bulgaria, Ukraine, Serbia, Spain, Turkey and China.

## MATERIAL AND METHODS

Seed morphology was studied in 38 populations of *Orobanche cumana* belonging to 8 different European and Asian countries, as follow **Serbia** (conventionally noted as – ***1****-ORSR 04;* ***2****-ORSR 07;****3****-ORSR 11;* ***4****-ORSR 14;* ***5****-ORSR 24;* ***6****-ORSR 25;* ***7****-ORSR 43*); **China** (***8****-Xin Jiang;* ***9****-He Bei;* ***10****-Inner Mongolia*); **Turkey** (***11****-Trakia;* ***12****-Adana;* ***13****-Tekirdag;* ***14****-Edirne, Merker;* ***15****-Kirklareli, Luleburgaz;* ***16****-Edirne, Keşar*); **Bulgaria** (***17****-Silanovici;* ***18****-Radnevo;* ***19****-Rosenova;* ***20****-Debovo*), **România** (***21****-Brăila;* ***22****-Tulcea*); **Republic of Moldova** (***23****-Chisinau;* ***24****-Sarata-Merenești;* ***25****-Popeasca;* ***26****-Gura-Galbenei;* ***27****-Prepelița;* ***28****-Izbiste;* ***29****-Svetlii;* ***30****-Alexanderfield;* ***31****- Balti;* ***32****-Taraclia;* ***33****-Egoreni;* ***34****-Singera;* ***35****-Congaz*), **Spain** (***36****-Sevilia*), **Ukraine** (***37****-Odessa;* ***38****-Izmail*).

The morphometric parameters (length, width and the ratio l/w) of broomrape seeds were evaluate by direct observation under light microscopy (Axio Zeiss Scope A1). Seed length was measured using the longest axis from end to end and width was measured using the longest axis at a 90° angle of the length.

Data on the width, length and the ratio l/w of 100 seeds per populations were subjected to elementary statistical procedures (the mean, the standard deviation and coefficient of variation). Statistical calculations of investigated morphological characters of broomrape seeds were performed using XLSTAT software (*https://www.xlstat.com/*).

Morphological characters were evaluated by one-way analysis of variance (ANOVA). The test checks whether there are significant differences in mean values of observed characters between populations. Values were considered significant if $p < 0.05$ in the Tukey test. The correlation between the morphometric parameters of broomrape seeds were tested by calculating the Pearson's correlation coefficient. The data were analyzed by computing, for each pairs, dissimilarity scores among the samples, using the Euclidean distance measure.

## RESULTS AND DISCUTION

Broomrape seeds are smaller than 1.0 mm in length, with a wide variety of shapes (ellipsoid, oblongoid or ovoid) and seed coat (Plaza L. *et al*, 2004; Duca M. *et al*, 2017a). The morphometric analysis of broomrape seeds from eight different sunflower cultivating countries did not show significant differences in their size (*table 1*). Thus, mean seed length of investigated populations varying between 0.316-0.393 mm, with minimal and maximal values in the case of samples from Inner Mongolia (China) and Egoreni (Moldova), respectively. The most of the accession (79%) ranged between 0.341 mm to 0.375 mm.

For the seed length, the coefficients of variation ranged between 6.73-19.56%, which suggests a low level of intrapopulational variability. According to this parameter the most homogenous are populations from Tulcea, Romania (CV=6.73%), followed by Seville, Spain (CV=7.07%), Adana and Edirne, Merker from Turkey (CV=9.49% and 9.83%, respectively) and two populations (Egoreni and Balti) from the Republic of Moldova (CV=9.53% and 9.74%, respectively). Other populations are relative homogenous with the maximal values of CV in the samples belonging from Inner Mongolia, China (CV =19.56%) and Prepelita, Moldova (CV =17,22%).

Regarding the seed width, the lowest values were established in the population collected from Gura Galbenii (Republic of Moldova) followed by

samples from Inner Mongolia (0.148 and 0.149 mm, respectively) and the largest ones (0.176 mm) were revealed in Chinese and Ukrainian populations Xin Jiang and Ismail. In the case of the majority of analysed populations (74%) the width was included in the interval of 0.151-0.167 mm. The seed width was more variable than length, the coefficient of variation ranging between 11.4% and 23.43%, with minimum observed in the samples from Turkey (Kirklareli, Luleburgaz and Tekirdag) and maximum in those belonging to Rosnevo (Bulgaria).

Table 1

**Seed characteristics of *Orobanche cumana* belonging to different countries**

| Locality/ conventional notation | Seed length, mm | CV, % | Seed width, mm | CV, % | Length / Width ratio | CV, % |
|---|---|---|---|---|---|---|
| **Serbia** | | | | | | |
| ***1**-ORSR 04* | 0.343±0.044 | 12.76 | 0.154±0.023 | 14.85 | 2.265±0.413 | 18.25 |
| ***2**-ORSR 07* | 0.384±0.047 | 12.37 | 0.165±0.022 | 13.54 | 2.358±0.362 | 15.36 |
| ***3**-ORSR 11* | 0.335±0.045 | 13.48 | 0.160±0.023 | 14.42 | 2.133±0.372 | 17.44 |
| ***4**-ORSR 14* | 0.345±0.050 | 14.49 | 0.154±0.031 | 19.89 | 2.300±0.461 | 20.05 |
| ***5**-ORSR 24* | 0.346±0.045 | 12.87 | 0.158±0.023 | 14.65 | 2.236±0.452 | 20.20 |
| ***6**-ORSR 25* | 0.363±0.038 | 10.49 | 0.162±0.020 | 12.50 | 2.272±0.358 | 15.74 |
| ***7**-ORSR 43* | 0.359±0.037 | 10.40 | 0.153±0.021 | 13.44 | 2.387±0.415 | 17.39 |
| **China** | | | | | | |
| ***8**-Xin Jiang* | 0.360±0.050 | 13.95 | 0.176±0.023 | 12.82 | 2.083±0.389 | 18.66 |
| ***9**-He Bei* | 0.382±0.043 | 11.29 | 0.171±0.023 | 13.67 | 2.275±0.407 | 17.87 |
| ***10**-Inner Mongolia* | 0.316±0.062 | 19.56 | 0.149±0.029 | 19.27 | 2.172±0.455 | 20.97 |
| **Turkey** | | | | | | |
| ***11**-Trakya* | 0.358±0.051 | 14.25 | 0.158±0.024 | 15.40 | 2.314±0.460 | 19.90 |
| ***12**- Adana* | 0.337±0.032 | 9.49 | 0.155±0.020 | 13.25 | 2.208±0.302 | 13.68 |
| ***13**-Tekirdag* | 0.352±0.036 | 10.10 | 0.154±0.018 | 11.57 | 2.316±0.318 | 13.73 |
| ***14**-Edirne, Merker* | 0.355±0.035 | 9.83 | 0.164±0.022 | 13.28 | 2.207±0.354 | 16.04 |
| ***15**- Kirklareli, Luleburgaz* | 0.358±0.039 | 11.01 | 0.159±0.018 | 11.39 | 2.274±0.342 | 15.04 |
| ***16**-Edirne, Kesar* | 0.350±0.030 | 10.41 | 0.166±0.022 | 13.29 | 2.137±0.323 | 15.13 |
| **Bulgaria** | | | | | | |
| ***17**-Silanovici* | 0.363±0.059 | 16.14 | 0.157±0.025 | 15.73 | 2.355±0.465 | 19.74 |
| ***18**-Radnevo* | 0.353±0.058 | 16.51 | 0.162±0.032 | 19.79 | 2.224±0.408 | 18.36 |
| ***19**-Rosenova* | 0.337±0.060 | 17.86 | 0.151±0.035 | 23.43 | 2.296±0.458 | 19.93 |
| ***20**-Debovo* | 0.388±0.041 | 10.45 | 0.163±0.024 | 14.95 | 2.423±0.429 | 17.69 |
| **Romania** | | | | | | |
| ***21**-Braila* | 0.350±0.046 | 13.23 | 0.150±0.026 | 17.42 | 2.382±0.425 | 17.85 |
| ***22**-Tulcea* | 0.384±0.026 | 6.73 | 0.150±0.020 | 13.38 | 2.596±0.305 | 11.75 |
| **Republic of Moldova** | | | | | | |
| ***23**-Chisinau* | 0.372±0.047 | 12.58 | 0.174±0.028 | 16.01 | 2.196±0.443 | 20.19 |
| ***24**-Sarata-Mereseni* | 0.325±0.048 | 14.86 | 0.164±0.030 | 18.59 | 2.022±0.336 | 16.63 |
| ***25**-Popeasca* | 0.327±0.049 | 14.93 | 0.157±0.026 | 16.61 | 2.116±0.382 | 18.05 |
| ***26**-Gura-Galbenei* | 0.341±0.050 | 14.58 | 0.148±0.027 | 18.25 | 2.356±0.441 | 18.71 |
| ***27**-Prepelita* | 0.353±0.061 | 17.22 | 0.158±0.025 | 16.07 | 2.259±0.411 | 18.18 |
| ***28-Izbiste* | 0.344±0.046 | 13.52 | 0.157±0.025 | 16.07 | 2.241±0.445 | 19.87 |
| ***29**-Svetlii* | 0.344±0.050 | 14.68 | 0.157±0.026 | 16.41 | 2.226±0.350 | 15.71 |
| ***30**-Alexanderfield* | 0.361±0.050 | 13.88 | 0.165±0.028 | 17.19 | 2.228±0.394 | 17.67 |
| ***31**- Balti* | 0.358±0.035 | 9.74 | 0.161±0.022 | 13.61 | 2.258±0.352 | 15.57 |
| ***32**-Taraclia* | 0.386±0.046 | 11.82 | 0.163±0.028 | 16.94 | 2.434±0.464 | 19.07 |
| ***33**-Egoreni* | 0.393±0.037 | 9.53 | 0.174±0.025 | 14.17 | 2.312±0.420 | 18.18 |
| ***34**-Singera* | 0.353±0.035 | 9.92 | 0.167±0.021 | 12.56 | 2.155±0.356 | 16.54 |
| ***35**-Congaz* | 0.342±0.051 | 14.78 | 0.154±0.027 | 17.31 | 2.264±0.414 | 18.26 |
| **Spain** | | | | | | |
| ***36**-Sevilia* | 0.388±0.027 | 7.07 | 0.154±0.023 | 14.88 | 2.560±0.360 | 14.05 |
| **Ukraine** | | | | | | |
| ***37**-Odessa* | 0.375±0.040 | 10.81 | 0.174±0.023 | 13.14 | 2.179±0.312 | 14.30 |
| ***38**-Izmail* | 0.373±0.039 | 10.39 | 0.176±0.024 | 13.67 | 2.160±0.350 | 16.22 |

*Notes: Values represent the mean ± standard deviation of n=100 in mm. CV, % = (σ/μ)*100, where CV - Coefficient of Variation; σ - Standard Deviation; μ = Mean*

With the regard to length / width ratio, it varied between 2.022-2.596. Seeds collected from Tulcea (Romania) and Seville (Spain) had significantly higher values compared to other

samples (2.560 and 2.596, respectively), while the seeds from Sarata Mereseni (Moldova) and Xin Jiang (China) indicating the smallest values (2.022 and 2.083, respectively). The mean value of L/W ratio in all investigated populations (38) was around 2.3, being in agreement with the results obtained by other authors and showing that *O. cumana* has preferentially elongated shape of seeds comparative to other broomrape species. Thus, in the case of *O. cernua*, *O. crenata*, *O. minor*, *O. caryophyllaceae* and some *Phelipanche* species L/W ratio is ≤ 2.0, which denotes a more spherical shape of seeds (Krupp A. *et al*, 2014; Plaza L. *et al*, 2004). According to Krupp et al (2014) a more spherical shape of seeds is also characteristic for Asian *O. cumana* samples (L/W=1.87-1.96) comparing to European. In contrast, in our study the mean value of L/W ratio was higher than 2.0 (2.18) even in Chinese populations.

Broomrape seeds reached a mean size of 0.363 x 0.160 mm, with a L/W ratio of 2.31 in the 38 investigated populations (*table 2*). The association analysis revealed a moderate positive correlation ($r$=0.485) between length and width of broomrape seeds.

Table 2

**Mean values of morphometric parameters and the correlation coefficient**

| Number of populations | Morphometric parameters ($x \pm t_{05}Sx$) ***p<0,05*** | | | Correlation coefficient ***r* (*Pearson*, * *p-value* < 0,05)** |
|---|---|---|---|---|
| | **L (mm)** | **W(mm)** | **L/W** | **L:W** |
| 38 | 0.363±0.004 | 0.160±0.003 | 2.310±0.048 | 0.485* |

*Notes: L - seed length; W - seed width; Tukey test of statistical significance (α=0.05) was used*

The mean values of seed length, width, L/W ratio and coefficient variation (CV) per country are presented in *figure 1* (a, b). According to morphometric data, the most elongated seeds were observed in the case of Seville population, which indicated the highest values of seed length (0.388 x 0.154 mm) and L/W ratio (2.56). Previously, Plaza et al (2004) and Krupp et al (2014) reported seed size of 0.36-0.50 x 0.16-0.25 mm and 0.360 x 0.155 mm, respectively, for Spanish broomrape.

Similar, low divergences between the results of our measurements and those of Krupp have been revealed with the regard to Serbian (0.353 x 0.154 mm and 0.380 x 0.170 mm, respectively) and Romanian populations (0.367 x 0.150 mm and 0.357 x 0.159 mm, respectively).

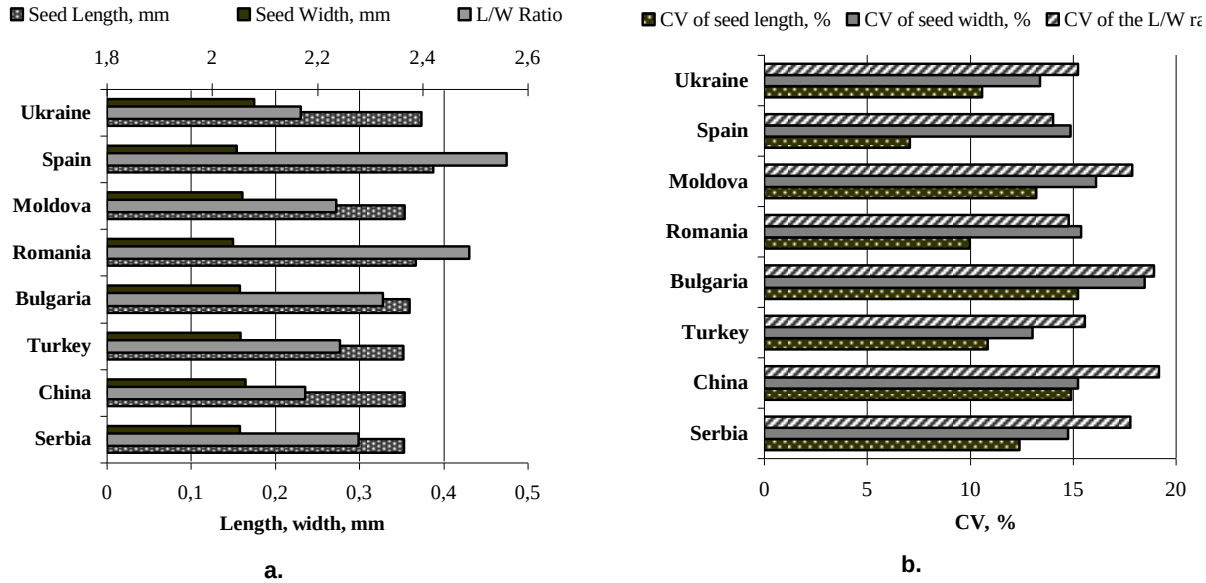



Figure 1. **The mean values of seed length, width, L/W ratio (a) and coefficient variation (b) per country**

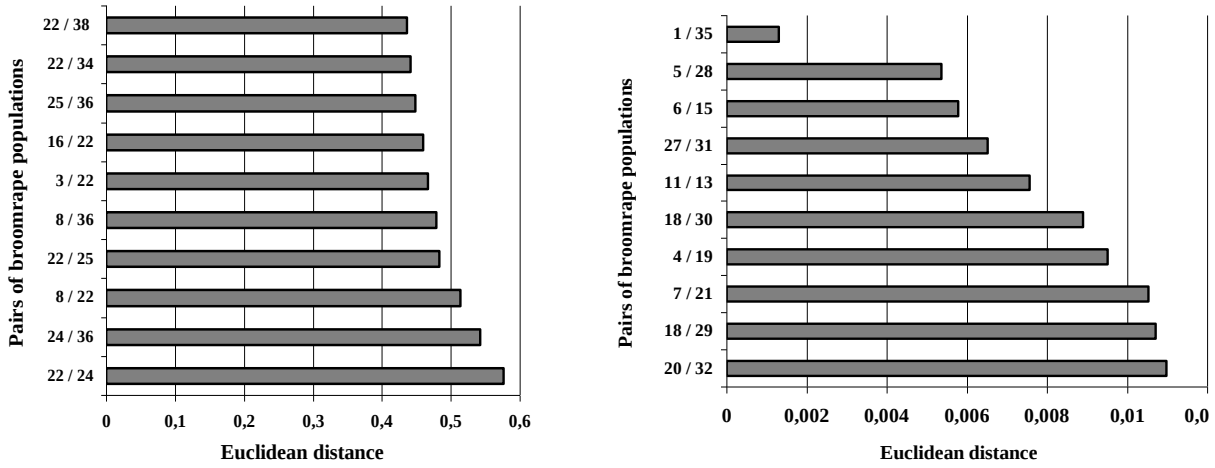
As for Moldavian samples, comparing obtained results with those of the analysis on 39 populations of sunflower broomrape collected in 2014 (Duca M. *et al*, 2017a) and 5 collected in 1921, 1938, 1948 and 1979 (unpublished data), no significant differences have been found. Thus, seed parameters have not changed substantially during *O. cumana* evolution.

A moderate magnitude of variability was recorded in the sunflower broomrape populations collected from different countries (*figure 1b*). Length/ width ratio showed the highest variability, especially in the samples collected from China and Bulgaria (CV=19.17% and 18.93%, respectively), followed by the Republic of Moldova (CV=17.89%) and Serbia (CV=17.78%).

Notably, Bulgarian samples indicated the highest values of CV inclusively for seed length (15.24%) and width (18.48%). On the other hand, the less variable trait was the seed length, the mean of CV ranging between 7.08-15.24%.

According to the measured seed parameters, the variability was higher within the individuals from the population (100 individual seeds) than among populations.

The analysis of Euclidean distance showed small distances between studied *O. cumana* populations, the shortest distance (0.001) being observed between the Serbian samples conventionally noted ORSR04 and Moldavian population Congaz and the longest one (0.577) between Tulcea (Romania) and Sarata Mereseni (Moldova) (*figure 2*). For almost 77.6% of the total combinations, the distance values were smaller than 0.200 and only in 19 cases (2.7%) the distance ranged between 0.400-0.577. The Serbian samples ORSR04, ORSR24 ORSR25 and populations Congaz; Izbiste (Moldova) and Kirklareli, Luleburgaz (Turkey), respectively, were the most similar, presenting the smallest values of Euclidean distances (0.001-0.006) (Figure 2a).




**a.** **b.**

Figure 2. **The minimal (a) and maximal (b) values of Euclidean distance between broomrape samples**

The most distant broomrape populations (0.448-0.577) were those collected from Seville (Spain), Tulcea (Romania), Xin Jiang (China), ORSR11 (Serbia), Popeasca and Sarata Mereseni (Republic of Moldova) and Edirne, Kesar (Turkey) in different combinations (Figure 2b). The differences in the morphometric characters of broomrape seeds collected from different regions, can result especially from the differences in environmental conditions (climatic and soil conditions), as well as nutrient supply from the host (Piwowarczyk K., 2013).

## CONCLUSIONS

The current investigation reports the studies on morphometric parameters of the *O. cumana* seeds collected from 38 locations of the eight different European and Asian countries, as well as the Republic of Moldova, Romania, Bulgaria, Ukraine, Serbia, Spain, Turkey and China. Analysis of data (seed length, width and length/width ratio) did not show significant differences in broomrape seeds size. The coefficients of variation indicated low values, especially in the case of seed length (6.73-19.56%), which suggests a moderate level of intrapopulational variability, all studied populations being relative homogenous. More variable morphological trait were seed width and L/W ratio (11.39 - 23.43%). A moderate positive correlation (r=0.485) between length and width of broomrape seeds has been found. The present study provides some new data related the *O. cumana* phenotypical diversity and could be useful for understanding the complex parasite biology and development of the effective disease management strategies.

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## REFERENCES

**Abu Sbaih H.A., Jury S.L., 1994** – *Seed micromorphology and taxonomy*

*in Orobanche (Orobanchaceae).* Flora Mediterranea, 4:41–48.

**Antonova T.S., Araslanova N.M., Strelnikov E.A., Ramazanova S.A., Guchetl S.Z., Chelyustnikova T.A, 2013** –*Distribution of highly virulent races of sunflower broomrape (Orobanche cumana Wallr.) in the Southern regions of the Russian Federation.* Russian Agricultural Sciences, 39: 46–50.

**Benharrat H., Thalouarn P., Theodet C., Veronesi C., 2002** – *Orobanche species and population discrimination using intersimple sequence repeat (ISSR).* Weed Research, 42: 470-475.

**Bilgen B.B., Barut A.K., Demirbaş S., 2019** – *Genetic characterization of Orobanche cumana populations from the Thrace region of Turkey using microsatellite markers.* Turkish Journal of Botany, 43:38-47.

**Burlov V., Burlov V., 2010** – *Breeding of sunflower resistant to new races of broomrape (Orobanche cumana Wallr.).* Helia, 53:165–172

**Dominguez J., 1996** – *Estimating effects on yield and other agronomic parameters in sunflower hybrids infested with the new races of sunflower broomrape*. In: Proc. Symposium on Disease tolerance in Sunflower, Beijing, China, International Sunflower Association, Paris: 118 - 123.

**Dongo A., Leflon M., Simie, P., Delavault P., 2012** – *Development of a high-throughput real-time quantitative PCR method to detect and quantify contaminating seeds of Phelipanche ramosa and Orobanche cumana in crop seed lots.* Weed Research, 52:34–41.

**Duca M., Glijin A., 2013** – *The broomrape effect on some physical and mechanical properties of sunflower seeds*. Scientific Annals of „Alexandru Ioan Cuza" University of Iasi, Section II A, Vegetal Biology., vol. 59(2):75-83.

**Duca M., Boicu A., 2017a** – *Morphological diversity of seeds in* O. cumana *accessions from Republic of Moldova.* Helia, 40(67). https://doi.org/10.1515/helia-2017-0005

**Duca M., Acciu A., Clapco S., 2017b** – *Distribuţia geografică şi caracteristica unor populaţii de O.cumana din Republica Moldova.* Buletinul Academiei de SȘtiinţe a Moldovei. Stiinţele Vieţii 2(332):65-76.

**Duca M., Joiţa-Păcureanu M., Port, A., Martea R., Boicu A., Rîşnoveanu L., Clapco S., 2019** – *Genetic diversity analysis of sunflower broomrape populations from Republic of Moldova using ISSR markers.* Romanian Agricultural Research, 37:3-11.

**Duca M., Port A., Boicu A., Şestacova T., 2017c** – *Molecular characterization of broomrape populations from republic of Moldova using SSR markers.* Helia, 40(66):47-59.

**Gagne G., Roeckel-Drevet P., Grezes-Besset B., Nicolas P.***,* **1998** – *Study of the variability and evolution of* Orobanche cumana *populations infesting sunflower in different European countries.* Theoretical and Applied Genetics, 96:1216–1222*.*

**Gisca I., Joita-Pacureanu M., Clapco S., Duca M., 2016** – *Influence of broomrape on some productivity indices of sunflower,* Revista Lucrări ştiinţifice. Seria Agronomie., 2(60):97-102.

**Guchetl S.Z., Antonova T.S., Tchelustnikova T.A., 2014** – *Genetic similarity and differences between the Orobanche cumana Wallr. populations from Russia, Kazakhstan, and Romania revealed using the markers of simple sequence repeat.* Russian Agricultural Sciences, 40:326-330.

**Joel D.M., 1987** – *Detection and identification of Orobanche seeds using fluorescence microscopy*. Seed Science and Technology, 15: 119-124.

**Kaya Y., 2014** – *Current situation of sunflower broomrape around the world. In:* Proc. 3rd Int. Symp. on Broomrape (Orobanche spp.) in Sunflower, Córdoba (Spain), June 3-14. pp 9–18.

**Krupp A., Rücker E., Heller A., Spring O., 2014** – *Seed structure characteristics of Orobanche cumana populations*. Helia, 38:1-14.

**Martín-Sanz A., Malek J., Fernández-Martínez J.M., Pérez-Vich B., Velasco L. 2016** – *Increased virulence in sunflower broomrape (Orobanche cumana Wallr.) populations from southern Spain is associated with greater genetic diversity.* Front Plant Sci. https://doi.org/10.3389/fpls.2016.00589.

**Musselman L.J., Mann W.F., 1976** – *A survey of surface characteristics of seeds of Scrophulariaceae and Orobanchaceae using scanning electron microscopy*. Phytomorphology, 26:370-378**.**

**Pacureanu-Joita M., Raranciuc S., Sava E., 2009** – *Virulence and aggressiveness of sunflower broomrape (Orobanche cumana Wallr.) populations in Romania.* Helia, 32:111-118*.*

**Pérez-Vich B., Velasco L., Rich P.J., Ejeta G., 2013** – *Marker-assisted and physiology-based breeding for resistance to root parasitic Orobanchaceae*. *In: Joel DM, Gressel J, Musselman LJ (eds).* Parasitic Orobanchaceae. parasitic mechanisms and control strategies*, Springer, New York, pp 369–391.*

**Pineda-Martos R., Velasco L., Fernández-Escobar J., Fernández-Martínez J.M., Pérez-Vich B., 2013** – *Genetic diversity of Orobanche cumana populations from Spain assessed using SSR markers.* Weed research, 53:279-289.

**Piwowarczyk K., 2013** – *Seed productivity in relation to other shoot features for endangered parasitic plant Orobanche picridis F.W. Schultz (Orobanchaceae).* Pollish Journal of Ecology, 61: 55-64.

**Plaza L., Fernandez I., Juan R., Pastor J., Pujadas A., 2004** – *Micromorphological studies on seeds of Orobanche species from the Iberian Peninsula and the Balearic Islands, and their systematic significance.* Annals of Botany, 94:167–178.

**Shindrova P., 2006** – *Broomrape (Orobanche cumana Wallr.) in Bulgaria. Distribution and race composition*. Helia, 44:111–120.

**Vrânceanu A.V., Tudor V.A., Stoenescu F.M., Pirvu N., 1980 –** *Virulence groups of Orobanche cumana Wallr. differential hosts and resistance sources and genes in sunflower*. In: Proc 9th International Sunflower Conference, Torremolinos (Spain), July 8–13. pp 74–80.

https://www3.nuseed.com/eu/spotlight-on-sunflower-broomrape

# FOOD FRAUD PREVENTION AS AN ACTIVE TOOL IN MEAT INDUSTRY: A CASE STUDY OF POULTRY SLAUGHTERHOUSE

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**Abstract**

Worldwide latest food fraud incidents have emphasized the need to reinforce food fraud prevention across the global supply chain, which again is essential not just to protect public health, but also to regain weakened consumer trust in foods, in an economic context where entrepreneurs and regulators acknowledge that confidence is the cornerstone of efficient and productive economies. Unfortunately, current food safety and quality management systems were not initially intended to prevent fraud. Prevention of food fraud involves a particular approach: it must take into account vulnerability assessments and formulate a food fraud mitigation plan, that needs to be continuously updated, being correlated with national and international context on this subject and the fact that food fraud typically appears when the opportunity and the motivation of food crime are strong and the probability of being detected as well as the penalties are minimal. The central objective of this paper was to develop a functional analysis tool starting with a pre-existing "NSF Fraud Security Model" version, designed to support the large reputable food retailers and authorities in the prediction of potential for fraudulent activity in a variety of products. This case study, focused on three key strategic elements: the prediction, prevention and management of the food fraud mitigation plan in accordance with Guidelines for Implementation of the GFSI recognized schemes. The outcome of this project is a functioning prototype, a concept built over the past 2 years via collaborative sessions with project team members and tested for input from industry and regulatory representatives. This analysis provides a framework for evaluating the role of science and technology in identification, mitigation, and then prevention.

**Key words**: fraud, adulteration, vulnerability mitigation plan

Food fraud is a type of criminal activity, regardless of definition, with catastrophic implications for businesses, such as: loss of credibility, loss of customer trust, decline in the market, or termination of contracts for employees. The general implications are similar to other corporate frauds. For the individual businesses, usually the main consequences are social losses, punishments, third party losses (e.g. extra testing), confidence losses, sales losses & over payment, as well as recall losses (Bindt V., 2016).

Due to the cases found, there are a wide range of possible forms of fraud (dilution, substitution, concealment, mislabeling, unapproved enhancements, counterfeiting, grey market production – theft – diversion) as defined in the literature, all of them with one aspect in common: their unpredictable nature. By example, if we take the horsemeat incident as a case, it was seen its significant economic impact due to large product recalls with a severe economic consequence on European beef markets (Moyer D.C. *et al*, 2017).

There is a common perception that food fraud is primarily an external threat to the food supply chain from organized crime groups. While politically convenient, this is in fact more a issue inside the food system itself and includes legal players that take full advantage of criminal opportunities (Lord *et al*, 2017).

Some commodities are closer to food fraud than others. An inventory of records in the three global food fraud datasets for 2008-2013 showed that the six commodity groups most commonly identified were spices and herbs, olive oil, fish, dairy products, meat and other oils and fats (Weesepoel Y.J.A and van Ruth S.M., 2015). This study examines fraud risk through food supply chains and products which have been often documented in inventories of food fraud.

## MATERIAL AND METHOD

To update the information for the specific food fraud incidents that have occurred in the food

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supply chain networks linked with meat industry, we assessed 50 key food fraud elements, descriptors for opportunity and motivation, but also and control measures (NSF, 2014; van Ruth, 2018). As a direct result, we toked into consideration the factors mentioned in *table 1*.

Furthermore, all the information found in different blogs, in media, trade associations, research associations, industry network and personal networking was filtered. For the official communication channels, we used: EU RASFF Rapid Alert System for Food and Feed, EFSA European Food Standards Agency, National Competent Authorities for product recall alerts or changes in legislation and guidelines, food fraud known databases, testing laboratory information, commercial trade press, commodity price fluctuations, country risk classification and corruption perceptions index (EMAlert, 2020; EC, 2018; EC, 2019a; GFSI, 2019; SSAFE, 2019; Spink *et al*., 2016, 2017, 2019).

Table 1

**The three key elements of the food fraud vulnerability assessment and the meat industry specific associated fraud factors**

| Key element | Meat industry supply chain |
|---|---|
| Opportunities | - availability technology and knowledge to adulterate raw materials;<br>- fraud detectability in raw materials;<br>- fraud detectability in final products;<br>- access to production lines / processing activities;<br>- historical evidence of fraud in raw materials;<br>- historical evidence of fraud in final products; |
| Motivations | - valuable components or attributes;<br>- level of competition branch of industry;<br>- price asymmetries; |
| Control measures | - integrity screening own employees;<br>- fraud control industry;<br>- national food policy;<br>- law enforcement local chain;<br>- law enforcement chain network; |

The second step consisted in establishing the location (a company) and developing of an internal food fraud vulnerability assessment, respective food fraud mitigation plan (through a systematic process). The protocol was developed in an integrated poultry business: farm-slaughterhouse, with a capacity of 10 million-day old chicks / year and a share market in the N-E part of Romania of almost 20%.

For implementation, the frequency of assessment was done 2 times / year in the period 2017-2020 due to some ingredients market fluctuations and active induction of the people. Results were expressed as means from the last 4 Food Fraud Assessments, the steps in this process being:

a) establishing the product fraud assessment team;
b) identification of potential product fraud risk;
c) undertaking the product fraud vulnerability assessment;
d) developing the Product Fraud Mitigation Plan;
e) implementation and monitoring of the Product Fraud Mitigation Plan control measures;
f) review and refinement of the Product Fraud Mitigation Plan;

## RESULTS AND DISCUSSIONS

**a)** The product fraud assessment team [PFAT] included the company employees from purchasing department - directly involved with acquisition of incoming goods and services, logistics management and of technical management – production (process and packaging), maintenance, quality assurance (laboratory and quality technologists). It was implemented through Decision no. 3245 / 13.11.2017, which define the roles and responsibilities of the PFAT, the new creating team having full support of the company's senior management.

**b)** The identification of potential product fraud risk was done through 2 methodology panels: data gathering from the close meat supply chains (relationship between company and its suppliers) and literature research, all this activity being done to effectively undertake the vulnerability internal assessment process. For this, PFAT had identified first all sources of information and data that relate to the risk factors used within the vulnerability assessment. All information and data sources used to assess the potential of product fraud and other associated information was documented, including the frequency at which the data should be assessed and by whom (e.g. for example, commercial data, such as price and availability were the responsibility of the purchasing department or technical data, such as reports of fraudulent activity and detection methodology developments were activities attributed to the technical departments team members). This initial information was collated in an exhaustive list for all incoming goods (raw materials, ingredients and packaging) and the supplier of each of the

products. Because the company do not have outsourced processes (e.g. packaging, deboning, product transport), this category was not included in the risk assessment.

**c)** The product fraud vulnerability assessment has identified risk of possible fraudulent activity within the supply chain, identifying the weaknesses, which further were addressed in the Product Fraud Mitigation Plan to minimize the risk of fraud. We considered a number of risk assessments, which followed risk management principles, commonly used within its HACCP study (physical, biological, chemical) and within internal incident management procedure, to establish course of action. The applied method was those of quadratic matrix (Fig. 1), with a defined scale and ranking. The colour of the cells within the product vulnerability risk matrix are indicative of the product risk, namely: orange is considered as high risk, yellow as medium risk and blue would be regarded as low risk.

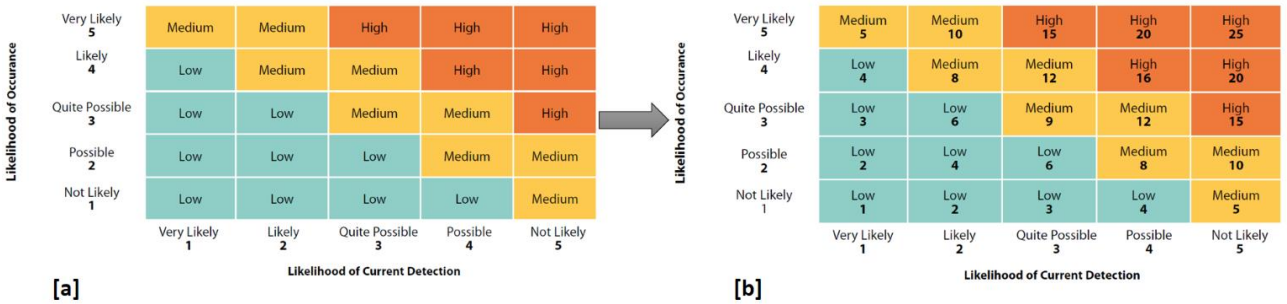



Figure 1 **Product Vulnerability Risk Matrix with Risk Rating for Likelihood of Occurrence and Likelihood of Detection on Axes [a] and Product Risk Rating within the Matrix [b]**

The product risk factors used for the risk rating within the matrix were:

- history of product fraud incidents [number, types and frequency of fraud - the more frequent that a product has food fraud associated with it, the higher the risk];
- economic factors [price - the higher the profit margin the higher the risk; availability of the product - the lower the availability of a product, the higher the risk; availability of adulterant - the high availability and low cost of an adulterant, the higher the risk; price fluctuation];
- ease of fraudulent activity [physical nature of the product - liquid, powder, minced pieces, whole; cost and complexity of fraudulent process - location, processing machinery, costs of production, packaging cost, distribution cost; staff involvement in the fraudulent activity - number, ease of concealment, number of locations; packaging formats];
- supply chain complexity [geographical origin - location of source and length of supply chain; types and number of organizations in the supply chain - manufacture, storage, distribution, agent or broker; number of factories within the supplier organization];
- current control measures for detecting fraud [testing authority - certification bodies, auditing body; testing laboratories and status - accredited / non-accredited; testing methodology - accredited / non-accredited; testing frequency - auditing, product inspection, product testing; cost of testing].

Criteria for supplier vulnerability assessment were: profitability, the risk of detection and ease of fraud, defined as follow:

- economic stability of the supplier and legal entity;
- the business history between the companies, the longer it is, the lower the risk become;
- business relationship: disputes, commercial or technical aspects;
- the frequency of purchasing; if the products are purchased through intermediaries, the risk becomes high;
- quality, transparency and time for delivery; technical information such as specifications, requests for specific information or responses to complaints; an important factor is also the competence of the technical staff, knowledge about food fraud and control measures, efficiency of the quality management system. (the faster the response, the lower the risk);
- obtaining or maintaining a high score for audits, small number of returned products, low number of complaints or small amounts of waste generated during the production process represents a low risk;
- frequency for governmental controls (e.g. higher the level of controls for the products origin and the better relations between governments, the lower is the risk).

A total of 70 suppliers were evaluated, for 14 distinct categories of purchased products, the largest number being attributed to packaging (*table 2*).

Table 2

**Food Fraud vulnerability assessment of raw material, auxiliary materials & packaging**

| PURCHASED PRODUCTS | Total no. of assessed suppliers | RISK OF CONTAMINATION WITH: | | | | | | 7. Other legislative risks | Supplier risk class | Product risk class |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1. Allergens | 2. Foreign body | 3. Biological | 4. Chemicals | 5. Other species | 6. Substitution / fraud | | | |
| Live chickens | 5 | low | low | low | low | low | low | low | **low** | **low** |
| Spices | 5 | medium | medium | low | low | low | medium | low | **low** | **medium** |
| Additives | 8 | low | low | low | low | low | low | low | **low** | **low** |
| Salt | 3 | low | low | low | low | low | medium | low | **low** | **low** |
| Sunflower oil | 4 | low | low | low | low | low | medium | low | **low** | **low** |
| Packaging (casseroles, foil, bags, cardboard boxes, bamboo sticks, stainless steel sticks, clips) | 20 | low | low | low | low | low | medium | low | **medium** | **low** |
| Third-party packaging (plastic containers, pallets, stretch foil) | 5 | low | low | low | low | low | medium | low | **medium** | **low** |
| Self-adhesive tape | 2 | low | low | low | low | low | low | low | **low** | **low** |
| Labels | 2 | low | low | low | low | low | low | low | **low** | **low** |
| Gas mixture | 1 | low | low | low | low | low | low | low | **low** | **low** |
| Working tools (knives, gloves) | 4 | low | low | low | low | low | low | low | **low** | **low** |
| Equipment (work, protection) | 3 | low | low | low | low | low | low | low | **low** | **low** |
| Hygiene substances | 5 | low | low | low | low | low | low | low | **low** | **low** |
| Cleaning equipment | 3 | low | low | low | low | low | low | low | **low** | **low** |

| Control methods - risk assessment | Risk class legend | | |
|---|---|---|---|
| **1. - 6.** = Technical specification (including specification for allergen cross contamination); Qualitative reception; Suppliers test reports; Internal laboratory analysis according to self-control plan; Supplier technological flow chart assessment;<br>**7.** = International and European law context & incidents that were appearing on the official sources of information. | | | |
| | low | medium | high |
| | Questionnaire | Quality certificate & 1 audit each 2 years | Audit each year |

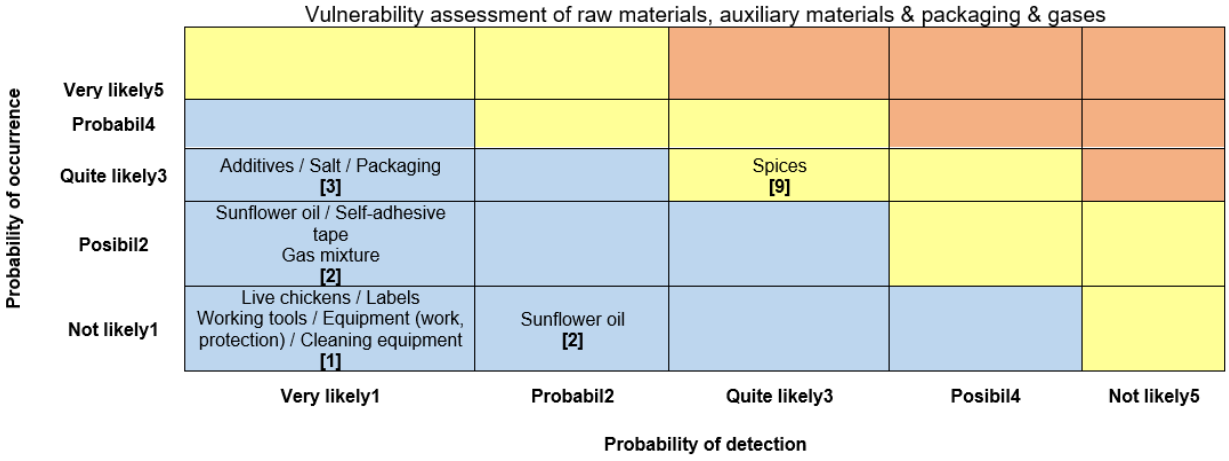



Figure 2 **Company Product Vulnerability Risk Matrix with Risk Rating for Likelihood of Occurrence and Likelihood of Detection on Axes [a] and Product Risk Rating within the Matrix [b]**

By product risk assessment, it can be seen that only in case of spices exist a medium risk for aduleration, especialy due to the: worldwide cases no., supply chain complexity, and easy of fraudulent activity, completed by the risk of contamination with allergens, foreign bodies and /or be substituted.

Although in case of salt and additives the risk was medium, due to the internal control measures and suppliers – company relation, bought remained low. Figure 2 represent the overall imagine of company Product Food Fraud Assessment, this being within Table 2 by product and supplier risk vulnerability with the afferent Mitigation Foo fraud Plan.

By supplier risk assessment, packaging suppliers were evaluated as medium risk, especially due to the new technologies that are now enhanced in some particularly cases (e.g. 100% biodegradable) or due to the complexity of chain, from producer of granules to the company (final client).

Table 3 defines the measures and controls that are required to be in place to mitigate the risks identified in the Product Fraud Vulnerability Assessment, especially for spices (overall high risk) and packaging materials.

The decisions of the PFAT were dependent on the evidence reviewed and may lead into the future to changes in policy in relation to supply of spices and “sensitive packaging”, while in the

meantime is maintain current specified control measures.

Table 3

**Food Fraud Vulnerability Assessment and Mitigation Plan**

| Raw materials, ingredients, auxiliary materials | Product Risk class | Supplier Risk class | Risk class | Current control measures- level | Team decision |
|---|---|---|---|---|---|
| Live chickens | 1 | 1 | 1 | Low risk | Accepted suppliers |
| Spices | 9 | 3 | 27 | High risk | Accepted suppliers |
| Additives | 3 | 2 | 6 | Low risk | Accepted suppliers |
| Salt | 3 | 2 | 6 | Low risk | Accepted suppliers |
| Sunflower oil | 2 | 2 | 4 | Low risk | Accepted suppliers |
| Packaging | 3 | 3 | 9 | Medium risk | Accepted suppliers |
| Self-adhesive tape | 2 | 2 | 4 | Low risk | Accepted suppliers |
| Labels | 1 | 2 | 1 | Low risk | Accepted suppliers |
| Gas mixture | 2 | 2 | 4 | Low risk | Accepted suppliers |
| Working tools (knives, gloves) | 1 | 1 | 1 | Low risk | Accepted suppliers |
| Equipment (work, protection) | 1 | 3 | 3 | Low risk | Accepted suppliers |
| Hygiene substances | 2 | 3 | 6 | Low risk | Accepted suppliers |
| Cleaning equipment | 1 | 2 | 2 | Low risk | Accepted suppliers |
| **Control measures:**<br>- selection and evaluation of suppliers of raw materials, ingredients, packaging and auxiliary materials in accordance with POP-BON-3.2 doc.<br>- request to suppliers for providing the following documentation for the delivered live chickens: declarations of conformity, veterinary certificate for transported live chickens, test reports issued by accredited laboratories;<br>- request to suppliers for providing the following documentation for the delivered packaging's: declarations of conformity, declarations of components migration reports / certification made in oily environment in accordance with E.U. Reg. 10/2011.<br>- quality control of one day old chicks [e.g. anamnesis, state of vivacity] and ingredients / auxiliary materials in conformity with IM-BON-01 doc. and compliance with E.U. regulations and technical specifications for: live chickens ST-P-01 / salt ST-SI-01 / sunflower oil ST-U -01 / spices ST-C-01 / packaging's ST-A-01; monitoring of it in doc. FL-BON-06;<br>- spices and packaging material (bags, casseroles, foils) quality control for the microbiological characteristics in the internal laboratory, recorded in FL-BON-07/09 and FL-M-110 doc. in accordance with IM-BON-01 doc;<br>- verification of gas content in the final product in accordance with FL-BON-109 doc.<br>- respecting the annual control program for laboratory analysis of the receipt micro components in accordance with auto control program;<br>- employees training on how to perform the reception; | | | | | |

As result of this active Food Fraud Assessment, company high management, with direct implication and supervision of PFAT had decide a systematic approach for Mitigation plan, as follows:

- selection and evaluation of suppliers of raw materials, ingredients, packaging and auxiliary materials in accordance with POP-BON-3.2 doc. minimum 2 times / year, especially for those which have high Risk Class (e.g.: spices, packaging materials);
- increasing the frequency for test reports provided by the suppliers of used packaging's (in accordance with Annex III of Regulation 10 / 2011).
- including in the annual auto control program of tests for origin and type of species at all ingredients and / or suppliers with High Risk Class;
- starting to collaborate with a third-party service supplier for acquisition process improvement, especially for the large quantities of imported ingredients and additives;

Until the next Food Fraud Vulnerability Assessment, PFAT decided to increase analytical surveillance from suppliers by use of accredited laboratories test report at each reception for spices. For maintain the required level of control measures the company established a frequency of 2 times / year for formal review of Product Fraud Mitigation Plan or when different changes appear.

## CONCLUSIONS

The outcome of this project is a functioning prototype, a concept built over the past 2 years via collaborative sessions with project team members and tested for input from industry and regulatory representatives. This analysis provides a framework for evaluating the role of science and technology in identification, mitigation, and then prevention.

The efficiency of this functional tools will be evaluated at the end of each year, in the management review meeting, in accordance with national and international context of food fraud worldwide.

## REFERENCES

**Bindt V., 2016 -** *Costs and benefits of the food fraud vulnerability assessment in the Dutch food supply chain*, Wageningen University internship report, on line at: chrome-extension://ohfgljdgelakfkefopgklcohadegdpjf/https://edepot.wur.nl/390258

**EMAlert, 2020** - *EMAlert vulnerability assessment tool*, online at: https://www.emalert.org

**European Commission (EC), 2018** - *EU coordinated control programmes,* online at:

https://ec.europa.eu/food/safety/official_controls/eu-co-ordinated-control-plans_en

**European Commission (EC), 2019a** - *Administrative assistance and cooperation system*, online at: https://ec.europa.eu/food/safety/food-fraud/aas_en

**Global Food Safety Initiative (GFSI), April 2019 -** *GFSI Position on Mitigating the Public*.

**Global Food Safety Initiative (GFSI).** *Guidance Document, Benchmarking Document, Version 7.*

**Lord N., Flores Elizondo C.J., Spencer J., 2017** - *The dynamics of food fraud: The interactions between criminal opportunity and market (days) functionality in legitimate business*. Criminology & Criminal Justice.

**Moyer D.C., DeVries J.W., Spink J., 2017 -** *The economics of a food fraud incident - case studies and examples including melamine and wheat gluten*. Food Control, 71, 358e364.

**NSF Safety and Quality, 2014** - *Risk Modelling Of Food Fraud Motivation – "NSF Fraud Protection Model" Intelligent Risk Model,* online at: chrome-extension://ohfgljdgelakfkefopgklcohadegdpjf/https://www.food.gov.uk/sites/default/files/media/document/NSF%20Final%20report.pdf

**Spink J., Fortin N.D., Moyer D.C., Miao H., Wu Y., 2016** - *Food fraud prevention: policy, strategy, and decision-making–implementation steps for a Government Agency or industry.* CHIMIA Int. J. Chem. 70, 320–328.

**Spink J., Ortega D.L., Chen C., Wu F., 2017** - *Food fraud prevention shifts the food risk focus to vulnerability.* Trends in Food Science & Technology, 62, 215-220.

**Spink J., Hegarty P.V., Fortin N. D., Elliott C.T., Moyer D.C., 2019** - *The application of public policy theory to the emerging food fraud risk: next steps.* Trends Food Sci. Technol. 85, 116–128.

**SSAFE, 2019** - *Introduction to SSAFE food fraud vulnerability assessment tool*.

**Weesepoel Y.J.A., van Ruth S.M., 2015** - *Inventarisatie van voedselfraude: Mondiaal kwetsbare productgroepen en ontwikkeling van analytische methoden in Europees onderzoek*. RIKILT report 2015.014. Wageningen: RIKILT Wageningen

# CHARACTERIZATION OF THE HARVEST YEAR AND THE QUALITY OF RED WINES FROM VALEA CALUGAREASCA DEPENDING OF THE TECHNOLOGICAL AND PHENOLIC POTENTIAL OF THE VARIETIES

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**Abstract**

The study was conducted during 2014–2018 period in order to define the quality level of the Cabernet Sauvignon and Feteasa neagra varieties, according to the characteristics of the harvest year. The grape harvest was recorded earlier with 12 days in case of Cabernet Sauvignon and with 14 days in case of Fetească neagră variety, compared to the multiannual average. During the years of study, harvesting of grapes from the Cabernet Sauvignon variety was made between September 17 and October 6, and that of the grapes from the Feteasca neagra variety during September 17-28. The dynamics of grape ripening was very fast in the harvest year 2014, fast in the years 2015 and 2016, slow in 2017 and 2018. In the 2014 harvest year for the Cabernet Sauvignon variety, the phenolic maturity of the grapes was assessed as good for all determined analytical parameters. Grapes from the Cabernet Sauvignon variety are well formed, with a percentage of normally developed berries, with the skin of the grapes in a high proportion, high in anthocyanins; small-medium grains, thick skin of the grapes. Cabernet Sauvignon wine was appreciated, compared to the average of 1990-1999, with a very good alcoholic concentration of 12.6% vol. alc. in 2016 and 12.8% vol alc. in the years 2017 and 2018. The wine from the Feteasca neagra variety was appreciated as being extractive, with a high alcohol concentration of over 13% vol. alc., with a medium acidity, intensely colored.

**Key words**: variety, phenolic maturity, technological potential, quality level

The quality of the grapes and the wine is largely influenced by the variety, which has its own physiognomy. Climate has an influence on both quality and productivity. Usually, the temperature influences the ripening period of the grapes in the vineyard. The evolution of the maturation process is greatly influenced by the variety, the vineyard, but especially by the specific conditions of the harvest year.

A component of the qualitative potential of the black grape harvest, phenolic maturity give information about the phenolic and anthocyanin richness of grapes, the extractability of anthocyanins and the share of astringent tannins (Glories, 1998). This is directly related to the wine climate.

The precocity of the vine represents the vine's response to its natural environment and is decisive for the quality of the phenolic potential of the grapes. It is evaluated by comparison with the average registration date of this phenophase.

Research on grape ripeness has indicated that it is closely correlated with ripening kinetics. Vivas *et al,* (2003) defined a model for describing the dynamics of grape ripening. This is a straight line, determined by the index of technological ripening of the grapes (sugar/acidity) and the sum of the degrees of temperature during the ripening period of the grapes. The value of the slope defines the maturation kinetics, which can be very slow, slow, fast and very fast.

In this context, the work aimed to quantify the quality of the phenolic potential of the grapes varieties characteristics for Dealu Mare-Valea Calugareasca vineyard area and to correlate it with the functioning components of the vine, such as the precocity and kinetics of grape ripening.

## MATERIAL AND METHOD

The study was conducted during 2014-2018 period, in the viticultural area Dealu Mare, Valea Calugareasca center, a wine producing area recognized mainly for the qualitative red wines. The varieties taken into study were Cabernet Sauvignon and Fetească neagră. The climate of the ripening period of red wine grapes was defined by comparing the values of the annual climatic parameters with the multiannual parameters of the period 1987-2017. The data from the climate database of IC-DVV Valea Călugărească were

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collected from the weather station belonging to Institute, having the following coordinates: 44°59' N lat: 26°13'E long; at the altitude of 210 m. Comparative analysis of the leverage for the chosen varieties, was performed compared to the multiannual average, and the registering differences were expressed in number of days (Carbonneau, A. Deloire *et al*, 2007). The harvesting of black grapes was done differently by variety. The precocity of varieties and the maturation kinetics of grapes were evalueted based on mathematical relation Ij= f(Cj) (Vivas N. *et al,*, 2003), where Ij is the maturity corrected index and Cj the climatic index of the ripening period. The slope of the straight *y= ax* has defined the kinetiks of maturation on the 4 levels: very slow (a < 0,8), slow (0,8 < a < 1,1), fast (1,1 < a < 1,4) and very fast (a > 1,4). The polyphenolic potential of the grapes harvest was assesed by specific parameters: total Polyphenol Index-IPT, Total anthocyanins-PA, Anthocyanins extractibility (EXA%) and contribute of grape seeds tannins-MS as determined by method Glories (1998), cited by (Anneraud C., Vinsonneau E., 2009). The technological properties of the grape harvest were evaluated for the two varieties for harvest years.
The following technological indices (Blouin J. et al, 2000), have been defined: ISST-grape structure index IB-grape berrie index, ICZB-grape berrie composition index, IRD-yield index.
Polyphenolic Potential of the Black Grapes for Winemaking was evaluated for the varieties studied, by harvest years. The analytical parameters that define the specific characteristics are the following: Polyphenol Index (IPT) using the method Folin Ciocalteu, Total anthocyanin potential (PA) and Anthocyanins extractibility (EXA) and seeds maturity (MS) using the method Glories (Christaki T. *et al,* 2002).

The qualitative level of the 2016, 2017 and 2018 harvest years on the specific composition of the wine from Cabernet Sauvignon and Feteasca neagra varieties was evaluated by comparison with the average of 1990-1999.

## RESULTS AND DISCUSSIONS

**Climate characterization during the maturation of grapes.** The climate of the ripening period (July-September) was good in terms of air temperatures (as mean values, minimum and maximum) and mediocre in the amount of precipitation recorded in 2018, compared to average the years 1987-2017 (*figure 1* and *table 1).*

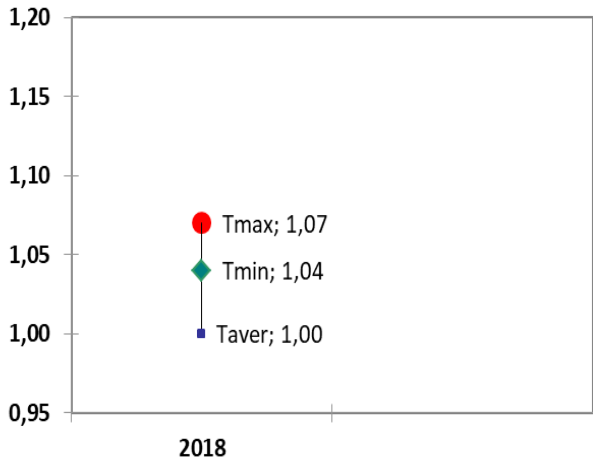



Figure 1 **Comparative analysis (year/multiannual average) of climatic parameters specific to maturation in the year of vintage 2018**

*Table 1*

**The evolution of the climatic parameters analyzed the ripening period of the grapes for wine**

| Harvest year/ Period | Specifi-cation | Air temperature | | | Rainfall (mm) |
|---|---|---|---|---|---|
| | | T aver. (°C) | T min. (°C) | T max. (°C) | |
| 1987-2017 | Min. | 18.1 | 12.5 | 23.6 | |
| | Max. | 23.7 | 17.4 | 29.1 | |
| | Aver. | 21.7 | 15.6 | 27.3 | |
| | Sum | | | | 195 |
| 2018 | Min. | 18.6 | 13.9 | 25.5 | |
| | Max. | 24.1 | 17.4 | 33.7 | |
| | Med. | 21.6 | 16.4 | 29.2 | |
| | Sum | | | | 146 |
| Evaluation 2018/1987-2017 | | | | | |
| 2018 | Aver. | 1.00 | 1.04 | 1.07 | 0.75 |
| Compartive analysis of data | | good | good | good | mediocre |

**The precocity** was registered earlier with 12 days in case of Cabernet Sauvignon variety and 14 days in case of Feteasca neagră, compared to the multiannual averege *(table 2).*

*Table 2*

**Comparative analysis regardind the veraison to black wine grapes of Cabernet Sauvignon and Feteasca neagra varieties**

| Harvest year | Annual date (number of days) | | Differences number of days compared to the multiannual average | |
|---|---|---|---|---|
| | Cabernet Sauvignon | Fetească neagră | Cabernet Sauvignon | Fetească neagră |
| 2014 | 213 | 208 | -11 | -14 |
| 2015 | 212 | 206 | -12 | -16 |
| 2016 | 208 | 203 | -16 | -19 |
| 2017 | 215 | 210 | -9 | -12 |
| 2018 | 214 | 212 | -10 | -10 |
| Multiannual average | 224 | 222 | | |
| Average | | | -12 | -14 |

**The maturation kinetics** were specific to the variety and were correleted with the value of the regression coeffficient and with the value of parameter «a» (determined from the slope of the straight y= ax).

The regression coefficient for Fetească neagră, specific for 2017 and 2018 harvests was 0,990 and 0.991, respectively, the maturation kinetics being slow (*table 3*).

*Table 3*

**Harvest and variety specificity of the regression equation Ij= f(Cj) to the Fetească neagră variety**

| Harvest year | Regression coefficient | Value of parameter „a” | Evaluation of grapes maturation kinetiks |
|---|---|---|---|
| 2014 | 0.992 | 1.502 | very fast |
| 2015 | 0.991 | 1.372 | fast |
| 2016 | 0.993 | 1.163 | fast |
| 2017 | 0.991 | 1.084 | slow |
| 2018 | 0.990 | 1.057 | slow |

The values of the analytical parameters that define the characteristics associated with the phenolic potential of red wine grapes were collected in a basis for the quantification on this potential presented in *table 4.*

The analysis of the data put into evidence (*table 4*) variations of parameters and their different classification, depending on the harvest year and variety.

In case of Cabernet Sauvignon, Total anthocyanin potential (PA), was appreciated as excellent in 2016, 2017 and 2018 year and for Fetească neagră it was just good.

The specific values of Anthocyanins extractibility (EXA%) were good for both varieties in the 2014 and 2018 harvest years.

The maturity of the seed was excellent in the 2016 harvest year both for Cabernet Sauvignon and Fetească neagră and very good in 2015, 2017 and 2018 years. The variation of the technological indices according to variety and harvest year is presented in *table 5*.

The data presented certify that the black grapes are well composed, with a normally developed berry content, the skin of the grapes is in a high proportion, with a high content of antocyanins and specific flavors.

Grapes from the Cabernet Sauvignon variety contain more must and have an thinner skin than those from the Fetească neagră, they have smaller berry (the values of the IRD-yield index are very

small) and the skin of the grapes is thicker, specific to the variety of origin.

**The influence of the quality level of the harvest year on the composition of the wine.**
The wine from the Cabernet Sauvignon variety was appreciated, compared to the average of 1990-1999, with a very good alcoholic strength, of 12.6-12.8% vol. Alcohol (*table 6*). The acidity of the wines was good (*table 6*), specific to the variety, the non-reducing extract good and the total polyphenol content high. The values of coloring intensity were very high for the potential of the variety, the nuance very good in 2016 and good in the 2017 and 2018.

*Table 4*

**Base for the phenolic potential quantification of black grape for winemaking**

| Variety | Harvest year | Analyticals parameters | | | |
|---|---|---|---|---|---|
| | | IPT (UA) | PA (mg/L) | EXA (%) | MS (UA) |
| Cabernet Sauvignon | 2014 | 66 | 1099 | 56 | 54 |
| | 2015 | 45 | 882 | 48 | 72 |
| | 2016 | 39 | 1547 | 44 | 95 |
| | 2017 | 40 | 1575 | 53 | 62 |
| | 2018 | 72 | 1661 | 54 | 68 |
| Fetească neagră | 2014 | 56 | 839 | 50 | 53 |
| | 2015 | 34 | 947 | 59 | 74 |
| | 2016 | 39 | 1456 | 54 | 94 |
| | 2017 | 39 | 1266 | 47 | 66 |
| | 2018 | 65 | 1383 | 52 | 72 |

*Table 5*

**The variation of technological indices according to variety and harvest year**

| Variety | Harvest year | Analyticals parameters | | | |
|---|---|---|---|---|---|
| | | ISST | IB | ICZB | IRD |
| Cabernet Sauvignon | 2014 | 31.3 | 97.4 | 2.8 | 4.6 |
| | 2015 | 28.7 | 82.1 | 5.7 | 4.3 |
| | 2016 | 28.4 | 93.2 | 8.0 | 2.6 |
| | 2017 | 32.1 | 85.6 | 6.7 | 3.0 |
| | 2018 | 46.5 | 78.3 | 6.5 | 3.9 |
| Fetească neagră | 2014 | 43.6 | 72.8 | 9.9 | 3.7 |
| | 2015 | 41.1 | 60.6 | 4.8 | 3.1 |
| | 2016 | 31.5 | 91.1 | 6.9 | 2.2 |
| | 2017 | 35.1 | 87.2 | 8.1 | 2.2 |
| | 2018 | 55.6 | 67.9 | 7.8 | 3.0 |

The wine from the Fetească neagră variety was appreciated as extractive, with a high alcoholic strength of more than 13% vol. alcohol (*table 7*).

The wine had a medium acidity and was intensely colored.

*Table 6*

**The composition of the wine from the Cabernet Sauvignon variety, compared to the average of 1990-1999**

| Particularity | | Tad* (% vol) | AT (g/L sulf. ac.) | Enr** (g/L) | IC*** (mm) | Nuance |
|---|---|---|---|---|---|---|
| Average (1990-1999) | Very good | 12.5-13.7 | 3.5-4.0 | >30 | 1.0-1.3 | >0.7 |
| | Good | 12.0-12.5 | 3.5-4.5 | 27.5-30 | 0.75-1.0 | 0.5-0.7 |
| | Mediocre | 11.5-12.0 | 3.5-4.5 | 25-27.5 | 0.50-0.75 | |
| | Slow | <11.5 | >3.5 | <25 | <0.5 | <0.5 |
| **Year 2016** | | 12.6 | 3.8 | 27.8 | 1.09 | 0.71 |
| **Year 2017** | | 12.8 | 4.4 | 26.7 | 1.16 | 0.64 |
| **Year 2018** | | 12.8 | 4.4 | 26.4 | 1.20 | 0.57 |

*Tad- high alcoholic strength; **Enr- nonreducing extract, ***IC- coloring intensity

*Table 7*

**The composition of the wine from the Fetească neagră variety, compared to the average of 1990-1999**

| Particularity | | Tad (% vol) | AT (g/L sulf. ac.) | Enr (g/L) | IC (mm) | Nuance |
|---|---|---|---|---|---|---|
| Average (1990-1999) | Very good | 12.5-13.7 | 3.0-3.5 | 27-29 | 0.8-1.3 | >0.7 |
| | Good | 12.0-12.5 | 3.5-4.0 | 25-27 | 0.6-0.8 | 0.5-0.7 |
| | Mediocre | 11.5-12.0 | 3.4-4.0 | 22.2-25.0 | 0.4-0.6 | |
| | Slow | <11.5 | 3.5-4.5 | <22.2 | <0.4 | <0.5 |
| **Year 2016** | | 13.0 | 3.78 | 18.85 | 0.70 | 0.87 |
| **Year 2017** | | 13.5 | 3.89 | 27.33 | 0.82 | 0.95 |
| **Year 2018** | | 13.6 | 3.75 | 27.33 | 1.03 | 0.62 |

## CONCLUSION

The rainfall regime in year 2018 registered a deficit of 49 mm compared to the average of 1987-2017.

The precocity was registered earlier with 12 days in case of Cabernet Sauvignon and with 14 days in case of Feteasca neagra, compared to the multiannual average.

Grapes maturation kinetiks was very fast in the 2014 harvest year, fast in 2015 and 2016 and slow in 2017 and 2018.

Phenolic maturity at the Cabernet Sauvignon variety in the 2014 was appreciated as good for all determined analytical parameters, in 2015 very good for grape seed maturity, in 2016 particularly good for the total anthocyanin potential and grape seed maturity, and in 2017 and 2018 excellent, regarding of total anthocyanin potential.

Phenolic maturity at the Fetească neagră variety of the grapes in the 2014 and 2015 was appreciated as being very good for the maturity of the grape seeds.

The maturity of the grape seeds in 2016 was exceptional and the anthocyanin potential was very good.

The years 2017 and 2018 are distinguished by a very good anthocyanin potential and a very good maturity of the grapes seeds.

The grapes are well composed, with a percentage of normally developed grape berries.

The wines have a high alcohol concentation, a good acidity specific to the variety, intensely colored.

The wines reveal the specificity of the variety and are balanced in taste, on the strength of the harmony between the chemical parameters of composition.

## ACKNOWLEGMENTS

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The study has the value of fundamental research, the data obtained may constitute reference elements for new experiments or for establishing efficient processing conditions in the wine industry, to achieve the quality and stability of finished products (wines), in accordance with modern quality standards.

## REFERENCES

**Anneraud C., Vinsonneau E,. 2009** - *Maturite technologique et maturite phenolique de raisins.* Lettre actualites 41, 1-4.

**Blouin J., Guimberteau G., 2000** - *Maturation et maturité des raisins*, Feret, Bordeaux.

**Carbonneau A. Deloire, Jaillard B., 2007** - *La vigne: Physiologie, terroir, culture,* Dunod, Paris, 2007.

**Christaki T., Tzia C., 2002 -** *Quality and safety assurance in winemaking.* Food Control, 13, 503–517

**Vivas N., Nedjma M., Vivas de Gaulejac Nathalie, Nonier M.F., 2003** - *Critères d'adaptation et spécificité des méthodes de vinification et d'élevage des vins produits dans le bassin méditerranéen.* Revue Française d'Oenologie-mai/juin –No 200.

**Vivas N., Saint-Cricq de Gaulejac N, Yves G., 1998 -** *Maturation phenolique: definition et control.*

# RESULTS ON THE USE OF BACTERIAL BIOPREPARATIONS (BIOLOGICAL FERTILIZERS) IN AGRICULTURAL CROPS IN RESEARCH AND DEVELOPMENT STATIONS FOR AGRICULTURE, ROMANIA

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**Abstract**

The development and use of strategies for organic fertilization of agricultural crops will lead to a decomposition of insoluble elements in the soil structure, which will lead to an increase in the number of soluble mineral elements in the soil structure, which will lead to significant plant growth and of agricultural production. Soil pollution with chemical elements has led to an increase in pH from a basic / neutral to an acid one. Soil acidification causes a decrease in agricultural production, a decrease in plant resistance to certain pests of soil structure, but especially soil pollution, groundwater with certain chemical elements found in the structure of fertilizers. Thus, following the research carried out within the research-development stations for agriculture in Romania, it was proved that the lots fertilized with biological fertilizer had a much higher production than the lots fertilized chemically.

**Key words**: bacterial biopreparations, biological protection and fertilization, ecological fertilization technologies

In order to support the growth and development of plants, the soil must be able to provide the plants with the mineral elements they need, in equal quantities so as to ensure the harmonious growth and development of the crop plants. The soil structure contains a highly developed bacterial fauna that has the role of ensuring the decomposition of insoluble elements into soluble elements as well as accelerating the process of decomposition of plant debris on the soil surface and its interior (Chandler D *et al*, 2010; Larkin and Hansen A., 2010).

The production of biological fertilizers that contain live bacterial cultures is an innovation for agriculture. The role of bacteria in bacterial biopreparations used as biological fertilizers is to recolonize the bacterial fauna of the soil, providing the nutrients that plants need in their growth and development and in the processes in soil structure (fixing atmospheric nitrogen in the soil, decomposition of insoluble elements in soluble elements, decomposition of plant residues in the soil, etc.) (Toncea I. *et al*, 2012; Voloșciuc L , 2009a).

Another aspect related to the use of bacterial biopreparations in agriculture is the impact that these bacteria have on pests in the soil structure and on the surface of plants. As a result of their activity, the bacteria eliminate a series of enzymes and phytohormones that have the role of fighting certain pests in agricultural crops. (Aggani S.L., 2013). Tests on maize have shown that the effect of inoculating the seed material in a solution of bacterial biopreparations has led to a halt to the attack of the pest *Tanymecus dilaticollis*. This is an important step in the biological control of pests resistant to chemical components in plant protection substances as well as those in the composition of chemical fertilizers (Toader G. *et al*, 2019). The ecological imbalance of the soil is characterized by the decrease of the activity of bacteria in the soil fauna (useful soil fauna), the use in large doses of these products will lead to soil acidification, decreased fertility, increased pest resistance and side effects. on the human or animal body (Chiurciu C *et al*, 2019).

In order to replace chemical fertilizers, agricultural researchers with the help of soil fertilizers and plant protection products have managed to restore the structure of the soil, its recolonization with beneficial bacteria and the decomposition of insoluble mineral elements into

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soluble components, easily assimilated by plants. These plant fertilization products have allowed the development of new technologies in the field of agriculture, green technologies, environmentally friendly and new technologies for fertilizing agricultural crops with these organic fertilization products (Voloșciuc L., 2009b).

## MATERIAL ŞI METHOD

The product Rom-Agrobiofertil NP was used as research material. The product represents a set of three living bacterial cultures: *Azospirillum lipoferum*, *Azotobacter chroococcum* and *Bacillus megaterium*. The three living bacterial cultures have their own role in the agricultural soil system (useful soil fauna) these bacteria accelerating the process of decomposition of residues and the release of insoluble comos from the soil structure into soluble compounds, easily assimilated by plants. The research methods were applied within the Research-Development Stations for Agriculture in Romania, namely S.C.D.L Buzău, S.C.D.L Bacău and S.C.D.A Suceava.

## RESULTS AND DISCUSSIONS

**1. Buzău Vegetable Research and Development Station.**

Following the tests of the bacterial biopreparation Rom-Agrobiofertil NP on some cultures within the resort, the following results were obtained:

**1.1. Cabbage crop, "de Buzău" variety:** within the resort, the Rom-Agrobiofertil NP product was tested on the cabbage crop. Different batches were made: control batch (chemical fertilizer-V1) (*figure 1*) and biological fertilizer batch-V2 *(figure 2*) (Rom-Agrobiofertil NP product). Numerous differences were identified between the two lots as follows (*figure 3*) and (*table 1*):

Tabelul 1

**Biometric data: seed culture of cabbage "De Buzău"**

| Lots | No shoots | Length siliques | No medium / plant siliceous | No seeds / syllable | Average seed / plant | | Average seed production kg / ha | Sales price / kg | Total value of seeds / lei |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | No seeds / plant | g/pl | | | |
| V1- Witness | 21 | 6.25 | 209 | 24 | 2021 | 8.31 | 422.46 | 500 | 211.230 |
| V2 - Rom-Agrobiofertil NP | 23 | 7.80 | 424 | 29 | 6564 | 44.4 | 1171.76 | 500 | 585.880 |
| Growth (%) | 9.52 % | 24.8 % | 102.87 % | 20.83 % | 224.79 % | 434.3 % | 177.4 % | 0.0 % | 177.36 % |



Figure 1 **Culture of cabbage witness lot**



Figure 2 **Culture of cabbage "De Buzău"- organic fertilized lot**



Figure 3 **Differences between the control group (fertilized) and the biological fertilized group (Rom-Agrobiofertil NP)**

Following the testing of the bacterial biopreparation Rom-Agrobiofertil NP in parallel with a chemical fertilizer, it was proved that in the cabbage culture, the production of the biologically fertilized lot was much higher than the production of the chemically fertilized lot. Thus, the percentage of production of the biologically fertilized lot compared to the chemically fertilized lot was between 224.79% (number of seeds per plant) and 177.4% (production of seed material per ha). Also, the profit increased by 177.36%.

**1.2. Tomato culture, "Florina 44" variety**

Within S.C.D.L Buzău, tests were also performed on tomato crops. Chemical fertilization products in parallel with biological fertilizer were used in the culture. The results obtained in the biologically fertilized batch were much more significant than the results obtained in the chemical batch (*table 2*).

Following the testing of the bacterial biopreparation Rom-Agrobiofertil NP in parallel with a chemical fertilizer, it was proved that in the tomato crop, the production of the biologically fertilized lot was much higher than the production of the chemically fertilized lot. Thus, the percentage of production of the biologically fertilized lot compared to the chemically fertilized lot was between 79.97% (total fruit production per kg), 69.27% (total production per ha) and 39.96% (total number of fruits per plant).

**2. Bacău Vegetable Research and Development Station.**

**2.1. Bean and corn cultures.**

Within S.C.D.L Bacău, tests were performed on bean and sweet corn crops. Chemical fertilization products in parallel with biological fertilizer were used in the culture. The results obtained in the biologically fertilized batch were much more significant than the results obtained in the chemical batch (*table 3*).

**3. Suceava Agricultural Research and Development Station**

**3.1. Rapeseed / phelium (lolium) crop.**

Within S.C.D.A Suceava, tests were performed on rapeseed and phelium (lawn) crops. Chemical fertilization products in parallel with biological fertilizer were used in the culture.

Table 2

**Tomato culture. "Florina 44".**

| Lots | No of Ripe fruit/pl | Ripe fruit weight/pl (kg) | No. of green fruits/pl | Weight of green fruits/pl (kg) | Total fruit/plant production (kg) | Total no. fruit/plant | Total production t/ha |
|---|---|---|---|---|---|---|---|
| V1- Witness | 11.2 | 0.802 | 14.2 | 1.06 | 1.862 | 25.4 | 78.3 |
| V2 - Rom-Agrobiofertil NP | 13.3 | 1.251 | 22.25 | 2.1 | 3.351 | 35.55 | 132.6 |
| Growth (%) | 15.78 % | 35.89 % | 36.17 % | 49.52 % | 79.97 % | 39.96 % | 69.27 % |

Table 3

**Bean and corn cultures**

| Lots | Bean “Auria Bacăului” | Corn “Dulce de Bacău” |
|---|---|---|
| V1- Witness | 1058 | 7896 |
| V2 - Rom-Agrobiofertil NP | 1219 | 8760 |
| Growth (%) | 15.22 % | 10.94 % |
| Production surplus | 161 kg/ ha | 864 kg/ ha |

The results obtained in the biologically fertilized batch were much more significant than the results obtained in the chemical batch (*table 4*).

It was proved that the lakes of the two

Table 4

**Rape and lolium cultures**

| Lot | Rape | Lolium |
|---|---|---|
| V1- Chemically fertilized | 3260 kg/ha | 240 kg/ha |
| V2 - Rom-Agrobiofertil NP | 3680 kg/ha | 310 kg/ha |
| Production surplus | 420 kg/ ha | 70 kg/ ha |
| Growth (%) | 12.88 % | 29.16 % |

cultures mentioned above, the productions of the biologically fertilized lots were much higher than the productions of the chemically fertilized lots. Thus, the percentage of production of the biologically fertilized lot compared to the chemically fertilized lot was 12.88% (rapeseed crop) and 29.16% (phelium crop).

These increases in agricultural production have shown that the application of an organic fertilizer leads to an increase in agricultural production in relation to the products obtained from a chemically fertilized lot. Another important aspect is the action of biological fertilizer on the soil (useful bacterial fauna as well as the amount of mineral elements in the soil).

Following the application of this fertilizer on the soil, it was proved that the bacterial activity in the composition of the biological fertilizer solubilized insoluble compounds in the soil structure into soluble compounds, which led to the enrichment of the soil with mineral elements easily assimilated by plants (*table 5*).

Numerous differences as well as fluctuations in the increase and decrease of the main mineral microelements were identified between the lots arranged in the field.

Thus, from *table 5* it can be seen that the pH shows a slight increase (+3.53%). Another element is given by the decrease of humus (-8%). The decrease of organic matter in the biologically fertilized lot is due to the bacterial activity in the soil because these bacteria have an important role in the decomposition of complex compounds in the soil structure (chelated compounds).

This decomposition is a process by which insoluble compounds are converted into soluble compounds, easily assimilated by plants. The fact that on the biologically fertilized soil the amount of humus and oeganic matter has decreased, this phenomenon can be explained by growing plants and obtaining high yields.

The activity of soil bacteria has led to the recolonization of soil bacterial fauna. This recolonization brought with it a decomposition of insoluble elements in the soil. Their conversion gave the plants the essential elements they needed in their growth and development both as a plant itself but especially as a production.

A large increase in agricultural production in the biologically fertilized lot was due to the increase in the elements that the plants needed. The higher the amount of mineral elements in the soil, the higher the plants and the higher the production.

These aspects make the use of fertilizers based on bacterial cultures beneficial to be the "right choice" in agriculture, these fertilizers being compatible with the development and sustainable agriculture of agricultural crops. The present paper aims to present the effects of the action of biofertilizers on the crops to which this product was applied. From the obtained biometric data, a significant difference can be observed between the two batches, which denotes the benefits of using these types of biological fertilizers. Also, the action of these biofertilizers on the soil and, implicitly on the agricultural crops, can be observed from the differences recorded in the total

production. A large production represents a surplus for the farmer, this aspect being equivalent to a greater profit for it.

Biofertilizers are organic products, they are environmentally friendly so that they do not affect the surrounding flora or fauna.

Table 5

**Fluctuation elements identified soil analysis**

| Growth | Tests performed | | | | |
|---|---|---|---|---|---|
| | pH | Humus | Nt | $P_{AL}$ | $K_{AL}$ |
| | unit.pH | % | % | mg/kg | mg/kg |
| Lot treated vs untreated (field) | **3.53 %** | **-7.79%** | **4.67%** | **59.49 %** | **14.04 %** |
| Untreated vs. treated lot (field) | **-3.41 %** | **8.45 %** | **-4.46 %** | **-37.30 %** | **-12.31 %** |
| Treated vs. untreated lot (solar) | **0.62 %** | **-3.61 %** | **-4.32 %** | **10.64 %** | **8.96 %** |
| Untreated vs. treated lot (solar) | **-0.62 %** | **3.75 %** | **4.52 %** | **-9.62 %** | **-8.22 %** |

## CONCLUSIONS

Following the application of the organic fertilizer product Rom-Agrobiofertil NP on certain lots, in parallel with a chemical fertilizer it was proved that between the two lots were identified differences related to the height of the plants and their actual production.

Thus, the bacterial activity in the soil structure led to the acceleration of the process of decomposition of complex compounds in the soil structure as well as the solubilization of insoluble compounds in the soil into soluble compounds essential for the growth and development of crop plants. Another important aspect is the increase of the productions registered at the biological batches.

The application of biological fertilizer on the lots established within the research and development stations led to the appearance of internal processes in the soil structure. Following the mapping of the soil, it was demonstrated that the bacterial activity in the soil led to the decomposition of insoluble mineral elements in the soil into soluble elements easily assimilated by plants. The "abundance" of mineral elements in the soil structure led to the stimulation of the growth of crop plants so that the plants showed a significant increase in both height, plant material and production itself.

The most important aspect in the use of biofertilizers is the ecological soil as well as the significant reduction of environmental pollution and the improvement of the conditions in the soil structure. These innovative technologies (biofertilizers) represent a contribution in obtaining large yields, in enriching the soil with the necessary elements for the growth and development of plants but especially in recolonizing the bacterial fauna of the soil.

Another important aspect regarding the use of these products is the provision of the important elements (nitrogen, phosphorus, potassium) necessary for the growth and development of plants. These products do not pose a threat to the health of humans and animals so biofertilizers can be applied in any culture.

Based on the present article, we can say that following the application of these organic products in relation to chemical fertilizers, the biometric yields and determinations were much higher compared to the chemical batch - biological batch vs. chemical batch. Following the analyzes carried out within the ICPA Bucharest in the lots where the biofertilizer was used Rom-Agrobiofertil NP was found a decrease of the complex compounds in the soil structure, an ecology of it but especially an increase of the soil fauna. Another important aspect is the increase of the soil loosening, loosening which allows a better aeration, a bigger water retention but especially a much faster facilitation of the energy exchange between soil-plant-environment.

The use of these products in the agricultural field represents a new innovation, a new technology and the fact that farmers are beginning to use these technologies proves that in the future agriculture will become sustainable, agriculture that will ensure large, healthy, products that will not affect human health and of animals.

## ACKNOWLEGMENTS

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## REFERENCES

**Agganni S.L. 2013 -** *Development of Biofertilizers and its Future Perspective.* Sch. Acad. J. Pharm., 2 (4): 327-332

**Chandler D., Greaves J., Prince G., Tatchell M., Bailey A**. **2012** - *Biopesticides: Pest Management and Regulation.* CABI, 2010. 256 p.

**Toader G., Chiurciu C., Chiurciu V, Burnichi F., Petre C., Chițonu P., Maierean N., Ilie L., 2019** - *Research on the action of rom-agrobiofertil np biofertilizer on agricultural crops.* In: Scientific Papers. Series A. Agronomy, Vol. LXII, No. 1, 2019. ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785.

**Toader G., Chiurciu C., Chiurciu V, Burnichi F., Petre C., Chițonu, P., Maierean N., Ilie L., Bora C., Păunescu G., 2019 -** *Research on the action of fertilizers based on bacterial cultures on some agricultural crops in Romania.* In: Agroprint timișoara: Lucrări Ştiinţifice, seria I, VOL.XXI (2). ISSN print 1453-1410; ISSN online 2069-2307.

**Toncea I., Enuţă S., Ioniţă Niţu Georgeta, Alexandrescu Daniela, Toncea V. A. 2012 -** *Manual de Agricultură Ecologică.* Cluj-Napoca, 2012. 360 p.

**Volоșciuc L.T., 2009a** - *Biotehnologia producerii şi aplicării preparatelor baculovirale în agricultura ecologică. Chişinău: Mediul ambiant*. Chișinău, 262 p.

**Volоșciuc L.T., 2009b** - *Probleme ecologice în agricultură*. Chişinău, 264 p.

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# THE HYBRID INFLUENCE ON THE *OSTRINIA NUBILALIS* HBN. LARVAE ATTACK LEVEL UNDER THE CONDITION OF CENTRAL OF MOLDOVA

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**Abstract**

From the first report of the species *Ostrinia nubilalis* Hbn. in Romania in 1898, the insect spread and is currently present in all corn crops in our country. The production losses that the insect produces vary from one year to another, from one field to another, one of the factors influencing the reduction of the attack is the cultivated maize hybrid. This paper presents the preliminary results obtained in 2019, where was studied the influence of the precocity group and the hybrid variety on the attack level produced by the european corn borers larvae in the conditions of the Center of Moldova. The studied maize hybrids show different values of the attack produced by the *Ostrinia nubilalis* Hbn. larvae. Depending on the maturity group, the genotypes that recorded high attack values are those from FAO groups 400 - 430 (Kerala and Olt), followed by semi-early hybrids in FAO groups 370-380, and the lowest attack was recorded by the hybrid Vibrion maize classified as FAO maturity group 290. Of the three maize varieties tested, the sweet hybrid was the most affected by the european corn borer larvae attack followed by the dentate ones from the semi-early maturity groups and the flint variety (Vibrion) was not affected due to the short period of vegetation.

**Key words**: hybrid, maturity group, attack, larvae, european corn borer

The important role that corn plays in the economy of a country, has determined the improvement of the production potential of genotypes and cultivation technologies. The biology of the plant, together with the diversity of possibilities to capitalize on its products, determined the researchers to initiate improvement works on corn, which led to the appearance in production of the first autothoni corn hybrids, from their own inbred lines (Murariu *et al.*, 2012).

Maize grains are an important source of raw materials in many sectors of industry. The uses of corn depend on its destination: in animal feed such as concentrated feed, silage or green meal, in the food industry, by processing by dry grinding (flour, semolina) or wet (starch, protein, fiber and germ). Snacks, breakfast cereals, syrups and alcohol are obtained from starch and ground products. From an energy point of view, corn tends to become one of the most important energy plants for the temperate zone, as a recent use of starch is related to the extraction of bioethanol (Roman *et al*., 2011).

From the first report of the species *Ostrinia nubilalis* Hbn. in Romania in 1898, the insect spread and is currently present in all corn crops in our country. The production losses that the insect produces vary from one year to another, from one soil to another, one of the factors influencing the reduction of the attack is the cultivated corn hybrid. Following the research conducted by Săpunaru and Hatman (1975) in Moldova, the production losses caused by the attack of *Ostrinia nubilalis* Hbn larvae they varied between 1400 - 2360 kg/ha. The most recent data published by Popov and Roșca (2007) suggest that the production losses that occurred due to the pest were 7.5%.

The research conducted by Trotuș *et al* (2018) highlights the fact that for the conditions in Central Moldova, the species *Ostrinia nubilalis* Hbn. it is abundant, registering a coefficient of variability of 20.01%.

The vegetation period of maize, which is expressed by the classification of the hybrid in the FAO maturity group, is an important factor in determining the range of hybrids suitable for cultivation in each favorable area of the country.

The link between grain production and the vegetation period of each genotype is very close, a wide range of maize hybrids from different maturity groups, ensure staggered production, especially in recent years, when in the summer

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months and especially in autumn, a prolonged drought sets in in Romanian conditions (Cristea et al., 2004). Thus, early hybrids will contain higher amounts of protein than late ones, but the starch will be lower than those with a longer vegetation period.

Resistance or tolerance to larval attack by the borer occurs in genotypes containing DIMBOA amino acids, found in late hybrids.

The chemical composition of the corn kernel depends on the variety of the hybrid or genotype: the indurate will contain a higher percentage of protein, and the indentate will be richer in starch. The choice of corn hybrids must be made taking into account the destination of the crop: food industry, animal feed, green energy (Mogârzan, 2012).

Under Ukrainian conditions, Pereverzev (2005) studied 28 maize genotypes in Spain and 23 in Portugal to determine their tolerance to borer attack. The tolerance of the studied genotypes varied because the genetic material of corn was diverse both in terms of precocity, hybrids from very early to late, but also in terms of variety, with flint and dent grain. He identified semi-late and late hybrids with a better tolerance to borer attack, but also semi-early maize populations with dent grain that showed higher grain yields and reduced attack.

This paper presents the preliminary results obtained in the agricultural year 2018/2019, from an experiment where the influence of the precocity group and the variety of the hybrid on the level of attack produced by the larvae of *Ostrinia nubilalis* Hbn was monitored in the conditions of the Center of Moldova.

## MATERIAL AND METHOD

In the agricultural year 2018/2019, two monofactorial experiments were placed in randomized blocks in three repetitions, in the experimental field of the Agricultural Research and Development Station Secuieni - Neamț, on a typical chernozem cambic soil, with pH in water 6,29, humus content 2.3, nitrogen index 2.1, mobile P2O5 39 ppm, mobile K2O 161 ppm. Their purpose was to monitor the contribution of the precocity group and the variety of the hybrid on the level of attack produced by the larvae of Ostrinia nubilalis Hbn. in the conditions of the Center of Moldova.

The biological material consisted in the first experiment of five hybrids belonging to different maturity groups, and in the second experiment of five hybrids belonging to the varieties of maize, dent, flint and sweet (Table 1). Each hybrid was sown on an area of 28 s.m.. The maize crop was established respecting the cultivation technology of this species in the conditions of Central Moldova (Trotuș et al., 2015).

From the climatic point of view, the agricultural year 2018/2019 was characterized as being warmly thermal, with a deviation of 1.1 ºC compared to the multiannual average temperature of 8.9 ºC.

The recorded temperatures showed the highest deviations in March (4 ºC), February (3.1 ºC), April (2.5 ºC) and October (2.2 ºC). The spring months showed a warming trend, this phenomenon being noticed in the autumn and winter months (*Figure 1*).

The precipitation fell to 430.2 mm, the deficit of 114.1 mm characterizing the year as dry (*Figure 2*). Analyzing the amounts of rainfall in each month of the agricultural year, it is noted that the months of October (-37.6 mm), March (-22.7 mm), June (-29.2 mm), July (-35.7 mm) ) and August (-39.8 mm) showed a deficit in precipitation, and May was the only one that recorded Aan excess in precipitation of 29.3 mm (*Figure 2*).

At the end of the vegetation period, 25 plants / variant were harvested, from the rows in the middle of the plot and which were sectioned to determine the frequency of attacked plants, the average number of holes / plant, the number of larvae and the length of the galleries. The cobs were also noted to determine if there were any holes, larvae or the presence of the pathogen Fusariu

The results obtained were calculated and interpreted statistically using the analysis of variance.

Table 1

**The biological material used**

| | **Hybrids** | |
|---|---|---|
| No | **Experience I - the variety of the hybrid** | |
| **1** | **Vibrion** | Flint |
| **2** | **Inventive** | Tropical dentate |
| **3** | **Method** | Tropical dentate |
| **4** | **Kerala** | Dent |
| **5** | **Deliciul verii** | Sweet |
| No | **Experience II - precocity group** | |
| **1** | **Turda star** | 370 - semi-early |
| **2** | **Turda 248** | 380 - semi-early |
| **3** | **Turda 332** | 390 - semi-early |
| **4** | **Olt** | 430 - semi-late hybrid |
| **5** | **Zlatan** | 500 - late hybrid |

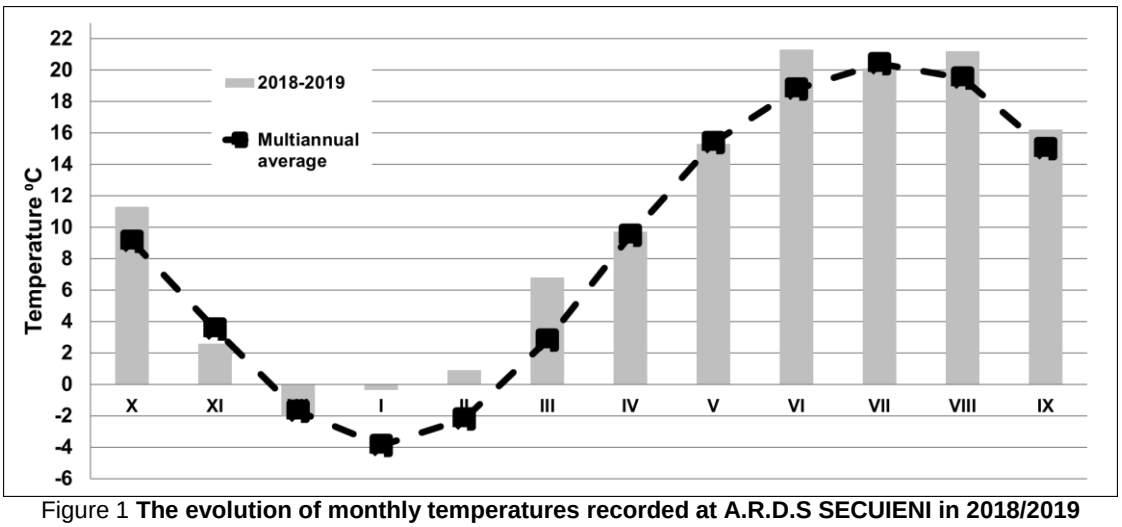



Figure 1 **The evolution of monthly temperatures recorded at A.R.D.S SECUIENI in 2018/2019**

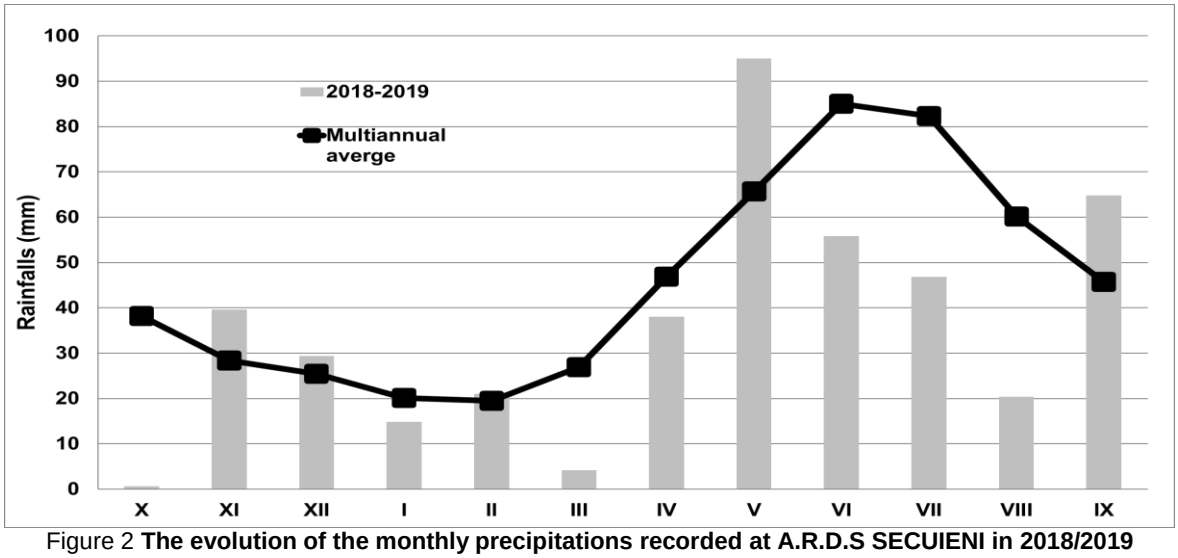



Figure 2 **The evolution of the monthly precipitations recorded at A.R.D.S SECUIENI in 2018/2019**

## RESULTS AND DISCUSSIONS

Influence of maize variety on the attack level produced by larvae of *Ostrinia nubilalis* Hbn. was highlighted by the variability of the parameters followed (frequency of attacked plants, average number of holes / plant, number of larvae and length of galleries) from one variant to another.

Analyzing the reaction of the hybrid according to the variety of the genotype to the attack of the larvae by the corn borer, it was highlighted by minimal attack the maize hybrid with flint grain (FAO 290).

Inventive, Method and Kerala dent hybrids recorded attack frequency values between 11.67% and 25.00%. The highest values were identified for the Kerala hybrid, where the average number of holes / plant was 1.83, were found 1.25 larvae / plant and the length of the gallery reached 7.18 cm (*table 2*).

The sweet corn hybrid Deliciul verii was the most affected by the corn borer larvae, the plants were affected in a percentage of 25.00%, recording, on average, 3 holes / plant, with an average gallery length of 14.92 cm.

Jarvis (1988) compared the level of attack by corn borer larvae on sweet corn, dent and popcorn, concluding that of the three varieties, sweet corn suffered the most damage and dent and popcorn varieties (everta) recorded close attack values.

The comparative study conducted by Schulz *et al.* (1997) which included 18 genotypes of flint maize and 23 genotypes of dent maize showed that under the conditions of the existence of a single generation, the number of broken plants is higher, the length of the gallery and small yields were recorded for flint grain maize varieties.

Table 2

**The influence of maize hybrid convariance on the attack parameters produced by the larvae of *Ostrinia nubilalis* Hbn., Secuieni - Neamţ, 2019**

| Maize hybrid | Maize variety | Frequency of attacked plants (%) | The average number of holes/plant | The number of larvae/ plant | The length of the galleries (cm) | Frequency of attacked of *Fusarium spp* (%) |
|---|---|---|---|---|---|---|
| **Vibrion** | **Flint** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Inventive** | **Tropical dent** | 12.50 | 0.50 | 0.50 | 5.42 | 2.50 |
| **Method** | **Tropical dent** | 14.50 | 0.42 | 0.42 | 3.80 | 2.50 |
| **Kerala** | **Dent** | 11.67 | 1.83 | 1.25** | 7.18 | 4.76* |
| **Deliciul verii** | **Sweet** | 25.00 | 3.00** | 0.83 | 14.92** | 2.83 |
| **Average (mt)** | **-** | 12.80 | 1,13 | 0,62 | 6,26 | 3.13 |
| DL 5% | | 3.94 | 0.80 | 0.33 | 4.70 | 2.13 |
| DL 1% | | 5.60 | 1.13 | 0.47 | 6.69 | 3.03 |
| DL 0.1% | | 8.10 | 1.64 | 0.68 | 9.68 | 4.38 |

Roderick (1992) argues that research to identify genotypes of dentate corn resistant to borer larvae has shown that genes that provide resistance to leaf-feeding generation have been easier to identify than resistance to attack on the stem. Resistance is influenced by the amino acid continuum DIMBOA and lignin in the leaves. Efforts to transfer resistance from maize to sweet corn have generally failed because many quality factors in maize are adversely affected. In areas where two generations are reported, future *Ostrina* attack management strategies should consider the use of genotypes with resistance to leaf attack by the first generation, and for the second, *Trichogramma* launches, the use of non-polluting insecticides and capturing adults through sex pheromones to reduce the population.

The results obtained during three years of studying by Beres (2012) show that the sugar corn was the most attacked by the borers larvae, the frequency of the attacked plants being between 89.5% and 93.0%.

Gardner and Hoffmann (2000) studied the resistance of several sweet corn genotypes to the attack produced by the larvae of *Ostrinia nubilalis* Hbn. and concluded that the susceptibility of a maize genotype to attack by borer larvae can be expressed in the number of galleries on the plant, whether small or large, which increase the length of the galleries. From the results obtained by researchers, large galleries create serious problems for corn plants, and genotypes where a large number of larvae are found suggest that they are more prone to attack.

A directly proportional relationship was established between the level of the attack and the number of galleries, genotypes with a high number of galleries recorded a higher level of attack, while a small number of galleries showed a low level of attack.

The attack on maize from different maturity groups was dependent on the biological cycle of the insect. Females choose taller, more vigorous plants with softer tissues so that the larvae, once hatched, feed and then, past the first larval ages, can easily create holes in the surface of the plant and galleries inside the stem (Brindley and Dicke, 1963).

Under the conditions of A.R.D.S. Secuieni, following the experimentation of five hybrids from different maturity groups, was noted with the highest values of attack the semi-late hybrid Olt (FAO 430) which recorded a percentage of attacked plants of 23.00%, one hole / plant, 0.58 larvae / plant and the average length of the gallery reached 5.79 cm (*table 3*). Data from the literature through those published by Georgescu *et al.* (2013,2016) claim that the Olt hybrid has a lower level of attack, due to the fact that it is a late hybrid and tolerates the attack more easily compared to other hybrids.

The results obtained are similar to those published by Malvar *et al* (1993) who concluded that late and normal genotypes are much more affected by the attack produced by *Ostrinia* larvae than early and early ones. These differences are due to the number of days needed for each genotype to bloom, as when the larvae appear, the extra-early ones are more mature, and the adults prefer to lay their egss on juicy, more succulent plants, so the extra-early genotypes have a lower attack.

Of the three semi-early hybrids with close vegetation periods, Turda star (FAO 370), Turda 248 (FAO 380) and Turda 332 (FAO 390), the frequency of attacked plants varied from 12.33% as recorded by the hybrid Turda star and 14.33% for the Turda 332 hybrid. The number of holes /

plant varied from 0.33 to the Turda 248 hybrid, while the Turda Star and Turda 332 hybrids each showed 0.50 holes / plant compared to the Olt hybrid. which recorded 1 hole / plant and the semi-late hybrid Zlatan (FAO 500) showed no signs of attack (*table 3*).

Analyzing the number of larvae / plant, in the semi-early hybrids Turda star, Turda 248 and Turda 332 were recorded between 0.33 and 0.50 larvae / plant, the length of the galleries was between 1.92 cm at the hybrid Turda 332 and up at 4.84 cm for the Turda Star hybrid.

The frequency of attack caused by the pathogen *Fusarium* spp in cobs was between 2.50% in the Zlatan maize hybrid and reached up to 6.67% in the Turda Star hybrid, the rest of the hybrids showed no signs of pathogen installation (Table 3).

Table3

**The influence of the FAO maturity group of the maize hybrid on the parameters of the attack produced by the larvae of the species *Ostrinia nubilalis* Hbn., Secuieni - Neamț - 2019**

| Maize hybrid | FAO maturity group | Frequency of attacked plants (%) | The average number of holes/plant | The number of larvae/ plant | The length of the galleries (cm) | Frequency attack of *Fusarium spp* (%) |
|---|---|---|---|---|---|---|
| **Turda star** | **370 - semi-early** | 12.33 | 0.50 | 0.33 | 4.84$^{**}$ | 6.67$^{***}$ |
| **Turda 248** | **380 - semi-early** | 13.67 | 0.33 | 0.42 | 2.25$^{0}$ | 0.00$^{00}$ |
| **Turda 332** | **390 - semi-early** | 14.33 | 0.50 | 0.50 | 1.92$^{00}$ | 0.00$^{00}$ |
| **Olt** | **430 - semi-late hybrid** | 23.33$^{**}$ | 1.00$^{**}$ | 0.58 | 5.79$^{***}$ | 0.00$^{00}$ |
| **Zlatan** | **500 - late hybrid** | 0.00$^{00}$ | 0.00$^{00}$ | 0.00 | 0.00$^{000}$ | 2.50 |
| **Average (mt)** | **-** | 12.73 | 0.47 | 0.36 | 2.96 | 1.83 |
| DL 5% | | 5.20 | 0.28 | 0.21 | 0.58 | 1.11 |
| DL 1% | | 7.39 | 0.40 | 0.29 | 0.83 | 1.58 |
| DL 0.1% | | 10.70 | 0.57 | 0.43 | 1.99 | 2.28 |

The results obtained are similar to those published by Trotuș *et al* (2018) which recorded a density of larvae / plant between 0.40 and 1.70 specimens/plant, and the frequency of attacked plants ranged from 15.00% to 52.60 %.

In the study by Schulz *et al.* (1997) note that genotypes from earlier maturity groups showed satisfactory yields and a low attack level with a reduse number of holes and the length of the galleries. If between the productions and the maturity group, respectively the number of holes and the frequency of the attacked plants, negative correlations were established, between the attack produced by *Ostrinia* and the maturity group, the connection was highlighted by a significant positive correlation.

In Poland, Beres and Gorski (2012) monitored a number of hybrids from different precocity groups, and concluded that most attacked plants were recorded in hybrids from FAO 190-250 maturity precocity groups, compared to hybrids from FAO 270-280. The authors motivate the intense attack of *Ostrinia* larvae on maize hybrids by the rapid growth and development of plants, which is why the females were attracted to them and laid their egg.

## CONCLUSIONS

Under the conditions in the Center of Moldova, the studied maize hybrids present different values of the attack produced by the larvae of the species *Ostrinia nubilalis* Hbn. depending on variety and maturity group.

Of the three maize varieties tested, the sugar hybrid was most affected by ostrinia larvae followed by Inventive, Method and Kerala toothed genotypes, while the flint grain variety had a reduced larval attack.

Depending on the maturity group, hybrids that recorded high values of attack was fao group 430 (Olt), followed by semi-early hybrids from groups 370-380 (Turda 248 and Turda 332), the Zlatan hybrid from group Fao 500 presented the lowest attack percentage.

## REFERENCES

**Bereś P.K**., **2012** - *Damage caused by Ostrinia nubilalis HBN. to fodder maize (Zea mays L.), sweet maize (Zea mays VAR. saccharata [STURTEV.] L.H. BAILEY) and sweet sorghum (Sorghum bicolor [L.] MOENCH) near Rzeszów (south-eastern Poland) in 2008-2010*, Acta Scientiarum Polonorum *Agricultura 11(3) 2012, 3-16, avilabile at*

http://agricultura.acta.utp.edu.pl/index.php/agriculture/index

**Bereś P.Ł.K., Górski Dariusz, 2012** - *Effect of earliness of maize cultivars (Zea mays L.) on damage caused by Ostrinia nubilalis HBN. (LEP., Crambidae),* Acta Scientiarum Polonorum., Agricultura 11(2), 5-17, *avilabile at* http://agricultura.acta.utp.edu.pl/index.php/agriculture/index

**Brindley T.A., Dicke F.F., 1963** - *Significant developments in european corn research*, Annul Review of Entomology, 1963(8):155-176

**Cristea M., Butnaru Gallia, Căbulea I., Haş I., Haş Voichiţa, Malschi Dana, Mureşan Felicia, Naghy Elena, Perju T., Sîrca T., Cărca Vasilchia. Scutaru D., 2004** - *Porumbul - studiu monografic - vol I - Biologia porumbului*, Ed. Academiei Române, Bucureşti, pag. 17-95

**Gardner J., Hoffmann M.P., 2000** - *Resistance to European Corn Borer in Processing Sweet Corn,* HORTSCIENCE 35(5):871–874.

**Georgescu E., Lidia Cană, Iordan H. L., Martura T., Gărgăriţă R., 2013** - *Comportarea unor hibrizi de porumb la atacul de Ostrinia nubilalis Hbn. în condiţii climatice diferite*, Analele I.N.C.D.A. Fundulea, LXXXI, 113-139

**Georgescu E., Maria Toader, Nicoleta Balaban, Luxita Rasnoveanu, Lidia Cana, 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

**Jarvis J.L.,1988** - *Damage by European corn borer (Lepidoptera:Pyralidae) to popcorn kernels compared with damage to kernels of dent corn and sweet corn*, Journal of Economic Entomology,81(4),1214:1216,https://doi.org/10.1093/jee/81.4.1214

**Malvar R.A., Cartea M.E., Revilla P., Ordas A., Alvarez A., Mansilla J.P.**, **1993** - *Sources of resistance to pink stem borer and European corn borer in maize*, Maydica, 38 (4), 313-319

**Mogârzan Aglaia, 2012**, *Fitotehnie* - Ed. Ion Ionescu de la Brad, Iași, pag. 148 – 205

**Murariu M., Murariu Danela, Haș Voichița, Haș I., Leonte C., PLacintă Domenica Daniela, Rîșca I.M., Simionuc D. P., 2012** - *Conservarea și utilizarea germoplasmei locale de porumb din România*, Ed Pim, Iasi, ISBN 978-606-13-1011-1

**Pereverzev D.S., 2005** - *Assessment of maize cultivars of Spanish and Portuguese origin in relation to their precocity, productivity and resistance to the steam borer Ostrinia nubilalis Hbn.,* Plant Protection News,3, 36:41, avilabile at http://www.vestnik.iczr.ru/engl/pdf/2005-3e.pdf#page=36

**Popov C., Rosca I., 2007** - *Technology of European corn borer (Ostrinia nubilalis Hbn.) mass rearing, in continuous system and successive generations*, Entomological Research, 37(1):126.

**Roderick G. McKinlay, 1992** - *Vegetable Crop Pests*, p.258, books.google.ro › books

**Roman Valentin, Tabara Valeriu, Pîrsan Paul, Stefan Marin, Robu Teodor, Axinte Mihail, Morar Gvril, Cernea Solovăstru, 2011** - *Fitotehnie – Cereale și leguminoase pentru boabe, Vol. 1,* Editura Universitară, București, 189-246

**Schulz B., Kreps R, Klein D., Gumber R.K., Melchingeru A. E., 1997** - *Genetic variation among European maize inbreds for resistance to the European corn borer and relation to agronomic traits*, Plant breeding, 116(5), 415-422, https://doi.org/10.1111/j.1439-0523.1997.tb01024.x

**Trotuș Elena, Druțu Adina Cătalina, Găucă C., Popa Lorena Diana, Lupu Cornelia, Pochișcanu 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, Iași, ISBN 978-973-147

**Trotuş Elena, Alexandra-Andreea Buburuz, Paula Lucelia Ursache, 2018** - *New data regarding the appearance, evolution and the attack produced by Ostrinia nubilalis Hbn. species, at maize crop, under the center of Moldavia conditions,* Romanian Agricultural Research, 35, 229-236

**Sapunaru T., Hatman M., 1975** - *The particularities of the phytosanitary state from area served by agricultural research station Podu-Iloaiei*, Problems of Plant Protection, 3(4):331-343.

# RESEARCHES REGARDING THE ENTOMOFAUNA OF COLEOPTERAS WITHIN SOME AGRICULTURAL CROPS FROM THE NORTH PART OF PORTUGAL

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**Abstract**

The purpose of this research was that to identify the useful entomofauna of Coleopteras from the agricultural crops which have been taken into the study: olive trees and orange trees. The researches were carried out within the Quinta da Pinhao station, which belongs to the University of "Tras os Montes e Alto Douro". The biological material was sampled by the mean of D-Vacuum at 20th of June of 2017, from each 6 trees belonging to each crop, which have been aimlessly chosen. The D-Vacuum has worked one minute for each tree taken into the study. After carrying out the experiments, all the sampled insects were bringing into the Laboratory of Entomology in order to be counted and determined.
From the *Coleoptera* order, species with the biggest number of samples were:
-within the olive trees: *Chrysomelidae* family-91 samples, *Coccinellidae*- 56 samples, *Aderidae*-42 samples and *Scarabaeidae*-38 samples. From the *Coccinellidae* family, species with the biggest number of samples were: *Coccinella septempunctata* (31) and *Hippodamia variegata* (16).
-within the orange trees: *Chrysomelidae* family-142 samples and *Coccinellidae* family- 54 samples.. From the *Coccinellidae* family, species with the biggest number of samples was: *Coccinella septempunctata* (33) .

**Key words**: D-Vacuum, *Chrysomelidae*, *Scarabaeidae*, *Coccinellidae*.

The insects of *Chrysomelidae* family are commonly known as leaf beetles and include more than 50.000 species, making up one of the largest and most common encountered of all beetle families. Leaf beetle are partially recognizable by their tarsal formula, which appears to be 4-4-4, but is actually 5-5-5 as the fourth tarsal segment is very small and hidden by the third one. Adult and larval leaf beetles feed on all sorts of plant tissue, and all species are fully herbivorous. Many are serious pests of cultivated plants (eg. *Leptinotarsa decemlineata*-Colorado potato beetle).

*Coccinellidae* family has species of round or oval species, almost hemispherical, with spots on the wings with color spots and contrasting patterns. The most species of *Coccinellidae* are beneficial predators which prefer the aphids as main feed.

According to the author (Foltz, 2002), there are more than 5.000 species all around the world. The most representative species of the *Coccinellidae* family are: *Coccinella septempunctata, Hippodamia variegata, Propylaea quatodecimpunctata.*

## MATERIAL AND METHOD

In order to carry out the researches, the insects were sampled from one station: Quinta da Pinhao, belonging to University of "Tras os Montes e Alto Douro", by using the method of D-Vacuum. The experiments were carried out at 20th of June of 2017. Each 6 trees belonging to olive and orange orchards were taken into this study, the vacuum working 1 minute for each tree. After finishing the experiments, all the samples were bringing into the laboratory, counted and determined by the mean of binocular magnifier.

## RESULTS AND DISCUSSIONS

The samples of the biological material were carried out at 20th of June of 2017. Within the olive trees orchard, the situation regarding the entomofauna of Coleopteras looks as follows (*table 1*):

-Tree number 1: there were 83 samples identified from Coleoptera order, belonging to *Chrysomelidae* family (22), *Coccinellidae* family (21), *Scarabaeidae (*15), *Staphylinidae* (11),

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*Aderidae* (14). From the *Coccinellidae* family, 13 species, 5 belong to *Hippodamia variegata* species, and 3 samples belong to *Propylaea quatordecimpunctata* species;

-Tree number 2: there were 51 samples identified from Coleoptera order, belonging to *Chrysomelidae* family (19), *Scarabaeidae* (8), *Mordellidae* (11) and *Coccinellidae* family (13). From the *Coccinellidae* family, 7 samples belongs to *Coccinella septempunctata* species, 4 samples belong to *Nephus quadrimaculatus* species and 2 samples belong to *Propylaea quatordecimpunctata* species;

-Tree number 3: there were 53 samples identified from Coleoptera order, belonging to *Chrysomelidae* family (20), *Aderidae* (17), *Cerambycidae* (12) and *Staphylinidae* (2) and *Coccinellidae* family (2). From the *Coccinellidae* family, the both samples belong to *Coccinella septempunctata* species;

- Tree number 4: there were 50 samples identified from Coleoptera order, belonging to samples belong to *Coccinella septempunctata* *Chrysomelidae* family (14), *Scarabaeidae* (12), *Aderidae* (8), *Mordellidae* (7), *Coccinellidae* (6 samples) and *Cetonidae* (3). From the *Coccinellidae* family, all the collectes samples belong to *Hippodamia variegata* species;

-Tree number 5: there were 30 samples identified from *Coleoptera* order, belonging to *Coccinellidae* family (9), *Anthicidae* family (8), *Chrysomelidae* (4), *Aderidae* (3), *Scarabaeidae* (3); *Dermestidae* (3). From the *Coccinellidae* family, 7 samples belong to *Coccinella septempunctata* and two samples belong to *Hippodamia variegata* species;

- Tree number 6: there were 21 samples identified from *Coleoptera* order , belonging to *Chrysomelidae* family (12), *Cerambycidae* family (4) and *Coccinellidae* (5). From the *Coccinellidae* family, 3 samples belong to *Hippodamia variegata* species and two samples belong to *Coccinella septempunctata* species.

Table 1

**Entomofauna of coleopteras sampled from olive trees by the mean of D-Vacuum**

| TREE | FAMILY | SPECIES | TOTAL SPECIES | TOTAL |
|---|---|---|---|---|
| 1. | *Chrysomelidae* | - | - | 22 |
| | *Coccinellidae* | *Coccinella septempunctata* | 13 | 21 |
| | | *Hippodamia variegata* | 5 | |
| | | *Propylaea quatodecimpunctata* | 3 | |
| | *Scarabaeidae* | | | 15 |
| | *Aderidae* | | | 14 |
| | *Staphylinidae* | | | 11 |
| | **TOTAL** | | | **83** |
| 2. | *Chrysomelidae* | - | | 19 |
| | *Coccinellidae* | *Coccinella septempunctata* | 7 | 13 |
| | | *Nephus quadrimaculatus* | 4 | |
| | | *Propylaea quatordecimpunctata* | 2 | |
| | *Mordellidae* | | | 11 |
| | *Scarabaeidae* | | | 8 |
| | **TOTAL** | | | **51** |
| 3. | *Chrysomelidae* | | | 20 |
| | *Aderidae* | | | 17 |
| | *Cerambycidae* | | | 12 |
| | *Staphylinidae* | | | 2 |
| | *Coccinellidae* | *Coccinella septempunctata* | 2 | 2 |
| | **TOTAL** | | | **53** |
| 4. | *Chrysomelidae* | | | 14 |
| | *Scarabaeidae* | | | 12 |
| | *Aderidae* | | | 8 |
| | *Mordellidae* | | | 7 |
| | *Coccinellidae* | *Hippodamia variegata* | 6 | 6 |
| | *Cetonidae* | | | 3 |
| | **TOTAL** | | | **50** |

| | | | | |
|---|---|---|---|---|
| 5. | *Coccinellidae* | *Coccinella septempunctata* | 7 | 9 |
| | | *Hippodamia variegata* | 2 | |
| | *Anthicidae* | | | 8 |
| | *Chrysomelidae* | | | 4 |
| | *Aderidae* | | | 3 |
| | *Dermestidae* | | | 3 |
| | *Scarabaeidae* | | | 3 |
| | **TOTAL** | | | **30** |
| 6. | *Chrysomelidae* | | | **12** |
| | *Coccinellidae* | *Hippodamia variegata* | **3** | **5** |
| | | *Coccinella septempunctata* | 2 | |
| | *Cerambycidae* | | | **4** |
| | **TOTAL** | | | **21** |
| | **TOTAL ENTOMOFAUNA OF COLEOPTERAS** | | | **288** |

Within the orange trees orchard, the situation regarding the entomofauna of Coleopteras looks as follows (*table 2*):

-Tree number 1: there were 42 samples identified from *Coleoptera* order, belonging to *Chrysomelidae* family (30), *Coccinellidae* (7) and *Curculionidae* (5). From the *Coccinellidae* family, 5 samples belong to *Coccinella septempunctata* species and two samples belong to *Coccinella 5-punctata* species;

-Tree number 2: there were 37 samples identified from *Coleoptera* order, belonging to *Chrysomelidae* family (22), *Coccinellidae* (10), *Curculionidae* (3) and *Staphylinidae* (2). From the *Coccinellidae* family, 5 samples belong to *Coccinella septempunctata* species, 3 samples belong to *Coccinella subpunctata* species and 2 samples belong to *Propylaea quatordecimpunctata* species;

-Tree number 3: there were 28 samples identified from *Coleoptera* order, belonging to *Chrysomelidae* family (16), *Cerambycidae* (4), *Scarabaeidae* (4), *Anthicidae* (2) and *Curculionidae* (2);

-Tree number 4: there were 41 samples identified from *Coleoptera* order, belonging to *hrysomelidae* family (27), *Coccinellidae* family (9), *Scarabaeidae* (3) and *Staphylinidae* (2). From the *Coccinellidae* family, 6 samples belong to *Coccinella septempunctata* species, 2 samples belong to *Coccinella subpunctata* and 1 samples belongs to *Adalia bipunctata* species;

-Tree number 5: there were 53 samples identified from *Coleoptera* order, belonging to *Chrysomelidae* family (26), *Coccinellidae* (16), *Cerambycidae* (10) and *Staphylinidae* (1). From the *Coccinellidae* family, 7 samples belong to *Coccinella septempunctata* species, 4 samples belong to *Coccinella 5-punctata*, 3 samples belong to *Adalia bipunctata* and 2 samples belong to *Coccinella subpunctata*;

- Tree number 6: there were 38 samples identified from *Coleoptera* order, belonging to *Chrysomelidae* family (21), *Coccinellidae* family (12), *Scarabaeidae* (4) and *Curculionidae* (1). From the *Coccinellidae* family, 10 samples belong to *Coccinella septempunctata* species and 2 samples belong to *Propylaea quatordecimpunctata* species.

Table 2

**Entomofauna of coleopteras sampled from orange trees by the mean of D-Vacuum**

| TREE | FAMILY | SPECIES | TOTAL SPECIES | TOTAL |
|---|---|---|---|---|
| 1. | *Chrysomelidae* | - | - | 30 |
| | *Coccinellidae* | *Coccinella septempunctata* | 5 | 7 |
| | | *Coccinella 5-punctata* | 2 | |
| | *Curculionidae* | | | 5 |
| | **TOTAL** | | | **42** |
| 2. | *Chrysomelidae* | - | | 22 |
| | *Coccinellidae* | *Coccinella septempunctata* | 5 | 10 |
| | | *Coccinella subpunctata* | 3 | |
| | | *Propylaea quatordecimpunctata* | 2 | |
| | *Curculionidae* | | | 3 |
| | *Staphylinidae* | | | 2 |
| | **TOTAL** | | | **37** |

| | | | | |
|---|---|---|---|---|
| 3. | *Chrysomelidae* | | | 16 |
| | *Scarabaeidae* | | | 4 |
| | *Cerambycidae* | | | 4 |
| | *Anthicidae* | | | 2 |
| | *Curculionidae* | | | 2 |
| | **TOTAL** | | | **28** |
| 4. | *Chrysomelidae* | | | 27 |
| | *Coccinellidae* | *Coccinella septempunctata* | 6 | 9 |
| | | *Coccinella subpunctata* | 2 | |
| | | *Adalia bipunctata* | 1 | |
| | *Scarabaeidae* | | | 3 |
| | *Staphylinidae* | | | 2 |
| | **TOTAL** | | | **41** |
| 5. | *Chrysomelidae* | | | 26 |
| | *Coccinellidae* | *Coccinella septempunctata* | 7 | 16 |
| | | *Coccinella 5-punctata* | 4 | |
| | | *Adalia bipunctata* | 3 | |
| | | *Coccinella subpunctata* | 2 | |
| | *Cerambycidae* | | | 10 |
| | *Staphylinidae* | | | 1 |
| | **TOTAL** | | | **53** |
| 6 | *Chrysomelidae* | | | 21 |
| | *Coccinellidae* | *Coccinella septempunctata* | 10 | 12 |
| | | *Prppylaea quatordecimpunctata* | 2 | |
| | *Scarabaeidae* | | | 4 |
| | *Curculionidae* | | | 1 |
| | **TOTAL** | | | **38** |
| | **TOTAL ENTOMOFAUNA OF COLEOPTERAS** | | | **239** |

**Table 3**

**Entomofauna of *Coleoptera-Coccinellidae* sampled within both crops (olive and oranges)**

| Current number | Tree | Species | No.of samples | Total |
|---|---|---|---|---|
| 1. | olive | *Coccinella septempunctata* | 31 | 56 |
| | | *Hippodamia variegata* | 16 | |
| | | *Propylaea quatordecimpunctata* | 5 | |
| | | *Nephus quadrimaculatus* | 4 | |
| 2. | orange | *Coccinella septempunctata* | 33 | 54 |
| | | *Coccinella subpunctata* | 7 | |
| | | *Coccinella var.6-punctata* | 6 | |
| | | *Propylaea quatordecimpunctata* | 4 | |
| | | *Adalia bipunctata* | 4 | |

Entomofauna of *Coleoptera-Coccinellidae* sampled within olive trees and orange trees is presented in the *table 3.*

During the day of 20th of June of 2017, by the mean of D-Vaccum method, species from *Coccinellidae* family (*Coleoptera-Coccinellidae*) have been sampled within Quinta da Pinhao station. Results look thus:

Within the olive orchard, 56 samples belonging to *Coccinellidae* family (*Coleoptera-Coccinellidae*) have been sampled. Species with the biggest number of samples were: *Coccinella septempunctata* (31) and *Hippodamia variegata* (16). In total, 4 species of *Coccinellidae* (*Coleoptera-Coccinellidae*) have been identified.

Within the orange orchard, 54 samples which belong to *Coccinellidae* family (*Coleoptera-Coccinellidae*) have been sampled. Species with the biggest number of samples were: *Coccinella septempunctata* (33) and *Coccinella subpunctata* (7).

In total, 5 species that belong to *Coccinellidae* family (*Coleoptera-Coccinellidae*) have been identified. species.

## CONCLUSIONS

It can be concluded that, during the day of 20th of June 2017, within the olive orchard, from a total of 288 samples of *Coleopteras*, the most significant number belongs to *Chrysomelidae* family (91), followed by *Coccinellidae* family (56), *Aderidae* (42) and *Scarabaeidae* (38), while the leastest number of samples belongs to: *Anthicidae* family (8), *Cetonidae* and *Dermestidae* families (each 3). The most dominant species of *Coccinellidae* family are: *Coccinella septempunctata* (31 samples), *Hippodamia variegata* (16 samples), while the leastest number of samples belongs to the following species: *Propylaea quatordecimpunctata* (5 samples) and *Nephus quadrimaculatus* (4 samples).

Within the orange orchard, from a total of 239 samples of *Coleopteras*, the most significant number belongs to *Chrysomelidae* family (142), followed by *Coccinellidae* family (54) , while the leastest number of samples belongs to: *Staphylinidae* family (5) and *Anthicidae* family (2). The most dominant species of *Coccinellidae* family is: *Coccinella septempunctata* species (33 samples), while the species with the leastest number of samples are: *Propylaea quatordecimpunctata* and *Adalia bipunctata* (each 4 samples).

The biggest number of samples from *Coleoptera* order was identified within olive orchard (288).

The biggest number of *Coccinellidae* samples has been registered within olive groove (56), in comparison to orange groove (54).

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## REFERENCES

**Andriev Sorina, Octavia, 2004** - *Cercetări privind cunoașterea Coccinelidelor (Insecta-Coleoptera-Coccinelidae) din România din punct de vedere sistematic, biologic, ecologic si biogeografic* Teza de doctorat, Universitatea ,,Al.I.Cuza'', Iași, 294.

**Arion, G., 1912 -** *Raport asupra insectelor dăunătoare din familia Coccidelor*. Buletin Agricol.;

**Baicu T., 1977** - *Elaborarea măsurilor de combatere integrată.* Probl. Prot. Plant.V.3; 203-221;

**Baicu, T., Săvescu, A., 1978** - *Combaterea integrată în protecția plantelor* - Editura Ceres, Bucureşti;

**Baicu T., 1992** - *Perspective în combaterea biologică a bolilor și dăunătorilor plantelor agricole*, 72 p., Ed. Tehnica agricolă, București;

**Baniţa Emilia, Serafim Rodica, Searpe Doina, 1997 -** *Evoluția populațiilor de coccinele (Coleoptera Coccinelidae) în culturile de câmp din centrul Olteniei.* Probl. de prot. Plant. XU (2);

**Baniță, E., Sterghiu, C., Luca E., Naidin, C., 1999** - *Studiul păianjenilor prădători (Araneae) ai insectelor dăunătoare culturilor de cereale*. Analele Institutului de Cercetări pentru Cereale și Plante Tehnice Fundulea, LXVI: 285-294.

**Bărbulescu, Al., 2001** - *Rezultate obținute în anul 2000 în cadrul cercetărilor privind bolile și dăunătorii cerealelor privind bolile și dăunătorii cerealelor și unor plante tehnice și furajere.* Probleme protecția plantelor, XXIX(2): 123-178.

**Boguleanu Gh., și colab., 1980** - *Entomologie agricolă.* Ed. Didactică și Pedagogică București;

**Borcea I., 1910** - *Rolul insectelor prădătoare și parazite în agricultură*. Rev. St. ,, V Adamachi. I, p.29-46, Iasi;

**Chapman and Hall, New York,USA Driesche RG,**

**Hoddle MS, Center T., 2008** - *Control of pests and weeds by natural enemies: an introduction to biological control*. Wiley, New York;

**Ciepielowska D., 1991** - *Ladybirds (Coleoptera-Coccinelidae) occurring on papilionaceaus crops in the Olzzlyn District*. Polskie Pismo Entomologyczne, G2 (1): 129-138;

**Ciochia V., 1986** - *Combaterea biologică a dăunătorilor, verigă esențială a protecţiei ecosistemelor*. Braşov

**Cozma V, Diaconu A., Grecu M., Tălmaciu M., Pareza Madalin, Vasiliu G., 2006** - *Observații privind abundența și diversitatea coleopterelor din coronamentul unor livezi de mar cu management diferit de exploatare.* Lucr. șt., Seria Horticultura, Iași, I (49);1093-1096;

**Dejeu, L., Petrescu, C., Chira, A., 1997**- *Horticultura și protecția mediului*. Ed. Ceres, Bucuresti;

**Filip I. şi colab., 2003**. *Strategies of integrated control of the grape moth (Lobesia botrana Den et Schiff.) in Murfatlar vineyard.* Analele Univ. din Craiova, Seria Biol., Horti., TPPA, vol VIII (XLIV) p.432.

**Ghizdavu I., Tomescu N., Oprean I., 1983**- *Feromonii insectelor, "pesticide" din a III-a generaţie*. Edit. Dacia, Cluj-Napoca.

**Ghizdavu L., Bunescu H., 1991**- *Feromonii - important mijloc de combatere biotehnică a insectelor dăunătoare*. Rev. Protecţia Plantelor, nr.3-4. Tipografia Agronomică, Cluj-Napoca.

**Hodek L., 1973-** *Biology of Coccinellidae*. Academia Publishing House of the Czechoslovak Academy of Sciences, Prague, 260;

**Filip I. şi colab., 2003** - *Strategies of integrated control of the grape moth (Lobesia botrana Den et Schiff.) in Murfatlar vineyard.* Analele Univ. din Craiova, Seria Biol., Horti., TPPA, vol VIII (XLIV) p.432.

**Foltz, J.L. 2002** - *Coleoptera: Coccinellidae*. Dept of Entomology and Nematology. University of Florida.http://entomology.ifas.ufl.edu/Coleoptera Coccinellidae.html, modified 12/01/14.

**Ghizdavu I., Tomescu N., Oprean I., 1983** - *Feromonii insectelor, "pesticide" din a III-a generaţie*. Edit. Dacia, Cluj-Napoca.

**Hodek L., 1973** - *Biology of Coccinellidae.* Academia Publishing House of the Czechoslovak Academy of Sciences, Prague, 260;

**Iperti, G., 1974** - *Les principaux auxiliaires entomophages Coleopteres. Les organismes auxiliaires en vergers de pommieres.* Brochure Bulletin International Biological Prevention Organization, West Palearctic Regional Section: 111-121 ;

**Isac Gr., 1989-** *Biotehnologia combaterii moliilor strugurilor prin folosirea entomofagilor*. Lucr. St. ICVV Ştefăneşti Argeş, p 279-292. Bucureşti 1989.

**Kalushkov P. K., Denkov K.D., Dimova V., I, 1990-** *Ecofaunistic studies on the coccinelids (Coleoptera-Coccinelidae) in lucerne plats near Pleven, Ekologiya., Bulgaria*. Zool. Inst. Bulgarien Acad. Sci.23: 37-66;

**Klausnitzer,B., Klausnitzer H., 1983 -** *Marienkäfer (Coccinellidae),* Amandus Ziemsen Verlag, Wittenberg, 103 pp;

**Klausnitzer, B 2004-** ***Harmonia axyridis (Pallas, 1773)*** *in Bassel-Sradt (Coleoptera Coccinelidae).* Mitteilungen Entomol. Gessellschaft Basel54: 115-122;

**Kovalenkov V.G., Tyurina N.M., 1992**- *Coccinelids against alfaifa pest.* Zashchita Rasteni (Moskva), 10; 13-14;

**Lăcătușu Matilda, Tudor Constanța, Teodorescu Irina Nadej. M, 1981**- *Structura faunistică din culturi de lucernă*. Stud. Cerc. Biol. Anim, 33, 2: 179-182;

**Malschi Dana, Mustea D., 1992**- *Dinamica entomofaunei dăunătoare specifice agrobiocenozelor de grâu din centrul Transilvaniei în perioada 1981-1990*. Probl. Prot. Plantelor, vol. XX nr.3-4, 237-348;

**Sonia A. P. Santos., 2012** - *Species abundance patterns of coccinellid communities associated with olive, chestnut and almond crops in north-eastern Portugal,* Agricultural and Forestry Entomology, 14(4) DOI: 10.1111/j.1461-9563.2012.00578.x, 4-6.

# SUSTAINABLE MANAGEMENT OF IRRIGATED SOILS IN UKRAINIAN AGRICULTURE

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**Abstract**

In the structure of land resources of Ukraine there are significant disproportions, the deepening of which can be a threat to the environment and living environment, as well as the effectiveness of economic activity, sustainable development of the national economy. Irrigation and drainage strategy of Ukraine until 2030 can to ensure sustainable ecologically balanced development of agriculture in Ukraine by modernization, rehabilitation and expansion of irrigation systems. The soil cover of Ukrainian irrigated land is featured a significant dissemination of poorly productive and degraded soils if unsustainable agricultural methods are pursued. Monitoring of the fertility of the irrigated lands, directed to the formation of the models of steady, ecologically safe and economically effective agriculture is required. The complex of measures to manage the fertility irrigated land was developed by authors. Analysis showed that investment along priority irrigation systems would require more than $ 3 billion. The main sources of finance for the of the complex of measures in Ukraine include the following: projects and grants for capacity development of the institutions; international development loans; private investment through leasing, regular bank loans and farmers' own capital.

**Key words**: irrigation system, irrigated soil, soil management, sustainable management.

More than half of the territory of the Ukraine is located in the zone of insufficient and unstable moistening, therefore irrigated lands located practically in all natural zones and subzones (Gadzalo Y. *et al*, 2018). The country's food and resource supply depends to a large extent on the availability, condition and efficiency of the use of the irrigated land (Bezugliy M.D. *et al*, 2012; Stashuk V. *et al*, 2009). The irrigated lands occupied the greatest area (2.6 mln. ha) at the beginning of the 90's of past century, which is 8 percent of area of plowed land. In recent years in the Ukraine the areas of the irrigated lands have decreased (predominantly spontaneously, without control). Currently, irrigation sector is facing a period of unprecedented challenge. Today, only 500-600 thousand hectares are irrigated in Ukraine. After years of reduced irrigation, the need for rehabilitation and modernization is becoming ever more pressing.

Irrigation and drainage strategy of Ukraine until 2030 (Strategy) was approved of the Cabinet of Ministers of Ukraine in 2019 (Irrigation and drainage Strategy, 2019). It is a nationwide cross-sectoral policy document. Irrigation restoration is a key tool development of the agrarian sector of economy and increase of export potential of Ukraine. It will minimize the impact of climate change on the processes of socio-economic development.

The Strategy notes: whether it will ever be economic to restore irrigation depends on multiple factors including climate change, world markets, the security situation and Ukraine's economic growth. The scope of the Strategy is to ensuring sustainable eco-balanced agriculture development in Ukraine. However, the issues of reservation and restoration of soil fertility during irrigation prevention of their degradation were not reflected in the Strategy.

At present, it has to be admitted that under the influence of the existing system of agriculture in Ukraine, there is often a deterioration of the soil-reclamation state of the land, loss of soil fertility and the imbalance of natural systems in general. The Sustainable Development Goals identify the need to restore degraded soils and improve soil health. At the 39th session of the FAO Conference, members unanimously approved a new edition of the World Soil Charter (Rome, June 6-13, 2015) as an instrument for promoting and institutionalizing the sustainable use of soil resources at all levels

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(FAO, 2015). According to the Revised World Soil Charter (2015): "Soil management is sustainable if the supporting, provisioning, regulating, and cultural services provided by soil are maintained or enhanced without significantly impairing either the soil functions that enable those services or biodiversity".

Voluntary Guidelines for Sustainable Soil Management (FAO, 2017) were developed on account of concerns about the state of soils resulted. In a broader context, the 2030 Agenda for Sustainable Development adopted a number of related targets in 2015 (United Nations, 2015), i.e. those aimed at restoring degraded soil, striving to achieve a land degradation-neutral world and implementing resilient agricultural practices that progressively improve soil quality and minimize soil contamination. Sustainable soil management strongly contributes to collective efforts towards climate change adaptation and mitigation, combating desertification and promoting biodiversity, and therefore has specific relevance to the United Nations Framework Convention on Climate Change - UNFCCC (United Nations, 1992) and United Nations Convention to Combat Desertification - UNCCD (United Nations, 1994).

Our research focuses on the necessary to clarify the soil aspects of the implementation of the Strategy in Ukraine given the current state of irrigated lands, the need to restore and increase the area of irrigated lands, the significant prevalence of degradation phenomena.

## MATERIALS AND METHODS

In research we have used international and nationwide cross-sectoral and sectoral policy documents, various reports and different type of articles regarding the irrigated land; agricultural development; food security; land reclamation; environmental security in Ukraine. It helped us to understand and explain the specific phenomena regarding soil resources in irrigation agriculture of our country. In order to estimate their impact on the development sustainability of the national agro-food sector we use the quantitative and qualitative comparative analysis of data of the total area of really irrigated soils, the area of soils promising for the development and restoration of irrigation, the area of degraded irrigated soils, which allowed us to generate some proposals taking into account the provision of national agriculture necessary quality soil resources. The science of economics provides the foundation for sustainable agriculture.

The research method is processing, comparisons, synthesis, conclusions and proposals.

## RESULTS AND DISCUSSIONS

Ukraine is one of the most agriculturally developed countries in the world. As of January 1, 2017, the land fund of Ukraine is 60.3 million hectares, or about 6 percent of the territory of Europe. Agricultural lands are about 19 percent of the European ones, including arable land - about 27 percent. Indicator of agricultural land per capita is the highest among European countries and is 0.9 hectares, including 0.7 hectares of arable land (the average European countries - 0.44 and 0.25 hectares, respectively).

The total area of agricultural land is 42.7 million hectares, or 70 percent of the total area of the country, and the area of arable land - 32.5 million hectares, or 78.4 percent of all agricultural land. At the same time, in the structure of land resources of the country and land use there are significant disproportions, the deepening of which can be a threat to the environment and living environment, as well as the effectiveness of economic activity, sustainable development of the national economy as a whole (Vargas R., *et al*, 2018).

Today we can see decline of the irrigation system on account of Economic and political changes after the collapse of the Soviet Union. Ukraine is needed in change to adjust to the new market economy, reverse the decline in the irrigation sector, and improve efficiency of irrigated land. Ukraine must manage its national land and water in the interests of all users and the environment and in line with the United Nations Convention to Combat Desertification (UNCCD), United Nations Framework Convention on Climate Change (UNFCCC), Land Degradation Neutrality, Revised World Soil Charter, Sustainable Development Goals until 2030, It recognizes Ukraine's Association Agreement with the EU and EU Water Framework Directive (EU, 2000 and 2017; FAO, 2015 and 2017; United Nations, 1992, 1994 and 2015).

One of the main goals of the Strategy is to ensure sustainable ecologically balanced development of agriculture in Ukraine. To achieve this goal, it is necessary to modernization the systems that currently work, to make them work better; rehabilitation the systems that used to work but have fallen into disrepair; and expansion the irrigation onto new areas that were not previously irrigated.

1. Modernization of systems that currently work, to make them work better. The economic gain would normally be an increase in profitability per hectare. It is necessary for slight increase investment into modernization with private-sector

investment. Total cost is estimated at $ 1.200 per hectare.

2. Rehabilitation of systems that used to work but have fallen into disrepair, resulting in an increase in irrigated area, so that systems are put back into function in better condition than before. It is need for comprehensive financing with public and private-sector investment. Costs will depend on the degree of deterioration in each case, but could average around $ 2.000 per hectare.

3. Expansion of irrigation onto new areas that were not previously irrigated, by installation of new, modern systems. This is need for comprehensive financing with public, International and private-sector investment. Costs would be similar to rehabilitation and are estimated at around $ 2.200 per hectare.

Modernization in all areas will require investments in the amount of about $ 3 billion and will provide an opportunity for additional irrigation on a total area of about 1180 thousand hectares. Despite the significant amount of need for funds, projects for the restoration and development of irrigation systems are investment attractive due to their short payback period.

In Strategy the calculations are given only for the modernization, restoration and expansion of the technical component of irrigation systems. However, a necessary condition for the long sustainable use of irrigation systems is not only the improvement of the productive functions of soils, but also the preservation and improvement of their ability to perform environmental, social functions and provide ecosystem services.

The irrigation is one of the most intensive and effective factors of anthropogenous loads on an environment as a whole and irrigated land in particular. Irrigation influences upon directivity of soil processes and evolution of soils, often bringing to development soil-degradation processes, this requires the study of changes in soil properties under the influence of irrigation to avoid soil degradation (Baliuk S., *et al,* 2017).

The results of these change can carry as positive (the improvement water supply, increasing of fertility, efficiency and etc.), so and negative character (salinization, appearance solonetzization, alkalinization of soils, contamination and others). Directivity, periodicity and alteration rate depend on the quality of irrigating waters, volume of water delivery, initial state of soils and degree of natural drain-ability of territory, technologies of irrigation, level of agriculture.

The soil cover of Ukraine is essentially featured:

a) diverse variety of soils (up to 1.000 kind of soil);

b) unique exceptionality of soil cover (more than 60 percent chernozem soil-formation types).

Ukraine is the fourth country in the world by total area of chernozem after Russia, USA and China. Per 100 residents of Ukraine accounts the 61 hectares of chernozem and per this index, Ukraine holds the 2nd place, next to Russian Federation (Bezugliy, M.D., *et al*, 2012); c) significant dissemination of poorly productive and degraded soils (~ 30%).

In Forest-steppe and Steppe zones of Ukraine is disposed 98% irrigated lands (*table 1*). The soil cover of the irrigated lands is extremely complex.

Table 1

**Distribution of irrigated lands in Ukraine by natural areas**

| Zone, subzone | Irrigated land, % of total area of irrigation |
|---|---|
| Polissya | 1.0 |
| Forest Steppe | 13.6 |
| Step Northern | 31.2 |
| Step Southern | 30.4 |
| Steppe Dry | 23.0 |
| Carpathian mountain region | 0.5 |
| Mountain region of Crimea | 0.3 |

Practically all types of the soils of the Ukraine are represented in its structure, but chernozem and dark-chestnut soils predominate (*table 2*).

Table 2

**Irrigated soils of Ukraine**

| Soil | | Area, thousands ha |
|---|---|---|
| In the national classification | In the WRB classification | |
| soddy-podzolic soils | albeluvisols umbric | 7.9 |
| light grey forest soils | albeluvisols umbric | 40.2 |
| dark grey podzolized soils | phaeozems albic | 26.0 |
| podzolic chernozems | chernozems albic | 50.0 |
| typical chernozems | chernozems chernic | 230.0 |
| ordinary chernozems | chernozems chernic | 720.0 |
| southern chernozems | chernozems chernic | 566.0 |
| meadow chernozems | phaeozems haplic | 99.0 |
| dark-chestnut soils | kastanozems haplic | 384.6 |
| chestnut solonetzic soils | kastanozems luvic | 10.0 |
| meadow-chestnut solonetzic soils | phaeozems sodic | 54.7 |
| chestnut solonetz | solonetz humic | 5.5 |

The most common forms of the degradation of the irrigated soils are soil over compaction, crustification; erosion; swamping and under

flooding; pollution of soils with heavy metals, pesticides, radioactive nuclides; secondary salinization, solonetzization and alcalinization. They are developed after using for the irrigation waters of the not proper quality (suitable for determined limit and not suitable for the irrigation) and/or because of the low level of agriculture and insufficient resource investments - humus and nutritious elements losses.

Let us pause at such forms of irrigational degradation as salinization, solonetzization and alkalinization (Baliuk S. *et al*, 2016).

Secondary salinization is accumulation in the soil of water-soluble salts, a change of the salt composition to increasing in sodium concentration and contraction is relation Ca:Na. The degree of soils salinization is determined by the content of gross and/or toxic salts taking into account chemism of salinization (its type). There are approximately 100 thousand ha of secondary salinized soils (content of salts in the layer 0-100 cm) among the irrigated lands.

Secondary solonetzization is accumulation of sodium and potassium in the soil absorbing complex, which gives to soils unfavorable physical properties. Secondary solonetzization is the most common degradation process on the irrigated lands. The area of the irrigated solonetzic soils is approximately 700-800 thousand ha.

Alkalinization is increasing of the alkalinity of soil solution and the formation of soda, which occurs under the effect of secondary solonetzization, ground and irrigating waters, reducing of sulfates or other reasons. The regions of the Ukraine, where there is a danger of the formation of soda, are geographically separated. The greatest danger exists in the regions of the cultivation of rice in Kherson region and in the Crimea over the area more than 60 thousand ha.

Basic complex characteristic of irrigated land, which determines the possibility, technological features and prospects for their further use, is ecological and agroameliorative soil condition (measured by hydrogeological, soil - ameliorative, ecological - toxicological and agronomic criteria).

Generally, in Ukraine about 20% of the total irrigated lands have good ecological and agroameliorative condition, satisfactory - about 65% and not satisfactory - about 15%. Areas with not satisfactory condition are lands which are used unsuitable for irrigation water, soils strongly or medium saline and / or solonetzic and waterlogged. By satisfactory conditions are the lands, which have a low level of salinity and solonetzicity, are irrigated limited suitability for irrigation waters and are in automorphic - hydromorphic conditions. In all other cases, ecological and agroameliorative soil condition is defined as good.

Control of the fertility of the irrigated lands, directed to the formation of the models of steady, ecologically safe and economically effective agriculture is required. At present time, the main sources of information on the current condition of irrigated soils in Ukraine include the following:

a) Large-scale soil assessment data,

b) Land registry ('land cadastre'),

c) Data from the agrochemical records ('passporting') of agricultural lands,

d) agro-ecological monitoring data,

e) Research data of scientific and educational institutions and

f) Data of the national environmental monitoring system.

Thus obtained information is of narrow-departmental nature, obtained by different methods and non-correlated observation programs. These disadvantages are strong constraints against consistent usage of materials for evaluation and forecast of changes of soil cover in order to manage it.

An urgent necessity has risen to Monitoring of irrigated soils aimed at systematic control over their condition, as well as early detection of negative changes, and elaboration of measures for upgrading environmental and productive values for the modernization, restoration and expansion irrigated systems. Necessary is to assess the suitability for irrigation for previously no irrigated soils. But, unfortunately, investments for Monitoring aren’t provided for in the Strategy.

Monitoring soils as a natural object should include an assessment of the health of natural ecosystems under conditions of irrigation. The development of strategies for controlling water and salt regimes of irrigated lands requires the knowledge of the scale and trends of natural processes of salt accumulation under different hydrogeological and hydrochemical conditions that existed in soils before irrigation started (Averianov S.F., 1978).

The aim of monitoring is to produce a spatial assessment of the character and degree of soil degradation processes on formerly and currently irrigated non- irrigated and adjacent lands as well as the impact of these processes on soil fertility parameters agrophysical, agrochemical, physicochemical and toxicological), crop yields and the quality of produce. A need for such monitoring is associated with an interaction between ecology and economy.

The former studies bio-abiotic interactions, while the latter involves the management of such interactions (Aidarov I.P., 2012; Aidaro I.P.,

Zavalin A.A., 2015). The degradation of natural ecosystems leads to a reduction in their environmental and agricultural role in climate change, the condition of water and soil resources and public health.

A necessary condition for highly effective, environmentally safe of irrigated land usage is implementing the complex of measures to manage the fertility of irrigated land, improve their agro-ecological condition and level of use. This complex must constantly adapt to the variability of natural and anthropogenic factors in order to obtain the highest possible profit subject to the requirements of resource conservation, soil protection and maintain of natural processes balance both within agro-ameliorative landscapes and in the biosphere as a whole.

In order to overcome the crisis situation across ameliorated land of Ukraine, we proposed to: withdraw (with the National Land-Use Cadastre) certain acreage of arable fields being in poor environmental-reclamation status; implement a complex reconstruction of relevant systems; introduce innovative agro-farming options in order to avoid deterioration of key soil-functions. Under current economic conditions, returning to traditional technology of overall chemical soil-reclamation is inexpedient due to its high cost. Instead, we propose a set of novel alternative approaches to solving the problems of sodic soils' amelioration, but with compulsory shift to employ resource-saving technologies. It is highly necessary to return the strategy of deep plantage plowing; whose effectiveness and aftereffects' duration are very significant factors.

Such complexes of measures include the main elements:

a) Rehabilitation and modernization of irrigation systems, taking into account their environmental and reclamation condition;

b) Conversion of irrigated agriculture on the adaptive-landscape environmentally safe (compensatory) agriculture systems;

c) Rational structure of sowing areas and crop rotation oriented on market economy with the obligatory inclusion in crop rotation the perennial legume grasses;

d) Restoration of works with chemical reclamation of irrigated land and irrigation water, on the fundamentally new provisions;

e) Usage of internally soil reserves of calcium salts (soil self-reclamation) through the reclamation plantage plowing on the area about 500 thousands of hectares;

f) a complex of engineering, agro-ameliorative and preventive measures nominated the composition of which for each region should take into account the occurrence causes and the development features of flooding processes;

g) Soil replenishment with organic matter by plant residues, organic fertilizers, crop rotation with perennial legume grasses;

h) Effective application of fertilizers.

Agro-technological approaches will ensure harmonious relationship between man-caused stress on soil and natural earth-potential, in compliance with soils varieties, needs of regions and the whole country, as well as goals of sustainable development thereof. The following measures are also required: acquisition substantial, trustworthy, reliable, accurate and timely information on status of soils; updating the materials on status of soil resources in Ukraine, using digital mapping and GIS-technologies; creating a National Soil-Information Center as a unified source of information on soils of Ukraine.

Thus obtained results will serve as a State-owned tool which would subsequently facilitate the use and protection of soil resources all over the country. Now major investment to Ukraine's irrigation system will be needed to let the sector fulfill its economic potential. Analysis above showed that investment along priority irrigation systems would require more than $ 3 billion, taking into account a range of measures to prevent and reduce soil degradation.

A comprehensive financing plan for the complex of measures to manage the fertility of irrigated land, improve their agro-ecological condition and level of use could include:

a) Self-funding of agricultural enterprises and associated organizations,

b) The state budget of Ukraine and local budgets at all levels,

c) Nature conservation funds at all levels,

d) Bank loans and finance lease,

e) Domestic and foreign investments and international technical support and other

f) Non-budget funds in accordance with current legislation. Investments can come from global and regional funds, common investment institutions, international financial and credit institutions and government loans from developed countries.

## CONCLUSIONS

In the structure of land resources of Ukraine (one of the most agriculturally developed countries) there are significant disproportions, the deepening of which can be a threat to the environment and living environment, as well as the effectiveness of economic activity, sustainable development of the national economy.

The country is needed in change to adjust to the new market economy, rehabilitated of the irrigation sector, and improve efficiency of irrigated land. Irrigation and drainage strategy of Ukraine until 2030 can to ensure sustainable ecologically balanced development of agriculture in Ukraine by modernization, rehabilitation and expansion of irrigation systems.

A necessary condition for the sustainable use of irrigation systems is not only the improvement of the irrigation system specifications and productive functions of soils, but also the preservation and improvement of their ability to perform environmental, social functions and provide ecosystem services.

The soil cover of Ukrainian irrigated land is featured a significant dissemination of poorly productive and degraded soils: 100 thousand ha of secondary salinized soils, 700-800 thousand ha of irrigated secondary solonetzic, 60 thousand ha with alkalinization.

Monitoring of the irrigated soils fertility, directed to the formation of the models of steady, ecologically safe and economically effective agriculture is required. The authors developed the complex of measures to manage the fertility, improve their agro-ecological condition and level of use irrigated land.

Analysis showed that investment along priority irrigation systems would require more than $ 3 billion, taking into account a range of measures to prevent and reduce soil degradation.

Financing of solutions to the problem of protection of soils and increasing their fertility are proposed to be implemented at the expense of State and local budgets, innovation and investment projects, entrepreneur and private business entities and other sources allowed by the legislation.

Bearing in mind the limited financial resources in the country and considering an amount of expenses to implement these goals, the economy-experts think it important to be guided by criterion of obtaining a maximum ecological effect.

## REFERENCES


**Aidarov, I.P., 2012** - *Ecological basis for land amelioration.* Moscow. 163 p. (Rus).

**Aidarov, I.P. & Zavalin, A.A., 2015 -** The basis for complex land amelioration (theory and practice). Moscow. 128 p. (Rus).

**Averianov, S.F. 1978** - *Salinity control within irrigated lands.* Moscow. 276 p. (Rus).

**Baliuk S., Nosonenko A., Zakharova M., Drozd E., Vorotyntseva L., Afanasyev Y., 2017** - *Criteria and Parameters for Forecasting the Direction of Irrigated Soil Evolution,* in: D. Dent and Y. Dmytruk (eds.), Soil Science Working for a Living, Spr. Int. Pub., 149 - 159.

**Baliuk S., Drozd E., Zakharova M., 2016** - *Scientific approaches to the rational use and management of saline soils fertility in Ukraine.* Arid Lands Studies (JALS) vol. 25, No.3, 69-72.

**Bezugliy, M.D., Baliuk, S.A., Truskavetskiy, R.C., 2012** - *Soils and Their Fertility in Legal Field of Land Market Relations.* News of agr. scien., 5: 5-10 (Ukr).

**EU, 2000** - *Water Framework Directive.* Official Journal of the European Communities, L 327, 1-72.

**EU, 2017** - *Association Agreement between the European Union and its Member States, of the one part, and Ukraine, of the other part*. (Available web site: www.kmu.gov.ua/storage/app/media/uploaded-files.pdf).

**FAO, 2015** - *Revised World Soil Charter.* Food and Agriculture Organization of the United Nations, Rome, Italy, 10.

**FAO, 2017** - *Voluntary Guidelines for Sustainable Soil Management.* Food and Agriculture Organization of the United Nations, Rome, Italy, 26 .

**Gadzalo, Y., Romashchenko, M., and Yatsiuk, M., 2018** - *Conceptual framework to ensure water security in Ukraine*. Proceeding of IAHS, 376, 63-68. (Ukr).

**Irrigation and drainage strategy of Ukraine until 2030, 2019** - *Official Bulletin of Ukraine*, 13.09.2019, No 70, p. 194, Art. 2473, act code 95918/2019 (Available web site: https://zakon.rada.gov.ua) (Ukr) .

**Stashuk,V., Baliuk,S., Romashchenko M., (Eds.), 2009** - *The scientific basis for the protection and management of irrigated land in Ukraine*. Kiev, Agricultural Science, 619. (Ukr).

**United Nations, 1992** - *United Nations Framework Convention On Climate Change*. Revised 2016, 33. United Nations Convention to Combat Desertification.

**United Nations, 1994** - *United Nations Convention to Combat Desertification* In Those Countries Experiencing Serious Drought And/Or Desertification, Particularly In Africa, A/AC.241/27 12 September 1994, 58 (Available web site: http: //www.unccd.int/convention/text/pdf/conv-eng.pdf).

**United Nations, 2015** - *Transforming our world: the 2030 Agenda for Sustainable Development.* A/RES/70/1, 41 (Available web site: https://sustainabledevelopment.un.org/post2015/transformingourworld/publication).

**Vargas R., Pankova E.I., Balyuk S.A., Krasilnikov P.V. and Khasankhanova G.M. (Eds.), 2018** - *Handbook for saline soil management.* Food and Agriculture Organization of the United Nations and Lomonosov Moscow State University, 144.

# LEADERSHIP STYLES ANALYSIS OF THE PLANT PRODUCTION CHAIN

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**Abstract**

The paper reveals the results of a study undertaken in two agricultural units located in the N-E of Romania. The units currently exploit areas of 12,000 ha, respectively 2000 ha of arable land, placing them as large, industrialized agricultural units, with agro technologies at European standards and last generation machinery, and also having irrigation systems that serve for an important surface of their total. The units practice an efficient management, implementing an integrated model for their business. Group Şerban is located in Bacău county and cultivates straw cereals and corn to support their bakery and pastry field, and oleaginous and beans for their chicken farm, and Domeniile Lungu is a farm located in Iaşi county and sets as one of the biggest grapes producer of the area, due to a modern irrigation system and important branding and marketing activity. The Şerban Poultry Farm was started in 2008 and has now three chicken farms, with a capacity of 4,100,000 broiler chicken/year and 400,000 slow-growing chicken/year, with dedication for the quality of their products and market changes, show a flexible and efficient management, making several decisions for optimizing the financial indicators. Domeniile Lungu, that was started in 2006, uses 132 ha to grow several types of wine grapes and inaugurated in 2014 a winery that produces wine at the best standards, with two processing lines of 100 tones/day and a storage potential of 2 million l. A series of leadership styles analysis and organizational structure are studied in this paper, showing the impact of farm management in productivity and efficiency indicators.

**Key words**: leadership, work efficiency, farm management

From a total of 238,000 km$^2$ that cover the surface of the country, 87% of it is rural. Of this total, agricultural land covers 57%, with 45% of the population living in rural areas. For this reason, the share of agriculture in the country's economy is one of the highest in the EU, 6.6% of the Gross Value Added, that is more than three times the EU average, that represents 1.7% of GVA. With approximate 3.9 million farm holdings, Romania sums one third of all farms in the EU, and farming structures are highly polarized, as medium and large farms are about 7% of the total, but cover about 70% of the total agricultural area, with a clear potential of management and competiveness.

Increasing farm efficiency involve working on large and compact surfaces as possible, so as to achieve large, efficient and high-performance integrated farms (Brezuleanu S. *et al*, 2017). The present paper aims to analyze the impact of leadership styles in two agricultural units and the way they developed since their establishment. The analysis focuses on their organizational structure and the impact of leadership skills on the economic efficiency, following the production process and management, which proves to be an efficient one due to the units development since they started and the integrated processes they make.

Group Şerban developed a high-generation fodder factory that serve their own needs and also sells to third parties, with a capacity of 8 tones/hour, meaning 34000 tones/year, with reduced energy use. In 2016 they finished an important investment for cereal and oleaginous storage with a total capacity of 80000 tones, and in 2018 they grew the production capacity of the bakery, improving work efficiency and the financial indicators. The level of the field crops indicates high technology standards and management involvement in the production area, where a wide vision of integrated activities made an articulated and coherent development, with growing indicators and expansion perspectives.

Domeniile Lungu started from their beginning with a solid technical equipment base of performant machinery and made major investments in irrigating systems for 1000 ha of their 2000 ha total. Of these, 132 ha represent a wine plantation with nine varieties, and achieved a capacity of 100 tones/day and a storage potential of

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2 million liters after inaugurating their winery in 2014. They produce approximately 1200000 l/year, and bottle half of the quantity.

## MATERIAL AND METHOD

The necessary studies for the elaboration of this paper were made during 2018-2019, using primary data, direct and indirect observation. A series of interviews took place at the agricultural units bases, in Iaşi and Bacău, and a leadership questionnaire was applied to employees. Dates from the secondary sources, specialized literature have been used, processed and interpreted thoroughly, for highlighting the leadership development in the studied units.

## RESULTS AND DISCUSSIONS

The Șerban Poultry Farm had in 2018 a number of 62 employees, all qualified. Each department has more sectors that are divided in management, so as to preserve product and service quality. The management for each department is rigorously defined, with clear responsibilities and competences that are required for achieving individual and general goals of success. They have a pyramidal organizational chart, and communication is made on the vertical. levels.

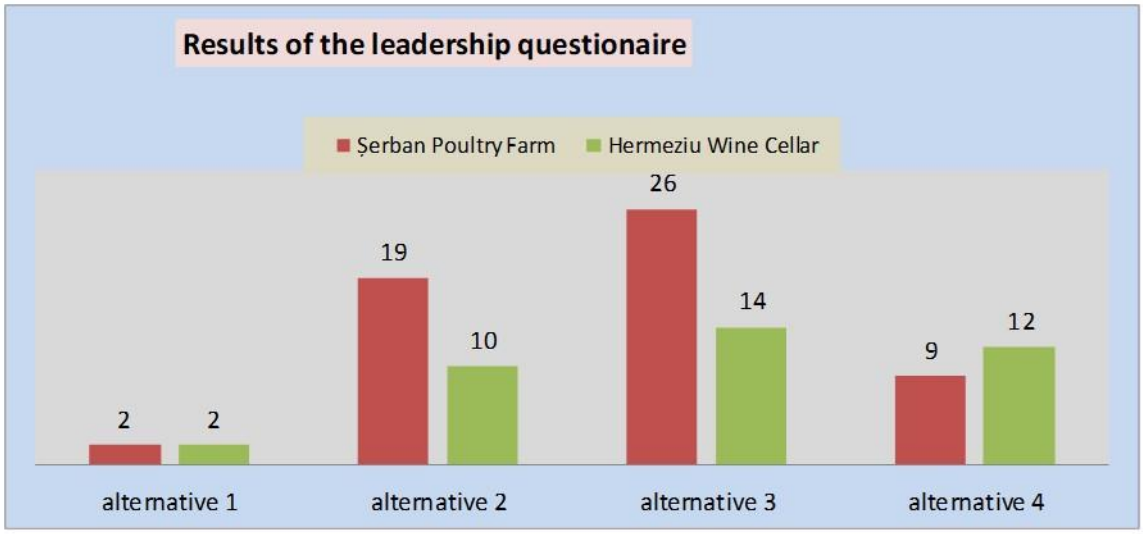



Figure 1 **The results of the leadership questionnaire**

Hermeziu Wine Cellar from the "Domeniile Lungu" unit has 43 employees, also with a hierarchical distribution, and direct liability to the administrator. The management is made in a decentralized way, with direct tasks, and communication is both horizontal and vertical, and the aim of delegating tasks is time management. Leadership practice in this unit is not based on hierarchic position, but trust and relationships between people, so as each employee has responsibilities and free initiative.

In Grup Șerban Poultry Farm, the chance of expressing leadership individually is big, the administrators offering freedom of action to subordinates, managing relatively low control of the people, as they use high technology techniques that require passionate and well-trained personnel. The unit teaches and support their staff in being creative, in constantly improving procedures, and the result is long-time commitment to the organization and a solid team. Also, this organization understood and used the fact that creating leaders starts with the capacity of transforming some work in a career. As referring to Hermeziu Wine Cellar, leadership manifestation can be easy as people have all the premises that encourage it: sociability, flexibility, cooperation, communication at all directions, open-minded spirit and the competitive vibe of the organization.

As to determine the leadership abilities in these two studied units, it was used the investigation method and a questionnaire was applied to all personnel that subordinates to the directors of each department. It contained twenty-five questions with one possible answer out of five. Each answer has one point, and the options are: total agreement, agreement, neutral, disagreement and total disagreement. At the end of the questionnaire, the points are summed up and multiplied with a conversion coefficient that differs: total agreement-12 points, agreement- 9 points, neutral- 6 points, disagreement- 3 points and total disagreement- 0 points. Depending on the total score, we can place the investigated personnel in four categories that we call alternative 1- 4.

The total number of people that were questioned was 94, 56 from Șerban Poultry Farm and 38 from Hermeziu Wine Cellar and the employees covered all departments (workers, team leader, department coordinator and manager) and all types of study levels.

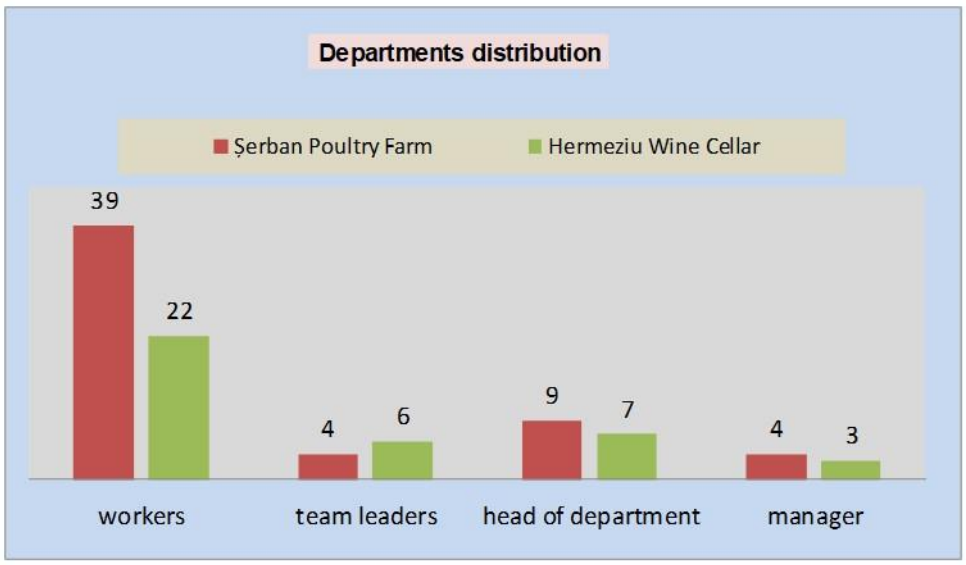



Figure 2 **Employees departments distribution**

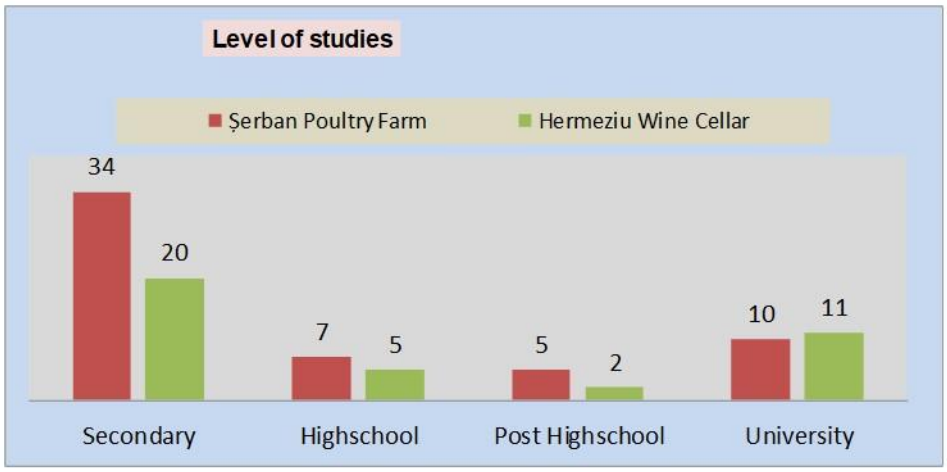



Figure 3 **Employees level of study**

The centralized results of the leadership questionnaire show us the situation of the employees' leadership skills in the two studied units.

Alternative 1-people in this category, with scores between 0-150 points, have very low leadership abilities. There were 2 employees from Şerban Poultry Farm (Unit 1) and 2 from Hermeziu Wine Cellar (Unit 2). Reported to the total number of people that answered, it is an acceptable result, these persons being either new employees or people close to retirement. They have low motivation, and a suggestion for improving could be participating in trainings and studying additional leadership resources, in a long-term process involving all the team.

Alternative 2-people in this category scored between 151-225 points and have medium leadership skills. There are 19 employees from Unit 1 and 10 from Unit 2.

This shows a balanced situation at the first unit, considering the total number of people interviewed, while at the second unit leadership skills look well-defined, each person having a clear job description and assignments and are capable of good results in team work. As a solution of improvement, setting personal development objectives, a well-defined action plan and intermediate terms could be efficient.

Alternative 3-people in this category scored between 226-268 points and shows good leadership skills. 26 people from Unit 1 and 14 from Unit 2 were placed here, representing mainly

sector coordinators from the two studied units. For Unit 2 this is a good score, but we see a better situation in Unit1.

That can be justified by a closer approach for developing the human resources sector and facilitating trainings for the employees. The improvements for people scoring here can be punctual, requiring attention and individual study.

Alternative 4-people scored between 269-270 points and show very good leadership skills. There are 9 employees from Unit 1 and 12 from Unit 2 here. People that situated here are department managers and a part of the production sectors coordinators, with better results for Unit 2, were activity is more concentrated and restrained and team work and cooperation well defined. It is recommended for people in this category to teach and mentor new employees, make team distribution and give direction to the whole group.

## CONCLUSIONS

The companies taken into study practice integrate systems so that work efficiency and economic increase are visible in their expansion since they started to present.

The company executive that manage the units practice an efficient leadership and a good management, proven among others by the size of the exploited area and the high- technologized equipment and machinery used.

The high number of employees that scored maximum at the leadership skills questionnaire in both units show a modern and efficient approach in farm management.

Each of the two studied units still have an unexploited potential concerning leadership skills, but an encouraging fact is that leadership skills are found at all hierarchic levels, and mainly at the production sectors where activity is more concentrated, focused on yield, on team spirit, direct and active communication between people.

## REFERENCES

**Brezuleanu S., 2008** - *Sisteme de producție în agricultură,* Alfa Publishing House, Iași.

**Brezuleanu S., 2009** - *Management în agricultură*, Tehnopress Publishing House, Iași.

**Ștefan G., 2007** - *Economia și filiera produselor agroalimentare,* Alfa Publishing House, Iași.

****-National Institute of Statistics*, 2019, Romanian Statistical Yearbook for 2018;

****-Agency for Payments and Intervention in Agriculture*- APIA, 2019, Yearly reports on agricultural areas.

# OPPORTUNITIES FOR THE DEVELOPMENT OF AGRICULTURAL FARMS IN NE REGION BY ATTRACTING EUROPEAN FUNDS

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**Abstract**

The paper aims to present a synthesis of data from the literature on the situation of Romanian agriculture in the European context, emphasizing the concept of agricultural farm development by attracting European funds.The research aimed at the diagnostic analysis of the results obtained by agricultural farms and the impact of European funds in the context of integration into the European Union. It is found that, after Romania's accession to the European Union, the possibilities for the development of agricultural farms have increased, as a result of their advantage of accessing European funds, with a fairly large share of their non-reimbursement. In this context, the research started from the economic-financial analysis of the situation of agriculture in the North-East Development Region, according to which to proceed to adopt measures that will lead, first of all, to the increase of agricultural production and, in secondly, to make it more efficient by attracting European funds. The need to reorganize this sector according to European Union standards requires the adoption of a new model of planning, organization, motivation, coordination and control at the level of all its mechanisms. From the point of view of the measures offered in support of the European Union, it should also be mentioned that, atypically, for the EAFRD, it was not the aggressive media coverage that determined the placement of certain counties in the first positions, but rather the capital inflows that penetrated the last. period in these counties, in conjunction, most likely with open management by the local authorities involved. Research methodology was based on the investigation of information from official documents, but also from technical-economic analysis, SWOT analysis and case studies. The results obtained through the research undertaken can be models for farmers to develop their agricultural activity and improve the technologies used, both in plant production and in animal husbandry.

**Key words**: tools, financing, agriculture, objectives, strategies

The integration of Romanian agriculture in the structures of the European Union was a difficult process, due to the dysfunctions faced by this economic sector, and which are maintained today, such as excessive fragmentation of property, predominance of subsistence and semi-subsistence farms, characterized by self-consumption. high and marginal links with the market, poor economic, social and ecological efficiency, high share of the rural population in the total population, extremely low income of agricultural producers, persistence of significant disparities in economic, social and infrastructural, between rural and rural areas. the urban one etc.

In this context, the accession of our country to the agrarian structures of the European Union required sustained efforts on economic, social, ecological, institutional and legislative levels, an important aspect being the integration in the European single agricultural market.

The modulation mechanism "seeks a better allocation (distribution) of Community support between market policy and rural development policy in order to meet Community requirements and concerns regarding the environment, food security and animal health and comfort. It was thus decided to reduce payments for large farms through a "modulation" mechanism and as a result the amounts in question will support rural financing. The modulation mechanism consists of cutting the amounts for a Member State by the end of 2012 (EC Regulation No 1782/2003)".

For the period 2007-2015, the MMF set six points with CAP expenditure (Conservation and Management of Natural Resources) which is the most important section of the EU budget (ranging from 43-51% of its total). In Romania, especially in the period 2010-2012, such an expense being the most important in EU national funding (over 60%).

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## MATERIAL AND METHOD

The methodological and scientific support in this paper was based on a series of direct and indirect documentation such as: observation, analysis (qualitative, quantitative, and historical), synthesis, comparison, systemic, monographic, statistical, figures and tables in the full and complex exposure and rendering of phenomena and economic processes studied.

The theoretical support of the research focused on the study of important scientific papers in the field of economy and management, with reference to the fiscal administration and the current problems in the public finances

## RESULTS AND DISCUSSIONS

Supporting agriculture through the Common Agricultural Policy in 2014-2020, is a continuation of the rural development process and the distribution of direct payments to active farmers, a process that began with the period of Romania's pre-accession to European Union structures (Giurcă D. *et al*, 2006; Fîntîneru G. *et al*, 2010).

Taking into account the obligations incumbent on Romania as a result of the commitments assumed under the Treaty of Accession to the European Union as well as the need to complete the financial measures on the allocation of pre-financing and co-financing from the state budget to the institutions involved in managing European funds. The common agricultural policy, in order to accelerate and streamline the implementation process of the National Rural Development Program 2007-2013, required the modification of the Emergency Ordinance no. 67/2006 on the management of non-reimbursable funds intended to finance the common agricultural policy allocated from the European Community, as well as of the co-financing and pre-financing funds allocated from the state budget by Emergency Ordinance no. 120/2007. This amendment established the "general financial framework for the management of the non-reimbursable financial assistance allocated to Romania as a member state of the European Union, as well as the pre-financing and co-financing related to this assistance, in order to ensure an efficient financial management of European Guarantee Fund funds. and the European Agricultural Fund for Rural Development"(Article 1). This will be complemented by a series of GDs that can be found in the PNDR Progress Report for that year (2007).

The 2014-2020 IMF, approved in November 2014 (Council of the European Union, 2014), reveals a reduction in agricultural policy spending over the coming period. The amount allocated to the CAP amounts to 362.8 billion euros, 37.8% of the total EU budget (less than 47.1% in 2007-2014). Thus, in 2020, the CAP budget will account for 35% of EU spending, 5% less than in 2014 (*table 1*).

Table 1

**CAP expenses for the period 2014-2020 (2014 constant prices)**

| CAP expenses | 2014 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | Total |
|---|---|---|---|---|---|---|---|---|---|
| Competitiveness for growth and jobs | 18.0 | 15.6 | 16.3 | 16.7 | 17.7 | 18.5 | 19.7 | 21.1 | 125.6 |
| Economic, social and territorial cohesion | 52.4 | 44.7 | 45.4 | 46.0 | 46.5 | 47.0 | 47.5 | 47.9 | 325.1 |
| Sustainable growth: natural resources | 59.6 | 55.9 | 55.1 | 54.3 | 53.4 | 52.5 | 51.5 | 50.6 | 373.2 |
| Security and Citizenship | 2.5 | 2.1 | 2.1 | 2.2 | 2.2 | 2.3 | 2.4 | 2.5 | 15.7 |
| Global Europe | 9.1 | 7.9 | 8.1 | 8.3 | 8.4 | 8.6 | 8.8 | 8.8 | 58.7 |
| Administration | 0.0 | 8.2 | 8.4 | 8.6 | 8.8 | 9.0 | 9.2 | 9.4 | 61.6 |
| Compensation | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Grand total | 141.6 | 134.3 | 135.3 | 136.1 | 137.1 | 137.9 | 139.1 | 140.2 | 960.0 |
| CAP spending in the EU budget -% | **40.3** | **40.5** | **39.6** | **38.8** | **37.9** | **37.0** | **35.9** | **35.0** | **37.8** |
| **EAGF - %** | **72.4** | **74.4** | **74.4** | **74.5** | **74.5** | **74.5** | **74.4** | **74.4** | **74.5** |
| **FEADR - %** | **23.3** | **23.0** | **22.9** | **22.8** | **22.7** | **22.7** | **22.6** | **22.6** | **22.8** |

Source: Rural Development 2014-2020, based on data from the European Commission

The Commission's Multiannual Financial Framework confirms that the structure with two pillars of the CAP is retained by EUR 277.8 billion allocated for direct payments and market measures in Pillar I, while EUR 84.9 billion is earmarked for rural development expenditure under Pillar 2. The Commission proposes and another € 3.5 billion for agricultural crisis management measures to be financed outside of the multiannual financial framework. This leads to the establishment of an emergency mechanism to combat crisis situations in order to provide immediate support to farmers in an accelerated procedure.

At the level of the European Union, in the period 2014-2020, Romania has allocated a value of 8,128 million euros, which represents 8.18% of the total funds allocated by the EAFRD for the current financial year (*table 2*), while Bulgaria

receives a almost three times lower, a value of 2,366.7 million euros. However, the aim of the study is to identify those agricultural sectors that could benefit from EU integration, provided that producers are able to make the most of the opportunities that arise. Hence, it follows that the model seeks to identify possible changes that may occur in production in the agricultural sector and in the economy as a whole, rather than accurate predictions of likely changes in income. Regarding the coefficient of elasticity of the imported goods considered here, the sensitivity tests performed revealed that it provides the model with references to structural parameters.

There are many written studies on this topic that have used the AGE method to solve the problems that have arisen with the enlargement of the European Union and its impact on the agricultural sector in countries with economies in transition (Liapis and Tsigas, Acar, Herok and Lotze, Kuhn and Wehrheim, Maliszewska, Frandsen).

Table 2

**Distribution of the allocation of European Funds related to EAFRD 2014-2020, at the level**

| Total funding for 2014-2020 | € million |
|---|---|
| Health, demographic change & wellbeing | 7 472 |
| Food security, sustainable agriculture and forestry, marine/maritime/inland water research and the bioeconomy | 3 851 |
| Secure, clean & efficient energy | 5 931 |
| Smart, green & integrated transport | 6 339 |
| Climate action, environment, resource efficiency & raw materials | 3 081 |
| Inclusive, innovative & reflective societies | 1 310 |
| Secure societies | 1 695 |

Source: Processing by: Rural Development 2014-2020, http://ec.europa.eu/agriculture/rural-development-2014-2020/country-files/

The provisions of the Europe 2020 Strategy, for the period 2014-2020, the CAP will invest almost 20 billion euros in the agricultural sector and in rural areas in Romania. Key policy priorities, defined at EU level, include jobs, sustainability, modernization, innovation and quality. Romania has the flexibility to adapt both

direct payments as well as rural development programs to its specific needs.

The ex-ante analysis of the National Rural Development Program 2014-2020, Pillar 2 of the CAP, revealed a number of 6 major priorities in rural development for the period 2014-2020. These were materialized in areas or areas of intervention, subclassified into measures and sub-measures.

Priority P1 Encouraging knowledge transfer and innovation in agriculture, forestry and rural areas comprises 3 areas of intervention DI:

Area of intervention DI 1A) Encouraging innovation, cooperation and the creation of a knowledge base in rural areas responds to the priority P1 identified at the level of NRDP through the following rural development measures:

- Measure M01 - Actions for knowledge transfer and information actions, according to Article 14 of Regulation (EU) no. Regulation (EC) No 1305/2013 of the European Parliament and of the Council of 17 December 2013 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD) and repealing Regulation (EC) no. 1698/2005 of the Council;

- Measure M02 - Advisory services, farm management services and on-farm replacement services (Article 15 of R (EU) No 1305/2013)

- Measure M16 - Cooperation (in response to Article 35 of R (EU) No 1305/2013).

The related measures and sub-measures aim at increasing the existing knowledge and skills at the level of agricultural and forestry holders (SMEs), as well as employees in the agri-food and forestry fields as a premise for increasing their competitiveness and market proximity (Giurcă D. *et al*, 2006; Fîntîneru G. *et al*, 2010).

Area of Intervention DI 1B) Strengthening the links between agriculture, food production and forestry, on the one hand, and research and innovation, on the other hand, including for the purpose of better environmental management and improved environmental performance also in response to priority P1 of the RDP, and its implementation is proposed to be achieved through measure M16 Cooperation, in accordance with Article 35 of R (EU) 1305/2013. This area of intervention aims to facilitate and strengthen the links between agriculture, food production and forestry, on the one hand, and research and innovation, on the other, including for the purpose of better environmental management and improved environment by supporting the establishment and

operation of operational groups for the development of pilot projects, new products, practices, processes and technologies in the agricultural, agri-food and forestry sectors).

Evaluation of the technical and scale efficiency of the agricultural exploitations with financing through Pillar II

The evaluation of the technical and scale efficiency of the agricultural holdings under study was performed by the DEA method starting from the financial-accounting statements of the holdings taken as case studies (E1- Sc Trifesti, E2-Agri-Pe,; E3- Agrimarvas, E5-AVE Agromer, E6-Arhonda with 500-1000 ha; E7-Criscom, E8- Mobil MFM, E9-Panifcom with over 1000 ha). The DEA (Data envelopment analysis) method of analyzing the relative efficiency of agricultural holdings according to the weighted ratio of inputs and outputs requires the construction of the database for the analysis period 2005-2014. Also, as a support for this analysis it was necessary to use econometric models based on the regression method and the correlation method to establish the causal relationships and the meaning of the correlations between the variables used, but also to find out the forecast trend. This approach will allow us to prioritize agricultural holdings taken as a case study according to the technical efficiency and scale of all holdings.

The analysis in the previous chapter showed deficiencies in the exploitation activity that affected the overall profitability of the farms under study. In this context, we aimed to evaluate by econometric and non-parametric methods both the overall activity of the holdings and the operating activity.

As a scientific support of the non-parametric models of hierarchy of agricultural holdings that we want to use, we applied at the level of each holding the following econometric models (regression) based on data from 2014-2020 (*table 3*):

Table 3

**Regression model specifications**

| | **Independent variables X** | **Dependent variable Y** | **Regression functions *(where* t=2005-2014 and i = holding)** |
|---|---|---|---|
| Model 1 | Expenditure on raw materials and materials (Cm)<br>Expenditure on external services (Ce)<br>Staff costs (C) | Operating income (Ve) | $\mathbf{Ve_{ti} = a + b * Cm_i + c * Ce_i + d * C_i}$ |
| Model 2 | Surface (S)<br>Fixed Assets (A)<br>Capital (own and borrowed) (K)<br>Staff costs per employee (Cs) | Total income (Vt) | $\mathbf{Vt_{ti} = a + b * S_i + c * A_i + d * K_i + e * Cs_i}$ |

The variables required for econometric and non-parametric models are presented in and the multifactorial regression models were run through the Data Analysis program in Excel, which allows obtaining the main indicators and verifying the validity of the analyzes performed.

*Performance of agricultural holdings.*

The AGE model is used to simulate in another multi-sectorial static based on economic theories, which would respond to the shocks of foreign trade policies on the agro-food sectors in Romania. Consequently, it is a powerful tool for predicting the possible effects of regional integration. In addition, the simulation is an analytical model used to separate agricultural policy changes from many other factors that may occur after accession.

Regarding the structure of the model, it is built according to the standard procedures described by perfect competition, open economy theory, production functions that have a constant scale of yields, full and perfect employment, labor and capital mobility. It should be borne in mind that much more important issues, such as imperfect competition, increasing or decreasing returns to scale, and other aspects of dynamics, have not been taken into account. In addition, the model does not contain characteristic aspects and structural constraints of a transition economy, such as: market uptake, weak infrastructure, high transaction costs and the presence of subsistence agriculture. For the period (2014-2020), in order to establish the budget and the mechanisms of the new CAP, the European Commission proposed three options: improved status quo; developing a better targeted, balanced CAP and more sustainable support; abolition of market support and revenue. Taking into account the process of gradual increase of direct payments (up to 100% in 2016) and according to the estimates regarding the budget and the future Common Agricultural Policy, it would result that Romania would benefit, in the period of future multiannual financial programming (2014 - 2020), of fairly substantial European funds for agriculture and rural development. The main impact of European funding for the period 2014-2020 will be to increase direct payments to 100% of the amount

established in the accession negotiation process (which will take place in 2016) and will increase from about 183 euro / ha to 203 EUR / ha; this will lead to the allocation of additional funds of almost 7 billion euros, an amount that is practically more than double the funds allocated for direct payments in the current financial programming period (2007-2013).

Table 4

**Evolution of the net added value per hectare and labour productivity, per sectors, for the period 2013-2018**

| | 2013 | | 2018 | | 2018/2013 (%) | |
|---|---|---|---|---|---|---|
| | VAN/ha | VAN/AWU | VAN/ha | VAN/AWU | VAN/ha | VAN/AWU |
| Field crops | 312.1 | 3193.4 | 467.7 | 16473.0 | 149.9 | 515.8 |
| Horticulture | 5262.8 | 3359.2 | 2426.9 | 2804.8 | 46.1 | 83.5 |
| Wine | 1678.2 | 3018.7 | 1381.4 | 6041.9 | 82.3 | 200.1 |
| Other permanent crops | 1290.0 | 3853.8 | 1434.3 | 5446.6 | 111.2 | 141.3 |
| Milk | 1023.9 | 2411.5 | 923.6 | 3944.1 | 90.2 | 163.6 |
| Other grazing livestock | 565.6 | 1917.6 | 855.5 | 4669.4 | 151.3 | 243.5 |
| Other granivorous animals | 7774.5 | 5289.1 | 4498.7 | 11777.8 | 57.9 | 222.7 |
| Mixed | 499.8 | 1156.5 | 833.9 | 2911.7 | 166.9 | 251.8 |

Source: FADN processing (RICA)

The analysis of economic performance shows that in 2013 without receiving subsidies the farms in the field crops and granivores would have lost, while the wine sector had a negative income rate due to the unfavourable climatic conditions (*Table 5*). In 2014, the income ratio varied between 26.5% in horticulture and 85.5% in the dairy cow sector, while without subsidies the income rate reached only 22.1-62.6%. Major increases in economic performance compared to 2013 were recorded mainly in the livestock sector and in the wine sector.

Table 5

**Evolution of income rates, per sectors, for the period 2013-2018**

| | 2013 | | 2018 | | 2018/2013 (+/-) Percentage points | |
|---|---|---|---|---|---|---|
| | Income rate (%) | Income rate without subsidies (%) | Income rate (%) | Income rate without subsidies (%) | Income rate | Income rate without subsidies |
| Field crops | 19.0 | -5.6 | 56.7 | 28.1 | 37.7 | 33.7 |
| Horticulture | 55.1 | 49.1 | 26.5 | 22.1 | -28.6 | -26.9 |
| Wine | -9.2 | -12.7 | 40.5 | 26.9 | 49.7 | 39.7 |
| Other permanent crops | 45.7 | 38.8 | 73.0 | 62.6 | 27.3 | 23.8 |
| Milk | 85.5 | 65.6 | 85.5 | 60.8 | 0.0 | -4.8 |
| Other grazing livestock | 55.8 | 40.2 | 81.3 | 60.6 | 25.6 | 20.5 |
| Other granivorous animals | 7.8 | -12.5 | 64.8 | 44.7 | 56.9 | 57.3 |
| Mixed | 42.9 | 30.8 | 69.1 | 52.1 | 26.1 | 21.3 |

Source: FADN processing (RICA)

The analysis of the subsidy structure in 2018 highlights that the most important subsidies were direct payments for the plant and livestock sector, followed by support for rural development and other subsidies, while in the livestock sector other subsidies were important, complementary national payments and support for rural development.

## CONCLUSIONS

The Community Agricultural Policy proved to be one of the most successful communitarian policies, having also a high degree of complexity. Exactly this success shall determine the difficulty of the reform, considering the changes in the initial conditions that represented the fundament of its elaboration. The need to increase the competitiveness on the European Agricultural Market, the creation of an integrated rural development program to accompany the reform process, the simplification of the legislative framework at the European level and the substantial decentralization in implementing the measures shall lead to a reform in phases, whose effects shall mark the entire European construct.

The analysis per types of production of the separation per sources of incomes, revealed us that the support through Pillar I – subventions for the vegetal and animal production – was more equally distributed among farms. The contribution of the income sources to forming the total income emphasized that the value of the agricultural production leads to around 67.1% of inequity, the remaining being under the influence of subventions. Among these, the most important

contribution was determined by the free payments (21.3%), these being followed by subventions for intermediary consumption and other subventions. The assessment of the effect of the modification of the income sources on the total income:

Incomes from the agricultural production and other subventions lead to the increase of inequity among farms that obtain different products (grains, wine, horticultural products, etc.); increase with 1% of the incomes from the agricultural production leads to the inequity increase with 5.76%;

The subventions lead, generally, to the decrease of inequity between them, especially subventions for the animal production (decrease of 3.33%) and direct payments (with 2.17%);

The analysis per types of specialized farms The European model has often been compared to agricultural support systems in other countries, highlighting both the weaknesses and the advantages of this organizational model. The United States has often been taken as a benchmark, with deep reforms in the country allowing a small number of farmers to ensure sufficient production at fair prices.

Integration in the European Union was one of the key priorities of Romania's foreign policy. As a substantial part of this strategy, Romania has had to gradually adopt an agricultural policy and an institutional framework fully compatible with the European Union's common agricultural policy (CAP). The two pillars of the European Union's Common Agricultural Policy are market and income support and rural development, and their financing is achieved through the EAGF and the EAFRD, respectively. The obtained results show us that a modification with 1% of the subventions granted through Pillar I: they have a negative effect leading to the increase of inequalities between different size farms; they have a positive effect leading to the reduction of disparities between the farms from different sectors or specialized on certain products.

## REFERENCES

**El Benni N., Finger R., 2014** - *The effect of agricultural policy reforms on income inequality in Swiss agriculture-An analysis for valley, hill and mountain regions*. Journal of Policy Modeling, 35(4), 638-651;

**Farrell M.J., 1957** - *The Measurment of Productive Efficiency*, Journal of Royal Statistical Society, A120, pag. 253-290.

**Fîntîneru G., Dona I., Fîntîneru A., 2010** - *The flexible approach of the second pillar on CAP to maximize advantages for EU farmers-Romania case*. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 10(3), 143-146.

**Fred G., 2015** - *Growth and Evolution in China`s Agricultural Support Policies*, p. 5, http://www.ers.usda.gov/media/1156829/err153.pdf, accesat la data de 02.06.2015.

**Giurcă D., Hurduzeu Gh., Rusu M., Sălășan C., 2006** - *Sectorul Agricol în perspectiva aderării României la Uniunea Europeană: implicații asupra sistemului de plăți*. Institutul European din România – Studii de impact III, Studiul nr. 6.

**Gorton M., Davidova S., 2004** - *Farm productivity and efficiency in the CEE applicant countries: a synthesis of result?* Agricultural Economics, 30: 1–16.

**Henke R., 2014** - *The Common Agricultural Policy after the Fisher Reform: National implementations, impact assessment, agenda of future reforms, Ashgate,* Publishing Lts., England, ISBN 978-140942-194-8.

# GRAIN PRODUCTIVITY AND QUALITY OF THE WINTER BARLEY VARIETY *ZIMOVYI* IN MULTIFACTORIAL FIELD EXPERIMENTS

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**Abstract**

The paper presents the results of 3 year research studies on the productivity, content and amount of crude protein recorded by the winter barley variety Zimovyi in multifactorial field experiments. It has been established the effect of forerunner plants on the productivity of winter barley crops which was of 72.37%. On average, over 2 years of research, it was recorded the yield of 3609 kg/ha after the forerunner grain peas, while after the forerunner vetch-oat it was of 2507 kg/ha. The effect of planting dates constituted 24.55%. The highest grain yield was obtained on the optimal planting dates - 3750 kg/ha after the forerunner grain peas and 2631 kg/ha on the admissible planting dates after the forerunner vetch-oats.The amount of crude protein in the winter barley grains is higher after the forerunner vetch-oats – 12.13%, exceeding the value of 0.16% obtained after the forerunner grain peas.

**Key words*:*** winter barley, forerunner plant, planting dates, productivity, crude protein.

Documentul de faţă este aranjat astfel încât să poată fi utilizat ca model. De asemenea, el este un şablon pe care se poate lucra în mod direct prin înlocuirea paragrafelor corespunzătoare.

Winter barley is a traditional grain crop cultivated in the Republic of Moldova since the end of the XVIII$^{th}$ century (Labcenco V.N., Niscii I.A., 1965; Vozian V.N., Jurat V.F., 2016). Recently, the winter barley varieties with a semi-winter type of development, i.e. cultivated both in spring and in autumn, have been identified as the most suitable for the soil and climatic conditions of the country. They are tolerant to a low soil fertility, because of the high cost of mineral fertilizers and longer periods of sowing (Vozian V.N., Jurat V.F., 2016).

The cultivation technology of the above mentioned varieties is quite thoroughly studied but only in simple experiments. The aim of our work was to study the productivity and quality of grains of winter barley variety *Zimovyi* in a multifactorial field experiments.

## MATERIAL AND METHOD

The experiments were conducted in the central agro-climatic zone of the Republic of Moldova at the Didactic Experimental Station "Chetrosu" in the period 2015-2017. During the multifactorial experiments, the following factors were studied:

Factor A: two forerunner plants (grain peas and vetch-oats); Factor B: three planting dates - optimal (19-24.X-control), admissible (19-30.X) and late (29.X-21.XI); Factor C: three seeding rates: 4.0, 5.0 (control) and 6.0 mln/ha.

The sowing of winter barley was carried out with the seeder CH-16A according to the research program. The experiment was designed with 3 replicates on a plot area of 40 m$^2$.

Total nitrogen was determined by the Kjeldahl ultra-method. Mineral fertilizers were applied in spring after the emergence of plants at the dose of 100 kg/ha of ammonium nitrate.

## RESULTS AND DISCUSSIONS

In conditions of the Republic of Moldova, the main factor determining the yield of field crops, including winter barley is soil moisture availability index, which depends on the amount of precipitation during the vegetative phase of plant development.

Over the years of research, the average grain yield after the forerunner grain peas varied from 2210 kg/ha in 2015 to 4647 kg/ha in 2017. After the second studied forerunner plant, vetch-oats, the yield varied from 1838 kg/ha in 2017 to 3791 kg/ha in 2016. On average, over the years of research, after the

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forerunner grain peas, the yield of winter barley grains was of 3609 kg/ha (*figure 1*, *table 1*). This forerunner plant ensured the maximum productivity of winter barley of 3888 kg/ha on the optimal planting dates and at the seeding rate of 4.0 mln/ha. The average grain yield after the forerunner vetch-oats is significantly lower than after grain peas amounting to 2507 kg/ha. This is by 1102 kg/ha lower than the yield obtained after grain peas and this difference is significant since the $LD_{05}$ value is of 78 kg/ha. In terms of planting dates, after the forerunner grain peas, the maximum grain yield was obtained on the optimal planting dates, which amounted to 3750 kg/ha.

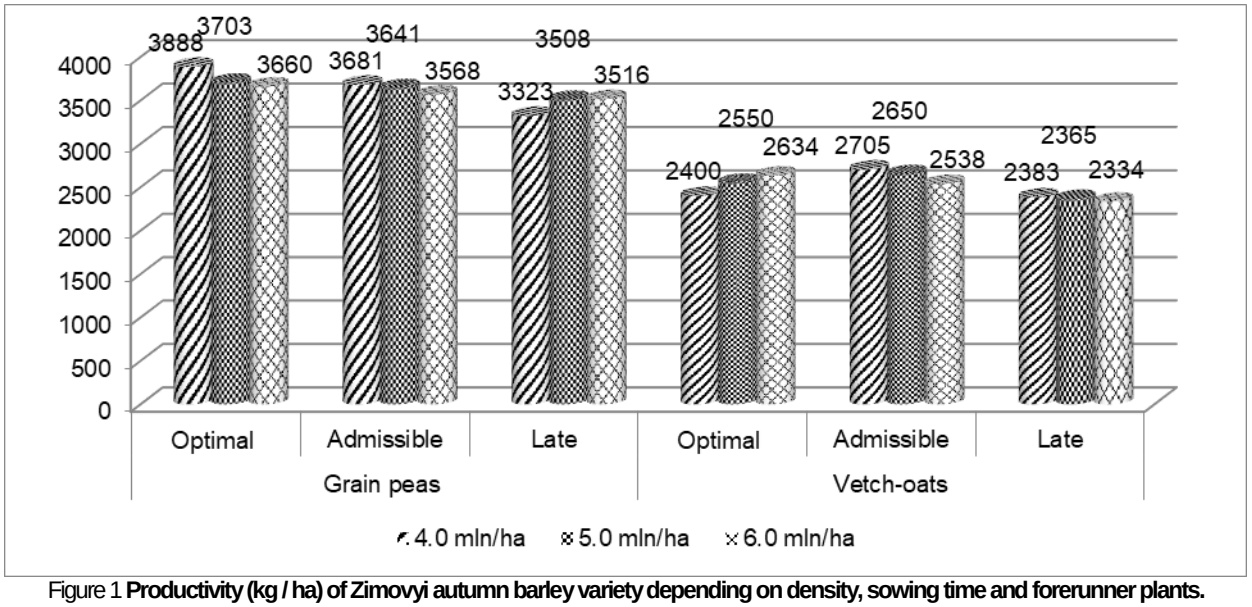



Figure 1 **Productivity (kg / ha) of Zimovyi autumn barley variety depending on density, sowing time and forerunner plants.**

Table 1

**Productivity (kg/ha) of winter barley variety Zimovyi in multifactorial field experiments, 2015-2017**

| Seeding rates, mln/ha (factor C) | Forerunner plants (factor A) | | | | | | Average according to factor $LD_{05}$ C-90, kg/ha | ± reported to the control 5.0 mln/ha |
|---|---|---|---|---|---|---|---|---|
| | Grain peas (control A) | | | Vetch-oats | | | | |
| | Planting dates (factor B) | | | | | | | |
| | Optimal (control B) | Admissible | Late | Optimal (control B) | Admissible | Late | | |
| 4.0 | 3888 | 3681 | 3323 | 2400 | 2705 | 2383 | 3063 | -7 |
| 5.0 (control C) | 3703 | 3641 | 3508 | 2550 | 2650 | 2365 | 3070 | - |
| 6.0 | 3660 | 3568 | 3516 | 2634 | 2538 | 2334 | 3042 | -28 |
| Average according to factor A | 3609 | | | 2507 | | | | |
| ± reported to grain peas | -1102 | | | | | | | |
| $HCP_{05}A$ | 78 | | | | | | | |
| Average according to factor B | 3750 | 3629 | 3449 | 2528 | 2631 | 2361 | | |
| ± reported to planting dates | - | -121 | -301 | - | +103 | -167 | | |
| $LD_{05}B$, kg/ha | 90 | | | | | | | |
| $LD_{05}$ of the experiment, kg/ha | 235 | | | | | | | |

On admissible planting dates, the grain yield was 3629 kg/ha, which is by 121 kg/ha less than the optimal period. On late planting dates, there is a further decrease in the grain yield down to 3449 kg/ha, which is by 301 kg/ha less than on the optimal period. It was noticed a significant decrease in the productivity level of winter barley grains going beyond $LD_{05}$ - 90 kg/ha

After the second forerunner vetch-oats, the average grain yield of the Zimovyi variety was of 2507 kg/ha. This forerunner plant ensured the maximum grain yield of 2705 kg/ha on admissible planting dates at the seeding rate of 4.0 mln/ha.

On average, over the years of research, on admissible planting dates, the highest grain yield amounted to 2631 kg/ha, which is by 103 kg/ha significantly higher than on the optimal planting dates.

The minimum grain yield of 2361 kg/ha, after the forerunner vetch-oats, was obtained on the late planting dates, which is significantly lower than on the optimal planting dates by 167 kg/ha and lower than on the admissible planting dates by 270 kg/ha.

According to the seeding rate options, the grain yield did not change significantly and it amounted to 3042 kg/ha at the seeding rate of 6.0 mln/ha and 3070 kg/ha at the seeding rate variant of 5.0 mln/ha. The marked decrease in productivity (7-28 kg/ha) was insignificant, within the range of $LD_{05}$ - 90 kg/ha.

The analysis of variance of the multifactorial field experiments allowed us to determine the influence degree of each of the studied technology elements and their interaction on the grain yield of winter barley variety Zimovyi (*table 2*).

Table 2

**The influence degree of factors on the productivity of winter barley**

| № | Factors | Influence degree, % |
|---|---|---|
| 1 | Forerunner plant | 72.37 |
| 2 | Planting dates | 24.55 |
| 3 | Seeding rate | 0.49 |
| 4 | Interaction: forerunner plant - planting dates | 1.47 |
| 5 | Interaction: forerunner plant - seeding rate | 0.45 |
| 6 | Interaction: planting dates - seeding rate | 0 |
| 7 | Interaction: forerunner plant - planting dates - seeding rate | 0.81 |
| | Total | 100 |

The forerunner plants had the most significant impact on grain productivity – 72.37%, the influence degree of the planting dates was 24.55%. Changes in the seeding rates and possible interactions of the studied factors influenced by 1.47 – 0.49%.

The determination of the crude protein content was carried out at the seeding rate option of 5.0 mln/ha. On average, over two years, the crude protein content in the grains of winter barley grown after the forerunner grain peas was 11.97%, which is by 0.16% less than after the forerunner vetch-oats - 12.13% (*figure 2, table 3*).

The planting dates had a significant impact on the dynamics of the crude protein accumulation in the winter barley grains. After the forerunner grain peas, the highest content of the main component highlighting grain quality was recorded on the late planting dates, amounting to 12.54%, which is by 0.46% higher than on the optimal planting dates and by 1.24% higher than on the admissible planting dates.

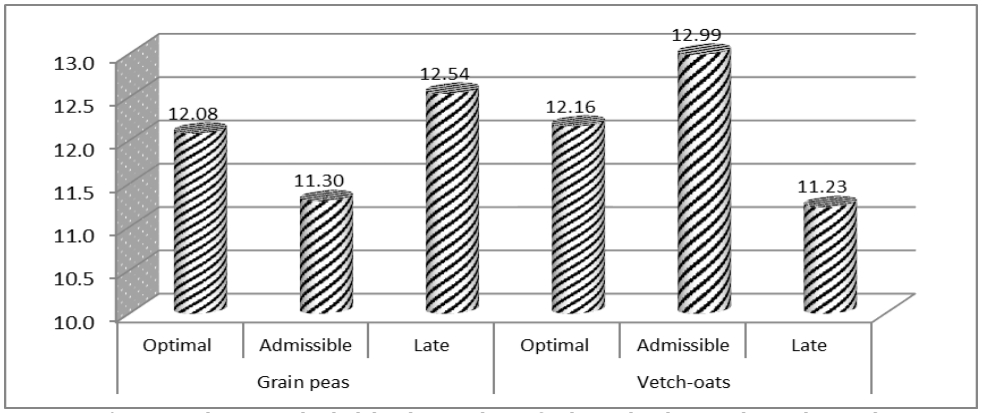



Figure 2 **The protein (%) in the grains of winter barley variety Zimovyi.**

Table 3

**Content (%) and amount of crude protein (kg/ha) in the grains of winter barley variety Zimovyi, 2016-2017**

| Seeding rate, mln/ha (factor C) | Forerunner plant | | | | | | Average of the experiment |
|---|---|---|---|---|---|---|---|
| | grain peas | | | vetch-oats | | | |
| | planting dates | | | | | | |
| | optimal | admissible | late | optimal | admissible | late | |
| % protein | 12.08 | 11.30 | 12.54 | 12.16 | 12.99 | 11.23 | 12.06 |
| Average reported to the forerunner pant | 11.97 | | | 12.13 | | | |
| ± reported to grain peas | +0.16 | | | | | | |
| ± reported to the 1st planting dates | - | -0.78 | +0.46 | - | +0.83 | -0.93 | |
| Amount of protein, kg/ha | 458.7 | 415.1 | 454.2 | 297.0 | 342.4 | 247.0 | 367.4 |
| Average reported to the forerunner plant | 439.2 | | | 295.5 | | | |
| ± reported to grain peas | -193.7 | | | | | | |
| ± reported to the 1st planting dates | - | -43.6 | -4.5 | - | +45.5 | -50.0 | |

After the forerunner vetch-oats, the maximum crude protein content of 12.99% was recorded on the admissible planting dates significantly exceeding the optimal planting dates by 0.87% and the late planting dates by 1.76%.

On average, according to the experiment, the content of raw protein in winter barley grains was of 12.06%, which is a very good indicator of their quality.

The amount of crude protein extracted from the grain yield after the forerunner grain peas averaged 439.2 kg/ha. According to the planting dates options, the values of this indicator amounted to 458.7 kg/ha on the optimal and 415.1 kg/ha on the admissible planting dates.

After the forerunner vetch-oats, the amount of crude protein extracted from the grain yield averaged 295.5 kg/ha, which is significantly lower than after the forerunner grain peas by 193.7 kg/ha. The maximum amount of crude protein of 342.4 kg/ha, extracted from the grain yield, was obtained on admissible planting dates. On average, according to the experiment, the amount of crude protein extracted from the grain yield was of 367.4 kg/ha.

## CONCLUSIONS

As a result of performed studies on grain productivity and quality of the winter barley variety Zimovyi in multifactorial field experiments, the following conclusions could be drawn:

1. Out of the studied forerunner plants, the most effective was grain peas as the grain yield was of 3690 kg/ha, the influence degree of the forerunner plants on the grain yield amount was of 72.37%;
2. It was determined a selective reaction of the Zimovyi variety to the planting dates after various forerunner plants. After the forerunner grain peas, the greatest effect was obtained on the optimal planting dates - 3750 kg/ha, and after the forerunner vetch-oats on admissible planting dates - 2631 kg/ha. The influence degree of the planting dates on the total yield of Zimovyi variety was of 24.55%;
3. The influence of the seeding rate on the winter barley yield was not detected – 0.49%;
4. The forerunner grain peas contributed to the creation of more favorable conditions for the accumulation of nitrogen compounds in the winter barley grains, which resulted in a higher crude protein content in the grains and its extracted amount from the grain yield.

## REFERENCES

**Dospehov B.A., 1985 -** *Field experiment technique*. M. Kolos, pp. 416.

**Labchenko V.N., Nishii I.A., 1965 -** *Results and prospects of selection and seed production of winter barley*. Materials of the scientific conference on selection and seed production of field crops. Chisinau, pp. 126-148.

**Voziyan V.N., Jurat V.F., 2016 -** *Winter barley in the Republic of Moldova*. Scientific Production Journal "Grains and leguminous crops", 1(17): 89-98.

# NON-FORMAL ENTREPRENEURIAL UNIVERSITY CURRICULUM: EXPERIENCES AND PERSPECTIVES

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**Abstract**

Rethinking the curriculum in general, especially the university one, is a major coordinate of educational reforms. The aim of these transformations is to adapt educational structures to the profound changes of the world where we live, emphasizing the proactive dimension of the educational effort. We proposed to analyze the evolution of the non-formal entrepreneurial university curriculum, highlighting university experiences in this regard. Entrepreneurial education (EE) is one of the fastest growing areas of education in the world. We integrate entrepreneurial education within "the new educations". Investing in entrepreneurial education is one of the most profitable investments Europe can make: research shows that participating pupils and students are 3 to 6 times more likely to open a business later, at some point in their lives, compared to the ones who do not benefit from entrepreneurial education. One of the eight key competences established at the EU level (2006) was entrepreneurial competence. Research has led to the creation of the entrepreneurial university, which was under the sign of a triple helix: university-industry-government. The key to a knowledge-based economy is research, education and innovation. The communication presents concrete action directions for the development of students' entrepreneurial skills through non-formal activities at USAMV Iași (Student Entrepreneurial Society, postgraduate entrepreneurship education courses, funding projects, trips and visits to agricultural companies and firms, internships).

**Key words**: non-formal entrepreneurial curriculum, entrepreneurship education, entrepreneurial university, entrepreneurship minor, entrepreneurial training of teachers

Entrepreneurial Education (EE) is one of the education fields with the world's fastest global development (Solomon D., 2007). We integrate entrepreneurial education into "new education" (Stanciu M., 2003). Investment in entrepreneurial education is one of the most cost-effective investments that Europe can do. Research shows that participating pupils and students have a chance of 3 to 6 times higher to set up a business subsequently, at a certain moment of their lives, compared to those who do not benefit from entrepreneurial education (European Commission, 2013).

Research showed that a superior educational level is coreelated to successful entrepreneurship (Foley and Griffit, 1998; Lee, 1997; Lefter and Svedberg, 2005; Van der Sluis *et al*, 2003).

## MATERIAL AND METHOD

We have proposed a qualitative analysis of the evolution of the non-formal entrepreneurial curriculum by highlighting university experiences in this respect. Our communication has in view the real labyrinth of the curriculum concept which is a key-concept of the contemporary pedagogy (van Bruggen J.C., 1992). The term was consecrated mainly due to the American pedagogy in the first half of the 20th century: John Dewey (1902), John Franklin Bobbitt (1918), Ralph W. Tyler (1949) and Hilda Taba (1962).

The contemporary literature shows us a new conceptualization of the curriculum concept (Pinar, 2004) (Jonnaert, 2015). The curriculum concept is "the Gordian knot", an essential engine for the conception and the execution, the evaluation and the adjustment of the educational systems." (Jonnaert, 2015)

By making a true bow over time, William Pinar will turn the noun *curriculum* into the verb "currere" as action, as a social practice (Pinar *et al*, 1995). We believe that the curriculum effort must be in the open area of "currere", the one of practical action steps to implement a curriculum relevant to the Romanian society at the beginning of the 21st century.

The theory of curriculum is under reconstruction (Jonnaert et al, 2009, note 2, p. 11), which exceeds the simple problems of rewriting curricula. They also distinguish two theoretical approaches of the curriculum: Anglophone (Tayler, 1950, Bobbitt, 1918 and

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1924, D'Hainaut, 1988) and Francophone (Reuter, Cohen-Azria, Daunay, Delcambre, Lahanier-Reuter, 2007). In this context, the conclusion has in view the complementarity of the two approaches.

The theory of the curriculum was outlined in a paper published by UNESCO: "take into account the educational process, the events that happen in the classroom"; it pays particular attention to learning and enhancement of interaction between the components of this process: objectives, contents, learning methods, assessment methods and techniques" (Rassekh Sh.,, Văideanu Ge., 1987, 8, p. 136)

The approach that we presented is a systemic one the school curriculum regardless of the level (*figure1*).

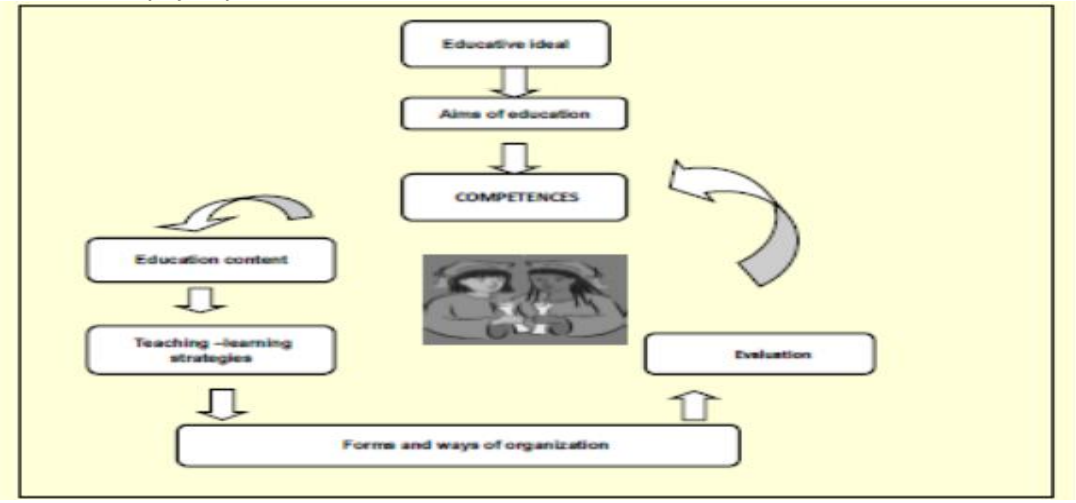



Figure 1 **Systemic-holistic perspective on the curriculum** (Stanciu M., 2018)

Another change of paradigm (Kuhn T., 1976) was to focus the educational approach on making competences (Vatier R., 1958; Le Boterf G., 1994, 1997 şi Levy-Leboyer C., 1996). One of the eight key competences established at the level of the EU (2006) was **entrepreneurial competence ”**Entrepreneurship education is about learners developing the skills and mind-set to be able to turn creative ideas into entrepreneurial action. This is a key competence for all learners, supporting personal development, active citizenship, social inclusion and employability. It is relevant across the lifelong learning process, in all learning subjects and to all forms of education and training (formal, non-formal and informal) which contribute to an entrepreneurial spirit or behaviour, with or without a commercial objective” (European Commission/ EACEA/ Eurydice, 2016**,** p. 19).

Education is achieved through three interdependent types (forms): formal, non-formal and informal. Non-formal (extra-school) education has the following features: it has a voluntary or optional character. Pupils are involved in designing, organizing and doing these activities. There are no grades, there is no rigorous assessment. It allows adding value to the attitudes and interests of children and teenagers; it allows a variety of forms with flexible structures; it knows different ways of funding; it facilitates the promotion of teamwork and a multidisciplinary approach or an interdisciplinary one; it points out objectives of formative-educational type (Stanciu M., 2003).

## RESULTS AND DISCUSSIONS

The idea of the **entrepreneurial university** was imposed after the American sociologist Burton R. Clark had published two books on this issue (*Creating Entrepreneurial Universities*, 1998; *Sustaining Changes in Universities*, 2004) (*apud* Gjerding A.,2006). The creation of entrepreneurial universities has been under the sign of a triple helix: University-Industry-Governance (Etzkowitz H. and Leydesdorff L., 1999). Globalization of the political economy, government funding reductions, links with the business, industry and marketing of educational and business services have changed the nature of the academic work (Slaughter S. and Leslie L.,1997). In the context of a knowledge-based economy, academic capitalism and entrepreneurial universities can be manifested in varied forms, too (Jessop B., 2017). The key to a knowledge-based economy is research, education and innovation universities. "The economy of knowledge and society come from the combination of four interdependent elements: producing knowledge, mainly through research; their transmission through education and training; their dissemination through information and communication technologies; their use in technological innovation. (European Commission, 2003).

A university may be entrepreneurial in two ways: 1. Academic entrepreneurship (trading the knowledge and the results of the research):

Knowledge HUBs; Technology Transfer Centers; Innovation Hubs/Labs. 2. Entrepreneurial Education - the development of entrepreneurial competences; Entrepreneurial HUBs; Startup Garage.

An initiative of the European Commission, a DG Education and Culture and of the OECD LEED Forum, supported by a group of six independent experts is HEInnovate (2011). It is a free instrument of de self- assessment for all the types of higher education institutions. In Romania, the HEInnovate exercise will focus on 3 main dimensions:

- Entrepreneurial Teaching and Learning;
- Preparing and Supporting Entrepreneurs;
- Knowledge Exchange and Collaboration.

Moreover, the European Commission created in 2008 the European Institute of Innovation and Technology (EIT) and organized the Conference of European Schools for Advanced Engineering Education and Research (CESAER).

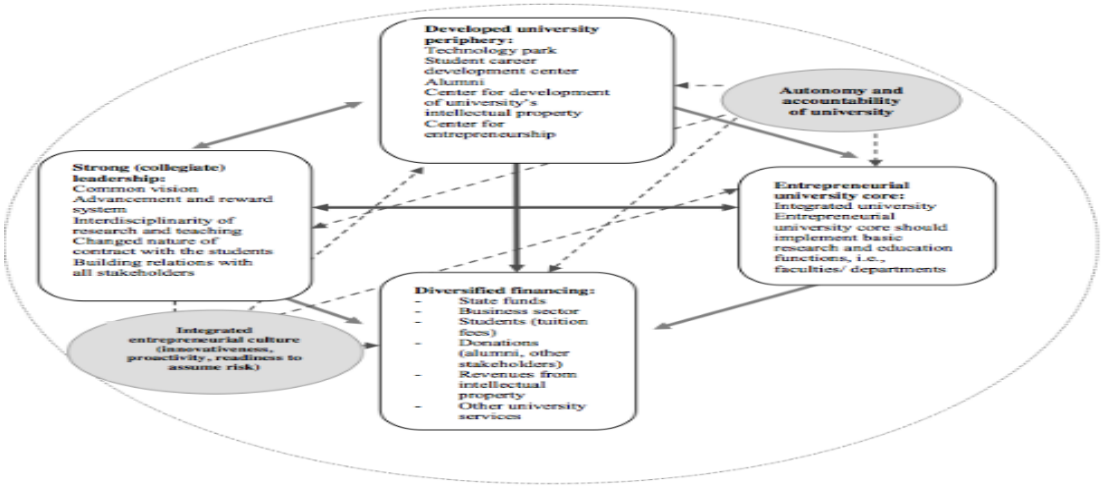



Figure 2 **Model of entrepreneurial university** (Oberman Peterka S, 2008)

In the communication of 2012, *Rethinking Education: Investing in skills for better socio-economic outcomes*, they focus on transversal competences and especially on entrepreneurial competences and they recommend: ”Member States should foster entrepreneurial skills through new and creative ways of teaching and learning from primary school onwards, alongside a focus from secondary to higher education on the opportunity of business creation as a career destination. Real world experience, through problem-based learning and enterprise links, should be embedded across all disciplines and tailored to all levels of education. All young people should benefit from at least one practical entrepreneurial experience before leaving compulsory education.” (COM, 2012, p. 4).

In "Entrepreneurship 2020. Action Plan” about the re-launching of the entrepreneurial spirit in Europe, it is mentioned that ”business and entrepreneurial aptitudes and skills are key competences for lifelong learning and that, in response to low economic growth and high unemployment, more decisive short-term and medium-term measures are needed to promote and enable entrepreneurship, especially among young people (COM, 2013).

At the level of USAMV Iași was established Entrepreneurial School to Support Innovative Business Initiatives for Students (SASIASI), in several projects FDI (2019), that aims at ensuring quality and at increasing the graduates' competitiveness on the labour market by developing competences and aptitudes with entrepreneurial character (http://sas-usamviasi.ro/). A Centre of Entrepreneurial Training was established at USAMV Iași. There were different activities with nonformal character in the development of entrepreneurial competences: theme conferences, workshops, meetings with successful business people, visits at farms and firms with agricultural character (ROSE project), internships, contests, microproduction workshops at USAMV Iași, the elaboration of business plans etc. The academic teaching staff will attend the postuniversitary course organized by us: ”Entrepreneurial Education - theoretical and practical innovative approaches”. There are several prestige universities: Foster School of Business- University of Washington; H. Wayne Huizenga College of Business & Entrepreneurship- Nova Southeastern University Florida; College of Business- Iowa State University, College of Business, Fort Collins- Colorado State University, Hong Kong, Minor Agribusiness Entrepreneurship- McGill University and Texas University and others) where there are student courses that have nonformal character and that are

correlated to the formal curriculum. These offers of nonformal entrepreneurial training are called **curriculum minor**.

## CONCLUSIONS

1. The systemic-cybernetic approach to the educational process is the paradigm that wants to highlight the complexity of this process and feedback mechanisms to ensure its efficient functioning.
2. The university must rethink its role and place in the dynamics of a society characterized by rapid changes, increasing globalization but also more and more complex economic socio-cultural relations.
3. More than ever, the universities especially the technical ones, must develop as entrepreneurial universities.
4. The coherence of the nonformal entrepreneurial curriculum with formal structures.
5. The acknowledgement and the validation of the nonformal experience of entrepreneurial type.
6. By promoting a pragmatic vision, the universities nowadays must prepare the youth to be agents of entrepreneurship at the micro level, but also at the macro level.

## ACKNOWLEGMENTS

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## REFERENCES

**Bruggen J.C van, 1992** - *Institutions for Curriculum Development and Educational Research*, in 7th CODIESEE Consultation Meeting "Curriculum Development in Europe: Strategies and Organisation", Bucharest, 1-5 June 1992.

**Comisia Europeană, DG Întreprinderi și Industrie, 2013** - *Educația antreprenorială: Ghidul formatorilor.* **Commission of the European Communities, 2003-**The role of the universities in the Europe of knowledge. Communication from the Commission, COM 2003/58. Brussels: CEC.

**Communication From The Commission To The European Parliament, The Council, The European Economic And Social Committee And The Committee Of The Regions, 2013 -** ENTREPRENEURSHIP 2020 ACTION PLAN, Brussels, 9.1.2013 COM(2012) 795.

**Etzkowitz, H., Leydesdorff, L., 1999 -** *The future location of research and technology transfer*. Journal of Technology Transfer, Summer.

**European Commission/ EACEA/ Eurydice, 2016** - Entrepreneurship Education at School in Europe. Eurydice Report. Luxembourg: Publications Office of the European Union.

**European Parliament resolution of 21 November 2013 on the Entrepreneurship 2020 action plan – Reigniting the entrepreneurial spirit in Europe (2013/2532(RSP)).**

**European Commission, 2012 -** Communication From The Commission To The European Parliament, The Council, The European Economic And Social Committee And The Committee Of The Regions, *Rethinking Education: Investing in skills for better socio-economic outcomes*, Strasbourg, 20.11.2012 COM(2012) 669 final.

**European Parliament and of the Council of 18 December 2006 -** Recommendation 2006/962/EC of the on key competences for lifelong learning (OJ L 394, 30.12.2006, pp. 10-18).

**Gjerding A.N.; Wilderom V.P.M. ; Cameron S.P.B.; Taylor A., Scheunert K.J., 2006 -** *Twenty Practices of an Entrepreneurial University*, Higher Education Management and Policy, OECD Publishing, 18(3):1-28.

**Jessop B., 2017 -** *Varieties of academic capitalism and entrepreneurial universities On past research and three thought experiments*, High Educ, 73:853–870.

**Jonnaert et al, 2009 -** *Curriculum et compétences*, De Boeck Université, Bruxelles.

**Jonnaert Ph., 2015 -** *Guide pour l'élaboration d'un programme éducatif dans la perspective de développement de compétences par les apprenantes et les apprenants*. Genè: Bureau International de l'Éducation de l'UNESCO (BIE)/ Montréal: Chaire UNESCO de Développement curriculaire.

**Kuhn Th., 2008 -** *Structura revoluțiilor științifice.* București : Ed. Humanitas**.**

**Oberman Peterka S., 2008 -** *Entrepreneurial universities in a function of effective dissemination of intelectual property of universities*, doctoral theses, J.J. Strossmayer University in Osijek, Faculty of Economics in Osijek.

**O'Connor A., 2013 -** *A conceptual framework for entrepreneurship education policy: Meeting government and economic purposes*, Journal of Business Venturing, 28:546–563.

**Pinar W. E, Reynolds, W. M., Slattery, P.,Taubman, P. M., 1995 -** *Understanding curriculum: An introduction to the study of historical and contemporary curriculum discourses*. New York: Peter Lang.

**Rassekh Sh.,, Văideanu Ge., 1987** - *Les contenus de l'éducation*, Paris : UNESCO.

**Slaughter S. & Leslie L. L., 1997 -** *Academic Capitalism. Politics, Policies And The Entrepreneurial University*, Baltimore, MD: Johns Hopkins University Press.

**Solomon G., 2007 -** *An examination of entrepreneurship education in the United States*. Journal of Small Business and Enterprise Development*, 14*:168–182**.**

**Stanciu M., 2003 -** *Introducere în pedagogie*, Iași: Editura ”Ion Ionescu de la Brad”.

**Stanciu M.,2018 -** *Teoria și metodologia curriculumului: Reconceptualizări*, Iași: Editura ”Ion Ionescu de la Brad”

# THE DEVELOPMENT AND DIVERSIFICATION OF THE RURAL ECONOMY BY FINANCING THE TOURISM PROJECTS

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**Abstract**

By this paper we plan to reconsider the touristic values by multiple perspective - economic, social, ecological - given that at national level were implemented many projects in the tourism area, some of which are strategic and of very large amplitude, with significant impact on the economic development in the rural areas. To this end, we take into account the issue of the rural economy development through value awareness and highlighting the programs for financing the tourism projects in the last 10 years for the North-East Development Region. The research, theoretical-empirical, is based on thematic description, analysis and synthesis. It considers the basic indicators of the rural economy development for the analyzed region and it concludes about the progresses obtained towards the diversification of the rural economy and the tourism contribution to this progress. The main result of the paper is highlighted by a dashboard built on the basis of the indicators that allow the quantification of the progress obtained in the rural areas through the economic diversification determined by projects funded in tourism. A main conclusion of the study is that, undoubtedly, a tourism project is a notable determinant of the economic development, with multiplier effects beneficial to the rural environment where was implemented.

**Key words**: rural economy, tourism, financing, projects

The large-scale topic of rural economy which attracts continuous interest from both the research environment and investment environment, has acquired a new growth perspective against the backdrop of the appearance of the financing opportunities specific to the rural environment. The non-reimbursable European financing programs have proven to be a particular opportunity of reorientation towards the rural economy and the recognition of its contribution to the economic growth as a whole. The need to support and develop the rural economy has been recognized at the practical level of financing the implemented projects exclusively in the rural areas or having an impact on the rural environment. The financing trends of the projects supporting the rural environment are connected to the need of diversification and development of the rural economy.

As a tertiary component of the economic environment, tourism proves to be more and more attractive for the rural investments, most likely as a consequence of the social changes based on the relationship urban-rural in the context of the technological and social progress performed in an accelerated manner.

Considered as less developed, the North-East Development Region has benefited from major investment projects by means of non-reimbursable European financing funds for almost all the fields associated to the economic development. The projects implemented in this region have triggered significant changes of the rural-urban approach and more particularly, they have had an essential contribution to the development of the rural economy in the region analyzed. Of these fields of interest for which financing projects have been initiated, submitted and implemented, tourism has represented a very attractive sector for these types of investment.

Tourism, perceived as a contributing factor to the economic growth of a region, currently holds sustainability trends, while 9the touristic development strategies and projects are in agreement with the sustainable development strategies - Horizon 2030. This modern and current aspect requires simultaneously, responsibility, commitment towards natural resources and social involvement in the touristic growth actions. The effects of such an approach are translated into a healthy and viable economic growth.

The projects implemented for the support and boost of tourism, with a favorable impact on

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rural economy, could not have been implemented without the existence of certain promotion policies of sustainable development such as: stakeholder's involvement, local development plans and considerable investments to reach the objectives which indicate the economic viability of the touristic sector.

## MATERIAL AND METHOD

The documentation pertaining to the research of this paper takes into consideration a set of basic, correlated elements: the topic of the rural economy, the development of tourism under sustainability conditions, non-reimbursable financing through European projects.

The World Tourism Organization (WTO), the Tourism Council (WTTC) and the Earth Council (EC) consider that sustainable tourism is a new form of tourism which "leads to the management of all resources so that economic, social and esthetic needs must be met, maintaining at the same time the cultural integrity, the essential ecological processes, the biological diversity and the support systems of life" (Coast Learn, Sustainable Tourism)

The Regional Operational Program and the National Program for Rural Development are the most significant for the financing of rural economy. By means of the priority axes and the measures aimed by these programs, the touristic sector benefits from considerable funding, such as the ROP 2014-2020, Priority Axis 7 "Diversification of local economies through the sustainable development of tourism" with 118.9 million Euros and Priority Axis 5 "Conservation, protection and sustainable valorization of the cultural heritage" with 466.5 million Euros (ROP, 2014-2020).

The rural economy, as a vital component of the national economy, produces added value and is a source of economic and social welfare for the entire population. It brings to life traditional products with a high valorization level on an increasingly growing market. These products must be continuously supported as a growth solution for the competitiveness of the agricultural sector (North-East Agency for Regional Development, 2007). The food industry creates jobs and has a wide range of opportunities to capitalize on the diversity of raw materials and human resources, while significantly contributing to the maintenance of the population's health state (North-East Agency for Regional Development, 2007).

The North-East Development Region, strongly influenced by the state of the rural economy, is prevalently agricultural and has a diverse natural and cultural heritage, mostly in a good state of conservation. The rural tourism is a viable alternative for the diversification of activities and increase in the life quality for the rural population.

The research methodology for the current paper is based on a chronological approach and data analysis. Statistical information and data taken from the implementation reports of non-reimbursable European funded projects are used. The research methods used are the analysis, selection and synthesis, completed with the observations of the progress made after the implementation of tourism projects in the North-East Region. The information sources are: reports, data, information of the Ministry of European Funds, Ministry of Regional Development and Public Administration, Agency for the North-East Regional Development, other institutions and agencies representative in this region. We also took into account the information of the studies and research which highlighted the dynamics of the rural economy in the region under analysis.

The paper has more of a practical touch, through the synthetic presentation of the impact results of the funded tourism projects and highlights the influence the financing of the touristic sector has on the rural economy.

## RESULTS AND DISCUSSIONS

At national level and implicitly at the level of the North-East Development Region, it became obvious that the tourism growth, through the implementation of large-scale projects, as well as through smaller projects, has a beneficial impact on the stimulation of the economic dynamics and insurance of the population's welfare. In this regard, it can be noticed the public involvement and that of economic agents in projects which prove to be exciting, influencing factors of the economic activities in the areas where tourism gets a facelift.

Based on the existing infrastructure and of its touristic heritage, the North-East Development Region has witnessed projects meant to valorize and capitalize on the already existing heritage basis. Among the main objectives which represented the common support of the funded tourism projects in the areas having a development potential of the rural economy one can count:

- the development of the sectors specific to the regional economy connected to the tourism sector;
- the maximization of the local incomes from tourism investments.

The most representative period when the results of the implementation of touristic financed projects with a very favorable impact on the rural economy growth are highly visible is the one covering the accession to the non-reimbursable European funds from 2007-2013, continued with the period 2014-2020. The main funds for the development of the touristic sector in the region

analyzed in the last 10 years have been obtained through the programs:
1. The Regional Operational Program 2007-2013 with the Priority Axis 1 "Support of the sustainable development of cities – urban pillars of growth", Priority Axis 5 "Sustainable Development and tourism promotion".
2. The National Program for Rural Development 2007-2013 with the Axis 3 "Life quality and diversification of rural economy" and Measure 313 "Encouragement of touristic activities".

These programs enabled investments in projects of valorization of the natural and anthropic potential in the North-East Development Region: accommodation infrastructure, recreational areas and/or spa treatment centers, adventure parks, renovation/modernization of religious places, etc. A synthesis of the main categories of investments made in the touristic development projects is presented in *table 1*.

Table 1

**Investment categories in the touristic projects implemented in the North-East Development Region**

| Category | Non-reimbursable financing value | % of total |
|---|---|---|
| Investments in touristic accommodation places | 78 109 990 € | 41% |
| Investments in touristic information centers | 4 511 536 € | 2% |
| Public investments in touristic infrastructure | 100 260 792 € | 53% |
| Private investments in touristic infrastructure | 8 293 232 € | 4% |
| TOTAL | 191 175 550 € | 100% |

Source: *Database of the Agency for the Financing of Rural Investments and of the Agency for the North-East Development Region*

In this region, 211 touristic accommodation units were built, for a total amount of 78109990 €, most of the investment projects of this type being located in the Suceava county, 118 accommodation units, while the fewest are in Botoșani and Vaslui (7 and 6 accommodation units, respectively). The Suceava county attracted 35% of the investments in touristic/agricultural guest houses as well as in extended/renovated hotel structures (29399795 €), while in the Neamț county, the value of these funds was 27258740 €.

Other investment components which determined the stimulation of the rural economy in the North-East Development Region are the reintroduction in the touristic circuit of the cultural heritage places and the development of the recreational areas. Of the total of these investments, 32% were performed in the Suceava county, where the projects with the highest value are the following: "A heritage building - a museum for the III$^{rd}$ millennium" - the Bukovina Museum. With a non-reimbursable financing of 9600526 € and "The Rehabilitation of the Throne Fortress of Suceava and of its protected area", a project with a non-reimbursable financing worth of 7802359 €. In the cities of Gura Humorului and Vatra Dorne i, alongside the neighboring villages and communes, projects with a very favorable impact on the economy and the local communities were implemented. In the Iași county, 29% of the total non-reimbursable funds were attracted from the program POR 2007-2013 for the touristic field in the North-East Development Region, while the project which benefited from the highest amount (10724005 €) is "The touristic valorization of the Metropolitan ensemble from Iași". In the Bacău county, 16% of the total touristic investments were attracted, in a total amount of 15963791 €. One of the most attractive projects implemented is "Ski Park Slănic Moldova".

66% of the non-reimbursable investments in private touristic infrastructures, totaling 5518967 €, are in the Suceava county and were focused prevalently in recreational areas. For the Iași county, the value invested is 1297553 €, which is 16% of the total investments of this type in the analyzed region. With a total value of the non-reimbursable funds invested of 985094 €, the Neamț county attracted 12% of the private investments in tourism in the region analyzed.

The highest value of the non-reimbursable financings performed in the North-East Development Region in the field of tourism starting with the year 2007 can be found in the public investments in touristic infrastructure. These represent 53% of the total amount invested in the touristic sector through the access to European funding by means of the Regional Operational Program 2007-2013 and the National Program for Rural Development 2007-2013. The investments in the touristic accommodation units represent 41% of the total amount of non-reimbursable financing dedicated to tourism investments in the North-East Development Region (the period 2007-2015). The private investments attracted 4% for the touristic infrastructure and 2% for the establishment of tourism information centers. Among the most significant projects in the tourism sector implemented in the region analyzed we can mention: "The consolidation, restauration and conservation of the church St. Ilie" Șcheia Commune, Suceava county (20268637.83 lei), "The restauration of the cultural heritage of the Secu Monastery, Neamț county (14036331.03 lei). In addition, there are other important cultural and religious projects such as "Gura Humorului - an active city with green areas" (21343406.83 lei), "The establishment of the recreational area Nada

Florilor, Fălticeni" (6223039.20 lei), "The recreational area Trotuș" (9442952.16 lei), "The recreational area Cacica" (5354787.00 lei), "Building of the recreational center Popasul Domnesc" - Suceava (4570141.80 lei). Until now, the implementation reports concluded are for the financing period 2007- 2013, while for the period 2014-2020, these are in progress, because some of the projects have been submitted starting with the year 2017 and are under implementation.

## CONCLUSIONS

The most significant investments for the tourism development, performed by means of non-reimbursable financing European projects in the analyzed region, were in the accommodation, recreational centers and spa treatment centers, cultural and historical monuments, places of religious worship and tourism information centers. Through their large-scale value and number, the projects have influenced the main components of the rural economy thus proving that tourism is a driver of economic growth in the rural area. The North-East Development Region distinguishes itself through the valuable touristic potential whose support for development is a guaranteed alternative for the revival of the less developed areas. The fields of the rural economy which benefited from the revival by means of the implementation of touristic projects in the North-East Development Region are: small industries, entrepreneurship boost, commerce, rural crediting, sustainable management of natural resources, occupational level and increase in the number of jobs, increase in the life quality and inhabitants' income, reduction of poverty risks, etc. All these enabled the harmonious blend of the sustainable development goals with the economic growth and rural economy development, the remediation of the economic and social problems in the disadvantaged areas, the change of mentality regarding the value of the rural environment. The economic indicators of the rural economy growth which justify the qualitative results through a qualitative approach are: the rural population structure, the labor force, the occupied population by fields of activity, incomes, poverty. The most significant impact results of the funded projects in the tourism sector on the rural economy are the following: the creation of jobs, the stimulation of the food and agricultural production, the involvement and revival of the crafts and arts, the promotion of traditional products, the foundation of small industrial processing units for agricultural and food products, the stimulation of ecological production, the reconversion and reuse of depleted soils, the ecological revival, etc. As a consequence, the stimulation of the rural development through the conservation and valorization of the touristic heritage is one way to support the sustainable development goals. The results worth mentioning are: the increase in the tourists' interest, the valorization of local resources and traditions, the complex valorization of the touristic potential, the assignment of new socio-economic meanings, etc. All these contribute to the development of the rural economy in the North-East Development Region and, prevalently, to the increase in the life quality of the region's inhabitants.

## REFERENCES

**Agency for the Financing of Rural Investments and of the Agency for the North-East Development Region.** *The database for the 2007-2013 period.*

**Coast Learn,** *Sustainable Tourism. On-line courses.* https://www.biodiversity.ru/coastlearn/tourism-eng/con_tourism.html

**InfoRegio Nord-Est**, *The projects situation*, http://www.inforegionordest.ro/situatie-proiecte.

**InfoRegio Nord-Est**, *Projects of the North-East Region*, http://www.inforegionordest.ro/proiecte/index.php?option=com_gmapfp&view=gmapfp&layout=default&id_perso=0&Itemid=59&limitstart=8

**National Institute of Statistics**. *National Statistical Program – 2019,* https://insse.ro/cms/files/legislatie/Initiative%20legislative/2019/PSNA_2019.pdf

**North East Agency for Regional Development.** *Regional Plan for Action for Tourism in North-East, 2007-2013.* December 2007

**POR 2014-2020 Program.** Regional Development. https://www.fonduri-ue.ro/por-2014

**The Management Authority for NPRD. Ministry of the Agriculture and Rural Development**, **2013.** *The social-economic analysis from the perspective of the rural development,* 2014-2020. http://www.madr.ro/docs/dezvoltare-rurala/programare-2014-2020/analiza-dezvoltarii-rurale-agricultura-iulie-2013.pdf

# RESEARCHES ON LEADERSHIP ABILITIES PROJECTION

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**Abstract**

Without any doubt, through their behaviour, leaders have a major impact on people, culture, society, but not least on the performance of an organization. All programes that require organizational changes start from the premises of first understanding the fact that the influence of people that hold the authority is vital for the company's succes. At the level of an organization, leadership development starts by first making an evaluation plan on all its levels. It is of extreme importance starting with a research-action approach, so as to be able to project leadership skills and ways they can be improved. Research – based actions use the gathered data to involve every person in the organization and understand its role (testing phase) and then project practical actions throughout awareness, acceptance and actios, and finally changes, that are recommended to the superior management (the action phase). The present analysis aims to highlight the importance of projections that are made on a research basis and conduct to efficiency and productivity in a proactively way. Projecting leadership abilities in a company influences the entire organization, from an individual person to a group and finally to the entire organization. The paper also focuses on showing how internal personal changes can influence the whole sistem, make it sensitive to external changes and able to quickly adapt.

**Key words**: leadership, projection, organizational performance

The food sector in Romania is a highly diverse one, from research and development companies to local producers, from household subsistence agriculture to food holdings with highly technologised equipment, from small shops to small and medium-size enterprises and multinational corporations, and gathers two economic elements: agriculture and food industry.

The agricultural production sector is particularly significant and extensive, as an important share of the population works in agriculture or areas related to it. In 2018, over 19% of the force labour was connected to agriculture, forestry and fisheries. (National Institute of Statistics, 2019).

Given these reasons, in order to reach a coherent management and increase the productivity of a farm, it is necesary to analyze and improve leadership skills and adapt them to the particularities of the people and the proceses involved in it. The present paper aims to highlight the importance of projections made after a previous research basis, so as decisions to be taken eficiently, proactively and productivly. Projecting leadership abilities in a company influences the entire organization, leading to correct and coherent management decisions. The paper analyses an agricultural unit in Neamț county regarding on the premises of leadership development and how projections influence a whole system, making it sensitive and adaptable to external development.

With an activity of almost 30 years based on a vertically developed system, TCE 3Brazi Group can be considered an integrated unit because of the variety of its activities: TCE 3Brazi, that in 2018 expoited 6.187 ha of arable land, TCE Boviselect that manages milk and milk cows, bulls, pigs and sheep, TCE Agrosuind that manages processing and selling cereals and animal-origin products, TCE Petroforest that manages wood exploitation, TCE Compil Impex that manages heavy industry, TCE Umaro that produces carousel lathes, TCE Mobile Dryers that sells plant protection products and TCE Durău, with tourism.

## MATERIAL AND METHOD

The methodological and scientific support in this paper was developed on a series of direct and indirect documentation, such as observation, analysis, synthesis, and complex exposure on the data gathered from the studied unit. Also, a questionnaire was applied on workers and executive staff, in order to collect and analize specific data, so as to have a complex and accurate situation of the unit. The theoretical

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support of this paper consisted of important scientific works in the field of leadership and management.

## RESULTS AND DISCUSSIONS

TCE Boviselect is representative for the milk and dairy products branch since its establisment in 2008 and is specialized on raising animals for milk and meat, producing and selling frozen seminal material, producing and selling dairy products through its own factory, with a 10 000 l/day processing capacity. The factory is located in Zăneşti, two km away from the animal farm, for an optimum efficiency. The dimension of the unit is moderate, as it had in 2018 a capacity of 3.05 thousand hectolitres, from a total of 1415 thousand hectolitres processed in the county, and has four animal production sectors and a processing sector. The products they offer are diverse, adjusted to the market trends, and they total 15 finite products from 8 groups of aliments, sold in a chain of 10 own shops in Moldova area.

TCE Boviselect has now 57 employees and works on a simple, balanced organizational structure, with a reduced number of formal connexions, so as atributions are clearly assumed and fulfilled. The organizational structure as a whole must satisfy technical production standards, economic and management requests and contribute to an efficient use of its resources.

Practising leadership does not depend on the hierarchic position or the job inside the organization, but on trust and relationship between people. For this reason, leadership skills development can be acomplished by each employee. In this specific unit, afer analyzing its organizational structure, we can state the fact that leadership can be identified and implemented in each department, as the hierarchic liability is made directly to the superior level, enhancing free initiative inside the group, making team work more efficient and optimizing the time.

At TCE Boviselect, the management and executive jobs are well-defined, yet here has not been a clear assignment on responsibilities and competences needed in order to acomplish individual tasks and goals. That can be a limiting factor for leadership skills improvement. The fact that individual goals are not specifically set can generate ambiguity, confusion and gaps in communication, affecting the unit's operational ability and signaling the fact that there can be some organizatoric elements to be optimized. A good communication requires feed-back and confirmation that the messages were well comprehended, and also a good feed-back must come in optimum time.

Within the studied unit, the questionnaire revealed important data to use in projecting strategies for enhancing leadership and satisfaction for all involved. Results on employee motivation level show that subordinates are passive to the company's non-financial, modern techiques, lack motivation and have little productivity, and would be more stimulated by financial ones, fact that sustains the need of an investigation first, before applying any method. Executives here show bigger motivation to non-financial factors, given probably to their level of study . In what concerns financial motivation factors at the studied unit, reasearch showed that both subordinates and executives consider financiar motivation as the most important stimulus they respond to. The main disadvantage of that is reduced posibilities of leadership skills development, as these are generally discovered and developed by non-financial motivational methods.

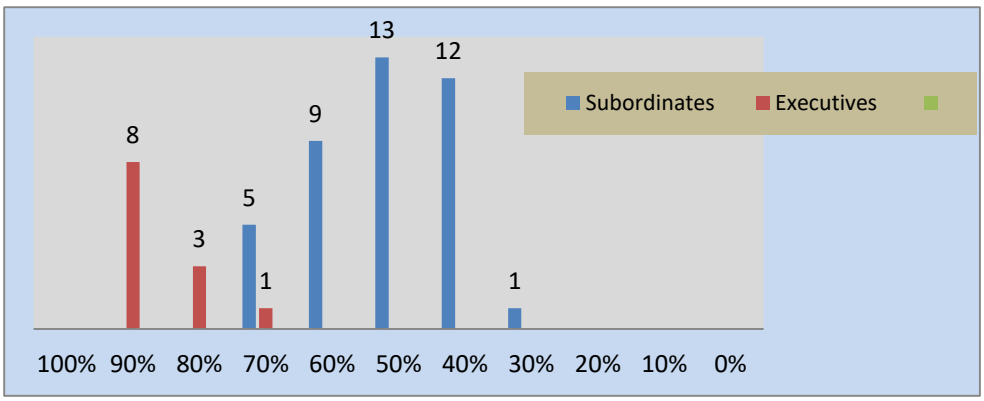



Figure 1 **Employee satisfaction at TCE Boviselect**

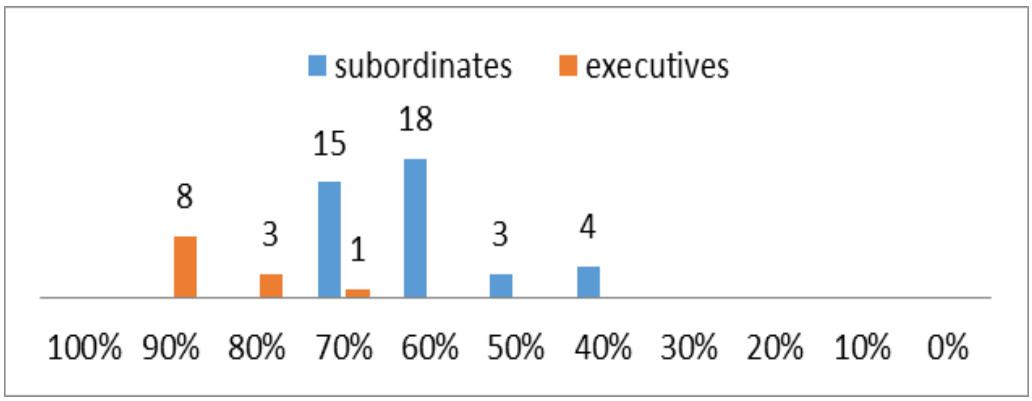



Figure 2 **Financial motivation on employees**

Another aspect that has been researched was the way employees rate increases, additions, earnings split, commissions and bonuses as types of financial motivation. The data indicates that people generally prefer bonuses, as this work area needs shifts on Saturdays, Sundays or legal holidays. Executives prefer, on the other hand, commissions and bonuses, altough most of them are rewarded for their performance in bonuses, not commissions, depending on their results.

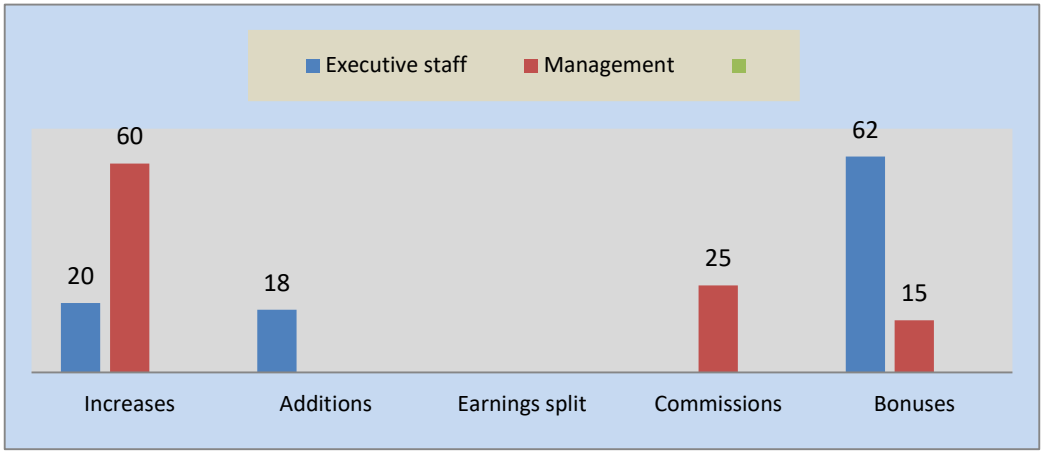



Figure 3 **Rating of financial stimuli on executive and management members**

The last thing that was investigated was to identify if delegating power and sharing authority with subordinates is a motivating factor. This method of delegating power is a top management factor that helps identifying and improving leadership skills in the studied unit, as it offers employees confidence and creates premises to enhance creativity and team spirit. On the other hand, workers don't see this as a key factor, leading us to the conclusion that financial motivating techniques are more appreciated.

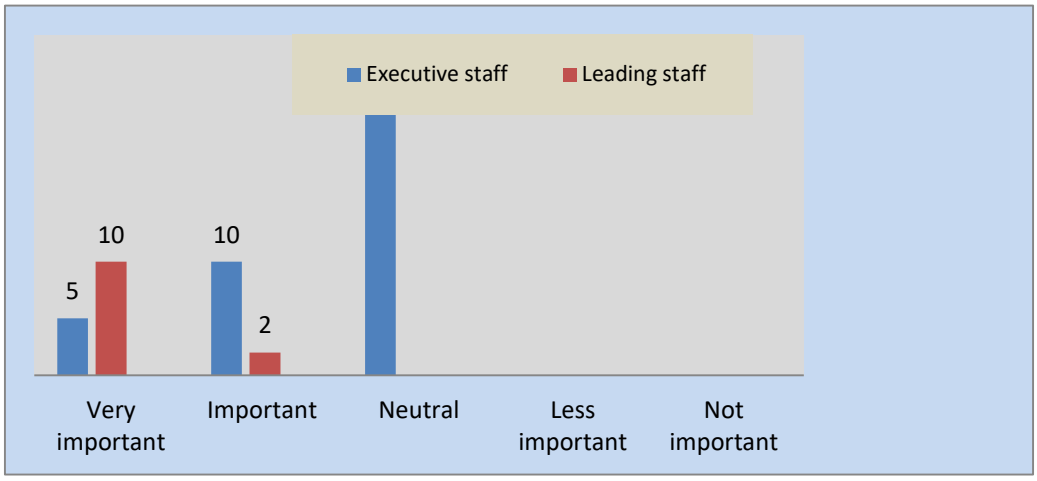



Figure 4 **The importance of delegating power to employees**

Situational leadership is a simple but practical model that helps managers diagnose the needs of every employee and provide with custom-aproach for each person involved. The manager identifies the four levels of development, from enthusiastic beginner (D1) to independent profesionist (D4), and the way to apply directive behaviours and encouragement needed for every team member, from directive (S1) to delegative (S4).

On the other hand, tribal leadership is a second good way of improving management and leadership in the studied unit. This method sees the development of an organization as life inside a tribe or a comunity. Although people are different, the main picture always looks the same.

This method of leadership development sets 5 stages and sees organization as a tribe or a comunity, seeizing the idea that although people are different and unique, the main picture always looks the same.

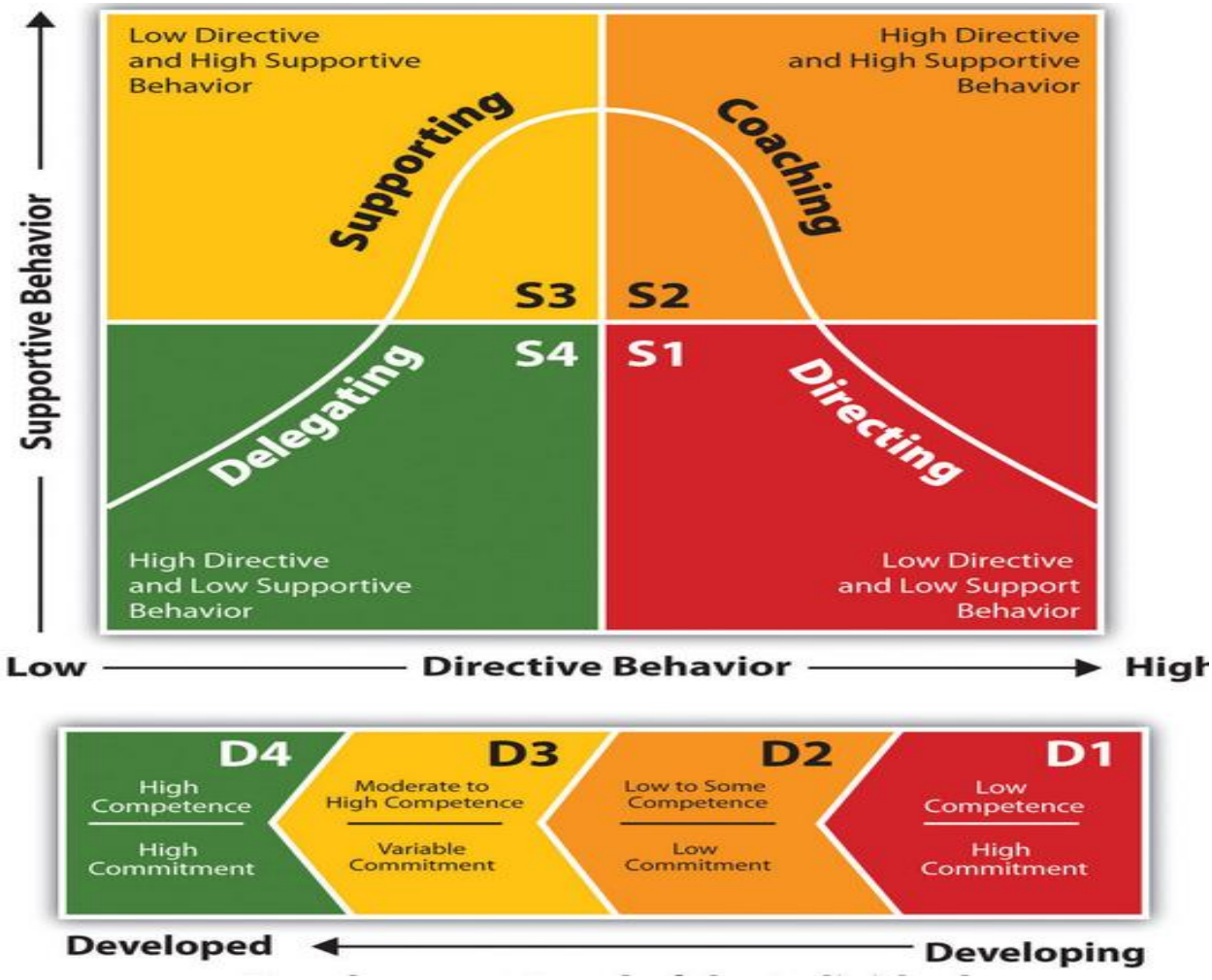



Figure 5 **Situational leadership**

At stage 1, the organization is associated with a furious criminal gang of hostile and depressed people. Fortunatelly, this stage is extremely rare to be found in organizations.

In stage 2, people victimize themselves and feel resignation, apathy and cynism, reject all that comes from the management. Productivity of the people is very low, new ideas are blured by pasivity and very few are taken into consideration.

Stage 3 is a stage of intern rivalries. Employees use every mean to win power or to win a battle. People that stage here rarely get satisfaction from their work and only involve superficially in the organization.

Stage 4 represents a real progress for the good functioning of the organization, as it represents passing from ”I” to ”we”. People cooperate and are glad to interact, have a strong feeling of belonging, the leader feels supported and pushed behind by the group.

Stage 5 groups rarely appear in organizations; their target is to write history, not to become number 1 on a market or to beat competition. After reaching a great accomplisment, these groups go back to stage 4 and prepare for a new goal.

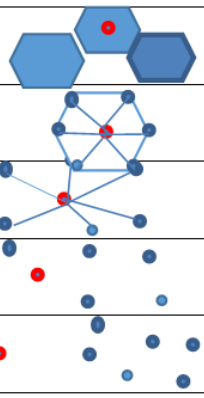
| | | | |
|---|---|---|---|
| STAGE 5 | TEAM WORK | TEAM CREATIVITY |  |
| STAGE 4 | ASSOCIACION | MUTUAL SUPPORT | |
| STAGE 3 | INDIVIDUALITY | RIVALS | |
| STAGE 2 | SEPARATION | LACK OF INTEREST | |
| STAGE 1 | LONELINESS | HOSTILITY TO ALL MESSAGES | |

Figure 6 **Tribal leadership**

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## CONCLUSSIONS

Projecting methods that can develop leadership skills needs individual, group and organizational adjustments, and also an improvement of the organizational way of responding to external factors. It involves intern capabilities improvement to assure a deep motivation, so as employees can work at their full potential.

Managers must identify the reasons why employees feel no or little motivation and see how important financial or non-financial stimuli are, to project proper solutions for the unit. More concern should come for communication between management and subordinates, to identify needs and orientate on solutions.

The structures of the organization, the human resources sistems, the jobs, the communication network and leadership management processes must all be part of a dynamic, flexible system. As different situations occur, we can sugest two approches that can be useful: situational leadership and tribal leadership.

## REFERENCES

**Brezuleanu S., Robu A.D., Viziteu Șt., 2017** - *Managementul și planificarea proiectelor în agricultură,* ”Ion Ionescu de la Brad” Publishing House, Iași.

**Brezuleanu S., 2008** - *Sisteme de producție în agricultură,* Alfa Publishing House, Iași.

**Brezuleanu S., 2009** - *Management în agricultură*, Tehnopress Publishing House, Iași.

**Ștefan G., 2007** - *Economia și filiera produselor agroalimentare,* Alfa Publishing House, Iași.

**Gorton M., Davidova S., 2004** - *Farm productivity and efficiency in the CEE applicant countries: a synthesis of result*, Agricultural Economics, 30: 1-17.

**Kneafsey M., 2001 -** *Rural economy: tourism and social relations,* Ann. Tour. Res. 28, pp. 761-782.

****-National Institute of Statistics*, *2019, Romanian Statistical* Yearbook *for 1991*

****-Agency for Payments and Intervention in Agriculture-* APIA, 2019, Yearly reports on agricultural areas

# EVOLUTION OF THE DROUGHT PHENOMENON IN THE REPUBLIC OF OF MOLDOVA - CONSEQUENCES, LOSSES AND ECONOMIC FLOATING

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**Abstract**

Natural risks have been and are for agriculture the negative factor, which needs to be taken into account in the development of the agricultural sector. Due to the fact that the Republic of Moldova is located in a climatic zone with insufficient humidity, it is periodically subject to the influence of particularly strong droughts. Droughts in recent years confirm the insufficient level of adaptation of agriculture in the Republic of Moldova to drought conditions, which more and more frequently and with increased intensity, especially in recent years, affect the agricultural sector. This article provides a brief analysis of the general synoptic mechanism of drought genesis in the Republic of Moldova, types of drought, economic impact, probability of occurrence, drought register for the period of X-XXI centuries. The authors emphasize from the beginning the great variety of dangers that appeared in this territory, giving us concrete data and examples. Also in this paper is described the fact that out of all the dangers appeared on the territory of the Republic of Moldova, as well as all over the world, drought prevails, caused by climate change. The completion of the drought register by 2020 indicates a general trend of increasing the frequency of their production, due to the anthropogenic impact on the environment and regional and global climate change. Through this work, the author makes a modest contribution to the study of natural hazards in the Republic of Moldova, with a great destructive potential and which can cause extremely great damage to the economy and the national environment. From this perspective, it is necessary for agricultural entities to analyze the probability of damage and their assessment, because the specifics of their field of activity, are environments in which the risk of drought can manifest itself, mainly. Thus, it becomes necessary to develop urgent as well as long-term measures to reduce the risk of drought.

**Key words**: agricultural sector, drought, economic impact, natural risk, soil moisture reserves

The basic process, related to the appearance of dry conditions is determined by the appearance on the territory of the Republic of Moldova, of the initially cold polar air, with a reduced amount of humidity. Penetrating further to southern latitudes, this air heats up and as the temperature rises in it, the saturation deficit increases, turning into a dry air mass. The deficit begins to be filled by soil moisture - thus intensifying the process of drought in the soil. Of great importance in the formation of dry conditions are the winds, which blow from eastern Eurasia and southeast (dry steppe wind), or that which forms in the cold, warming air (local dry wind).

Drought is a prolongation of insufficient rainfall and is a natural feature of the climate. It can occur in any climatic zone, but its characteristics can vary from one region to another. Drought is a temporary phenomenon (a year, two or three) and differs in terms of aridity. In ecological terms, drought is a dry period from which an ecosystem often recovers quickly after rains. Prolonged drought years eventually lead to desertification. Drying is a process as a result of intensified aridity.

Human activity, which includes deforestation, mismanagement of agriculture, improper irrigation, etc., are the main causes of desertification.

Drought produces a multitude of effects that harm different sectors of the economy. The effects of drought can be classified as: economic, social and environmental. Decreased crop productivity, forests, reduced water use, increased mortality rates, unsatisfactory health conditions are some of the characteristics of drought. Many of these factors lead to poor socio-economic conditions of the population, lead to large-scale migration on the one hand and ecological degradation of the environment on the other.

There are two ways to link drought and desertification. Droughts over several years lead to desertification. On the other hand, desertification has an effect on the climate and can cause droughts. The link between drought and desertification is so strong that it becomes almost

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impossible to separate the effects of drought from those of desertification, both processes often take place together.

The agrarian orientation of the economy of the Republic of Moldova conditions the high vulnerability of the economy due to meteorological and climatic factors. A considerable role is played by climate limiting factors, which have a direct influence on the ecological stability of agricultural crop varieties and species, largely determining the nature of annual crop changes. Most of the agricultural land in Moldova is located in the area of insufficient humidity. Droughts, which are reported in certain years, cause enormous damage to the country's agricultural production.

One of the cardinal geographical consequences of climate change may be an increase in the likelihood of climate extremes. This will undoubtedly lead to increasing economic losses and social conflicts in many regions of the world. Moreover, the extreme weather conditions, to which nature and society are less adapted, can be much more receptive to the changes that take place, than to the multiannual average climate, and the consequences of changing climate norms become unpredictable. In this context, changes in the extreme regime need to be seen as the main manifestation of current climate change (Alpatiev A. *et al*, 1958; Bucinschii I. 1957, 1976).

Of all the regions of the world that are more dependent on weather and climate are the arid and semi-arid regions. Namely in the semi-arid regions, to which a part of the southern territory of the republic belongs, the natural ecosystems are more vulnerable to the action of extreme climatic factors, and the degradation processes are destructive, contributing to desertification. Here, the balance of production and consumption often depends largely on the humidity regime, and in some years its deficit can be a serious problem for them. In the last 30 years, the problem of soil degradation in dry regions is becoming more acute. The United Nations Convention to Combat Desertification and Drought designates a qualitatively new conception of ecosystem management in arid, semi-arid - and no less important - regions for the management of sources of development assistance. In the past, arid and semi-arid lands easily regained their productivity after long droughts and dry periods. Under current conditions, they are rapidly losing their biological and economic productivity due to climate change and human activity. Currently, on all continents, also in the republic, there is soil degradation due to droughts due to overexploitation, grazing, deforestation and the use of inadequate irrigation methods. Such over-exploitation is linked to factors of an economic and social nature without adequate information.

According to existing estimates, climate zones with a higher probability of desertification and drought occupy about 47.5% of the land area, while 69% of these areas are already subject to desertification. 30% of the surface of irrigated lands are degraded, 47% - of non-irrigated sowings and 73% of pastures. More than 110 countries around the world have arid and semi-arid lands, threatened by desertification and drought (Ungureanu V. *et al*, 1995).

Droughts greatly affect the agriculture of the Republic of Moldova. They are part of dangerous natural phenomena, resulting in the destruction of agricultural crops over large areas. Droughts impoverish and pulverize the soil, which causes the destruction of its structure, the occurrence of wind erosion and the desertification process. Currently, the study of droughts and their prediction, the analysis of the genesis and the degree of repetition of the drought phenomenon are of major importance. Increasing the harvest of agricultural crops and productivity in the field of animal husbandry, the efficient use of water and land resources, are related to the study of natural climatic phenomena, including droughts, dry winds and desertification processes (Sofroni V. *et al*, 1994; Sofroni V. *et al*, 1999).

Although droughts can occur throughout the year, most occur in late summer and early fall. According to the intensity, there are several types of droughts (very strong, strong, moderate) (Lupaşcu M. 1999; Sofroni V. *et al*, 1999).

Very strong droughts are reported in the years when during the vegetation period precipitation falls less than 50% of the norm, and the average air temperature exceeds the climatic average by 3-4°C.

Strong droughts occur when the amount of precipitation is 60-70% of the norm, and the average air temperature during this period exceeds the norm by 2°C.

Moderate droughts are reported in those years when 70-80% of the precipitation rate falls, and the positive temperature anomaly is 1.0-1.5°C.

So, from the above, it can be concluded that the drought in Moldova is not a random phenomenon of nature, but it is a legality and therefore we must take into account its possible manifestations not episodically, but permanently, ahead of the onset. its destructive force. In this regard, it is necessary to restructure and adapt the existing system of agriculture of the Republic of Moldova to semi-arid conditions.

## MATERIAL AND METHOD

This study involves a rather complex environmental issue for the territory of the Republic of Moldova, in the context of global climate change. The research focused on the evaluation of the written sources and the archive data of the State Hydrometeorological Service. In terms of time, the information accumulated refers to the period of the tenth century and until today. The comparative analysis of the climatology works, drawn up in different periods, offers the possibility to highlight the dynamics of droughts on the territory of Moldova and the evolution of the geographical landscape towards a semi-arid one.

The mixed use of comparative, historical methods of analysis gave the opportunity to reveal the distinct features that characterize the current climate of the Republic of Moldova, viewed through its aspects of aridization (drought and desertification).

## RESULTS AND DISCUSSIONS

Using the climatological peculiarities of droughts, V. Potop (2012), identified periods of drought, based on hydrometeorological indices and maize harvest. All these served as a starting point for the elaboration of the register of droughts on the territory of the Republic of Moldova during the instrumental observations of the meteorological regime.

Droughts were assessed both for each season (spring, summer, autumn) and for the warm period of the year, based on the average values of temperature and precipitation recorded in the corresponding time period. According to the data obtained, it results that from the period under study the droughts were recorded in 36 years in the warm period, 35 years - in the spring season, 38 and 40 cases in the corresponding summer and autumn season. Of the total number of dry years in the warm period, over 60% of the years had a medium intensity - 14 and strong intensity - 10. Strong and very strong droughts are characteristic for all seasons of the warm period. Droughts in spring, summer and autumn are mainly strong droughts 15-20 cases, more rarely very strong droughts are recorded - in 3-11 years. In the summer months, droughts with strong intensity - 9 cases and very strong - 12 cases dominate. According to the register of very strong droughts in the summer season they became more frequent after the years 1950-1960. There has been a certain increase in the frequency of drought years since the 1960$^{s}$, reaching its maximum during the years 1981-1990, after the 1980$^{s}$ there is an increase in its intensity (Potop V. 2002).

The analysis of the probability of occurrence of droughts after V. Flood (Potop V. 2002), of different intensity showed that in the north of the republic in spring the probability of mild drought is 8% (once in 13 years), in summer the phenomenon is more frequent (once in 8 years), while autumn manifests itself once in 3 years. To the south, drought frequency indices change, in the center of the republic the probability of drought gradually increases for spring and summer up to 20% (once in 5 years), and autumn registers the same frequency as in northern Moldova, mild drought once in 3 years. In the south of the republic droughts of low intensity have a higher probability in spring - once in 4 years, and in summer once in 3 years and in autumn once in 2 years. Analysis of the time and space distribution of medium-intensity droughts indicates that they are subject to the same legalities as weak droughts. In the 3 areas they have a higher probability in the autumn season and especially in the south of the republic, where they can manifest once in 2 years. Strong droughts have a lower probability of manifestation: in the north of the republic once in 13 years in spring and once in 11 years in summer.

The frequency of 25% is manifested in autumn for the entire territory of the republic. The probability of manifesting a very strong drought is lower in northern Moldova, where spring can be once in 33 years, and in the central part gradually increases once every 14 years and 7 years in the south of the republic. For the drought the given intensity is 2% for the warm period of the year.

Based on the analysis of the materials according to the drought registers, performed by S.E. Bucinschi (1957, 1976), O.A. Drozdov (1980) and others, a selection of the dry years was made for the southwestern region of the Eastern European Plain, of which the Republic of Moldova is part, until 1944. Starting with 1945, the selection of these years of was made based on data from meteorological stations in the territory of the republic (until 2020, *figure 1*). For this, the monthly average of the air temperature, the monthly amount of atmospheric deposits and the deficit of air humidity were taken with the deviations from the norm (multiannual average) in each month of the current year, which allowed to appreciate the weather conditions. Since the tenth century, the number of droughts in the region has been steadily increasing, with the exception of the thirteenth and seventeenth centuries. Droughts have become more frequent in the last two centuries, especially in the twentieth century (Bucinschii I. 1957, 1976; Drozdov O. 1980).

*Figure 1* suggests the pace of drought development over the last millennium (994-2020).

The analysis of drought years by centuries, even for the last millennium, shows us that a strict periodicity of droughts in the sense of regular repetitions after a stable number of years, of course, is not. However, the systematization of droughts in the historical past is useful and necessary, as the accumulation of such information will succeed in more accurately concluding the manifestation of droughts in the territory of the republic.

The aridization of the land from the sec. twentieth century, is largely related to the anthropogenic impact on the environment, through the implementation of multiple technologies, irrational exploitation of natural resources, especially soil, forests, water and air basins, etc.

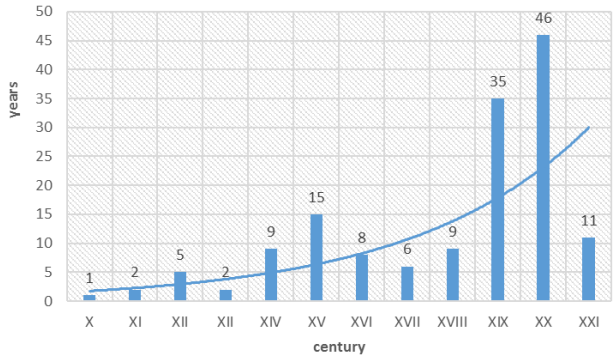



Figure 1 **Medium and strong droughts in the Eastern European Plain (number of years per century), including in the Republic of Moldova**

Generalizing the specifics of the cyclical development of temperature and deposition regimes, V. Proca (1983), determined the alternation of climatic rhythms. 0 heating was highlighted and comparatively a low regime of atmospheric deposits between 1860-1870 of 19th century. The yield of agricultural crops during this period was low. Between the years 1880-1890 of the 19th century, a new decrease in temperatures and an increase in the amount of atmospheric deposits developed. This period is characterized by a relatively cold and humid climate. The rhythm of the last ten years of the 19th century and the beginning of the 20th century was characterized by high temperatures and low deposits. After the 1911s, the rhythm began with low temperatures and high humidity. Since the late 1930s, the pace has developed with low temperatures and relatively low humidity. Small rivers flowed annually for a long time. The last rhythm of the twentieth century (conditioned in the mid-1950s by the accelerated development of the world economy), is characterized by a warm climate. The beginning of the 21st century (2001-2020) is characterized by quite warm summers and relatively cold winters (Proca V. 1983).

The analysis of the materials of the state Hydrometeorological service of the Republic of Moldova, from 1890-2020, indicates that during these years, annual droughts of different intensities were registered within 29 years (one in 6-7 years). If we consider that during this period there were also conditions close to drought, then we can mention that the aridity on the territory of the country appears once in three years. During this period there were also cases of biannual drought, when after a year of drought followed a year no less dry. Such droughts were nine in number: 1894-1895, 1923-1924, 1945-1946, 1999-2000, 2002-2003.

Droughts of three and four consecutive years 1923-1925 and 2017-2020 were also observed (***Arhiva de date climatologice; ***Arhiva de date agrometeorologice).

In the years of aridity, the conditions for the formation of agricultural crops are quite unfavorable, which leads to a decrease in fruit from 20 to 50% and more, depending on its intensity.

In addition to annual droughts, on the territory of the Republic of Moldova, there are also seasonal droughts (autumn, spring, summer), which lead to decreased productivity of one or several crops. The most common are autumn droughts. Their beginning coincides, as a rule, with the period of the second decade of September, and the duration oscillates within the limits of 25-35 days.

Summer droughts are rarer than autumn droughts and occur during the active vegetation period of all crops.

Spring droughts (April and May) occur less frequently than summer droughts.

The probability of occurrence of high intensity (catastrophic) droughts (<50% of the climatic norm of precipitation), in certain months of the vegetation period, is increasing from 11% to 41% (from a case in 9 years to a case in 2 years). The strong droughts of the autumn months (September-October) are well expressed in the annual process, and in the southern part of April.

In dry years, the hot and dry weather leads to the mass appearance of pests and diseases of agricultural crops, which in some places completely destroy the fruit. An unfavorable climatic factor for agricultural households, during spring and summer, apart from droughts and sometimes as a component of it, are dry and hot winds (suhovei type). On the territory of Moldova, the probability of their occurrence is 95-100%, with an average durability in the warm period from 6 to 18 days, and in dry years it reaches 45-50 days.

Due to the drought in 2020, the wheat harvest could decrease by 40-50%. May is not as dry as the previous period. It has been raining for the last two weeks, but they are not able to rectify the situation, because the consequences of the deficit of precipitation for the soil are still very pronounced. In a number of districts in Moldova, mainly in the south and center of the country, there is a very difficult situation due to the hydrological drought that prevailed in winter and spring. The precipitation that fell in the first decade of May, in the districts of Căușeni and Ștefan Voda, was not enough, and the humidity penetrated into the soil to a depth of only about 10 centimeters. In some parts of the south of the country there was practically no rain. The mustard and pea plantations near the village of Carahasani, badly affected by the lack of humidity, also look lamentable. And the condition of spring crops, such as sunflower and wheat, is not very good. Spring crops, fruits, vegetables can be saved only by heavy rainfall, which should last at least 5-7 days. Only such rains would help farmers in the south and center of the country to obtain an acceptable harvest for the second group of crops.

In the case of winter crops, at best, it will be possible to harvest 20% - 30% of the expected amount. In the north we should expect an average amount of harvest for winter crops, but significantly lower than last year. In the center and south there is no moisture in the soil. Farmers will be able to harvest less than 50% of last year's harvest volume for basic crops.

In the center and south of the country, he added, the winter crops, wheat, barley and rapeseed, from which biofuels are produced, will suffer the most from the drought.

This year's 2020 drought will aggravate the situation of cereal producers. Growers understand the risks - if the harvest is low, they may reseed some fields. For this reason, there is a tendency to increase prices. Edible wheat cost 3 - 3.5 lei at the beginning of the year, and now costs 3.7 - 3.9 lei.

The situation may also be influenced by the fact that of the 17 countries that have previously restricted food exports to protect their domestic markets, almost half have already lifted restrictions imposed due to the COVID-19 pandemic, including large wheat exporters.

Joint efforts to resolve the current challenges in agriculture as a result and the problems caused by pandemic COVID-19 and drought has been the subject number one in Republic of Moldova.

## CONCLUSIONS

We mention that the proposed new principle of analysis of temperature, atmospheric precipitation and humidity deficit (deviation from the multiannual average - norm), offers new climatic indicators, in appreciation of dry and rainy years, as well as establishing degrees of vulnerability of these meteorological elements in the regional plan of the republic.

The completion of the drought register by 2020 indicates the tendency to increase the frequency of their production, we consider due to the anthropogenic impact on the environment and regional and global climate change. Because the most dangerous droughts are those of summer, very strong droughts of the beginning of the 21st century have been identified, such as those of 2002, 2003, 2005, 2006, 2007, 2012, 2015, 2017, 2019.

So, drought in the Republic of Moldova, gradually acquires a systematic character in the context of regional and global climate change, and contemporary society must constantly strive for new possibilities of adaptation (irrigation, afforestation, forest strips, abandonment of agricultural land use in floodplains - their institutionalization as wetlands etc.).

## REFERENCES

**Alpatiev A.M., Ivanova V.H., 1958** - *Haracteristica i gheograficescoe rasprostranenie zasuh*. Zasuhi v SSSR ih proishojdenie, povtoreaemosti i vlieanie na urojai, Ghidrometeoizdat, Leningrad. pp. 31-45.

**Bucinschii I.E., 1957** - *O climate proşlogo Russcoi ravninî*, Ghidrometeoizdat, Leningrad. 141 s.

**Bucinschii I.E., 1976** - *Zasuhi i suhovei*, Ghidrometeoizdat, L., 213 s.

**Daradur M.I., Constantinova T.S., 2000** - *Zaconomernosti dinamichi i prognoz reghionalinîh zasuh*, Secetele: Pronosticarea şi atenuarea consecinţelor. INECO, Chişinău, pp. 125-126.

**Drozdov O.A., 1980** - *Zasuhi i dinamica uvlajnenia*, Ghidrometeoizdat, Leningrad. s. 95.

**Horjan O., Sofroni V., Fliurţă I., Nunu S., 2004** - *Seceta în Moldova şi metode de combatere în livezile amenajate pe pantă*. Monitorizarea dezastrelor şi poluării. Editura “Performantică”, Iaşi, România, pp. 125-130.

**Lupaşcu M., 1999** - *Consecinţele secetei şi căile de atenuare a lor în R.M*. Seceta şi căile fiziologo-biochimice de atenuare a consecinţelor ei asupra plantelor de cultură, Chişinău, IFPAŞ RM, pp. 28-35.

**Proca V. 1983 -** *Buduşee prirodî agro-promâşlenogo raiona*, Ştiinţa, Chişinev, s. 263.

**Potop V., 2002 -** *Caracterizarea climatică a secetelor în Republica Moldova*, Teza de doctor, Chișinău, 130 p.

**Selianinov G.T., 1958 -** *Proishojdenie i dinamica zasuh*. Zasuhi v SSSR ih proishojdenie, povtoreaimosti i vleianie na urojai, Ghidrometeoizdat, Leningrad. pp. 5-30.

**Sofroni V., Gavriliţa A. 1994 -** *La secheresse et l'ensemble des mesures de sa prevation*, Romain Jurnal et hidrologz, Water resources. Vol. 1, No. 2, Bucureşti, pp. 25-31.

**Sofroni V., Mangul I., 1998 - Analiza şi monitoringul secetelor pe teritoriul Republicii Moldova**, Rezultatele comunicărilor celei de a treia conferinţe internaţionale ştiinţifico-practice, Apele Moldovei, Chişinău, FEP "Tipografia centrală", pp. 226-228.

**Sofroni V., Mangul I., 1999** - *Combaterea desertificării - dezrădăcinarea sărăciei*, Edit. Serviciului "Hidrometeo", p. 44.

**Sofroni V., Mangul I., Lupaşcu M., Lala M., 2000 -** *Caracterizarea secetelor în Moldova şi măsurile de atenuare a consecinţelor lor*, Secetele: Pronosticarea şi atenuarea consecinţelor, INECO, Chişinău, pp. 14-21.

**Şulimeister C., 1975 -** *Boriba s zasuhoi i urojai*, Colos, Moskva. s. 335.

**Ungureanu V., Sofroni V., Mangul I., 1995 -** *Estimarea şi caracteristica secetelor atmosferice şi pedologice în Republica Moldova*, Apele Moldovei, Seceta şi măsurile complexe de combatere, Chişinău, pp. 152-153.

**Middleton N., Thomas D., 1992 -** *World atlas of desertification (United Nations environment programme)*, Edited by. Edward Arnold, ISBN 0340555122, London.

****Arhiva de date climatologice*, Serviciul Hidrometeorologic de Stat al Republicii Moldova.

****Arhiva de date agrometeorologice*, Serviciul Hidrometeorologic de Stat al Republicii Moldova.

# STUDIES CONCERNING WORLD, EUROPEAN AND NATIONAL FOOD SECURITY

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**Abstract**

The term food security appeared in the interwar period and over time there have been numerous attempts to define the notion. At global, European and national level, food security policies are regulated by a number of institutions and organizations with a supervisory, guiding and controlling role. The most important institutions dealing with food security regulation worldwide are: WHO, FAO, IFPRI, at European level: European Commission, Council of the European Union and European Parliament, and at national level: MADR, ANPC, ANSVSA and the Ministry of Health. Food insecurity is a prolonged lack of "sufficient safe, nutritious food to maintain a healthy and active life" (FAO, 1996) and is generally caused by extreme poverty. In the context of food security, extreme poverty is synonymous with acute food shortages. The factors can be varied: from high prices, to economic recessions, natural disasters, political unrest and violent conflicts. Two thirds of the world's population vulnerable to food insecurity live in African countries, or in countries with a large population such as: India, Bangladesh, Indonesia, Pakistan. In these countries, food security is correlated with both poverty and the many conflicts, we can add here environmental pollution, limited access to water resources. Regarding Romania, the agri-food stability is influenced by a series of factors starting from the reduction of the available agricultural areas, the precarious endowment of the Romanian farmer. A possible food crisis in our country will be generated, most likely by a mismanagement of an already existing vulnerability.

**Key words**: food security, vulnerability, agri-food stability, food crisis

The aim of interventions to stop food insecurity is to give the right to life and reduce vulnerability in the affected community, where programs to prevent and combat food insecurity will aim to increase the availability, accessibility and usefulness of safe and healthy food. More specifically, this involves supporting primary food production - agriculture, animal husbandry and fish farming (Brown L., 2000). These programs can also generate paid activities and jobs. In some cases, maintaining or sustaining access to the agri-food market by building motorways that facilitate trade between producers and consumers could become another solution in the event of a food crisis.

At present, social assistance programs are more focused on direct food aid. Food security assessments do not differ in purpose and methodology from assessments in general, but they focus more on analysis, ie by what means individuals strive to ensure their own food security and the extent to which they manage to achieve it.

The overall objective of a food security assessment is to measure and understand the degree of food insecurity. It is therefore important to determine whether external intervention is needed to enable those affected to find themselves within the limits of a short- or long-term sustainable food security.

***Global and European food security approaches***

In all food security assessments, the situation of each monitored group should be clarified in order to predict an imminent food crisis or the duration of an insecurity situation. More precisely, it must be established what resources they have, how much arable land, pastures, animals, labor. Food security is not necessarily static. It may also exist in cases of seasonal fluctuations under normal conditions in terms of availability, access and utility. It is important to note that for each situation of food insecurity, specific and particular means are intervened on that situation and state intervention is not always mandatory. Ensuring food security for a global population of 7.6 billion, and an estimated 9 billion by 2050, is a major challenge from a climate change perspective.

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Agriculture has always been considered the interface between the environment and human activity, and therefore has the "solution" for substantial interventions in two of humanity's global problems: food security and maintaining a stable climate. The world population reached 7.6 million people in 2018, more than double the level of 1960 (FAO, 2018). A recent report by FAO, IFAD, UNICEF, WFP and the WHO estimates that, despite significant population growth, the share of malnourished people in the world has fallen from 14.7% in 2000 to 10.8% in 2013, but has risen again. at 11% in 2016. Studies show that by 2050, when the world's population will exceed nine billion people and food production will have to increase by 70% (FAO, 2018), climate change could obstruct efforts to ensure global food security. Thus, any event related to climate change, being demonstrated by several studies that climate variability threatens food security through negative effects on crop productivity endangers food security.

Agriculture is an important component of the national economy. The development and efficiency of agriculture has contributed to increasing the purchasing power of the population as a result of cheaper food (Istudor N., 2019). Economic growth is a necessary condition, but it is not enough to eradicate poverty and malnutrition, whatever the stage of development. An appropriate economic and social policy is absolutely necessary to achieve the level of general access to food.

The EU currently produces much more expensive food than the US because the subsidy is in addition to the normal cost of production and thus food has a high social cost and low competitiveness in the international market.

Globally, the issue of food security is largely accounted for, analyzed and managed by the United Nations, which has set up institutions and bodies with expertise in the field of agri-food.

FAO - Food and Agriculture Organization of the United Nations provides information and support on the state of the world in terms of food security, provides support where the situation requires it and helps implement measures through aid, long-term projects and emergency operations.

The Codex Alimentarius Commission has been involved in creating a system of rules and laws agreed both nationally and internationally. Codex Alimentarius is a global benchmark through a set of standards, codes and assessments for everything from the production process from the production of the raw material to the final product, from the general standards applicable to all foods to product-specific standards, or food.

At European Union level, there is a strong emphasis on regulating the use of additives and flavorings, controls to ensure compliance with standards, precaution and scientific advice - the European Food Safety Authority (EFSA), safety limits for both food contact materials, as well as for feed additives, veterinary medicines and plant pesticides, ensuring that they are safe for humans, animals and the environment.

The first to talk about food security in Romania is Bulgaru Mircea, who in his book “The Right to Eat”, defines food security as a fundamental human right and as an integral part of national security. He believes that it is the duty of governments to ensure the food security of their populations, to respect the right to life of every individual (Bulgaru, 1996).

## MATERIAL AND METHOD

In the research we used online versions of several journals, brochures and book volumes to analyze the perspectives of different authors on the notion of food security.

Quantitative research is carried out by the method of observation and by the procedure of analysis of statistical data (secondary data), which covers the national level and the international or global level.

All data used were taken from the official websites of organizations, ministries and governments.

## RESULTS AND DISCUSSIONS

The indicators established by the FAO with regard to food security in the light of the four major dimensions of this notion are:

- Availability;
- Access;
- The use;
- Stability.

The indicators will be covered according to their classification within one of the 4 dimensions of food security, will be explained as a notion, calculation method and information used and where there is data in this regard will be compared the values of indicators in Romania with the values global indicators for the period 2016-2019.

Food availability at national, regional or local level exists when food is physically available because it has been produced, processed, imported or transported. Availability means that the food is visible and exists in the region.

Food accessibility is how individuals can obtain available food. Obviously food becomes accessible through production, stock, purchase, exchange, supply, loan or food aid.

Therefore, the accessibility of food is guaranteed by resource-income, financial resources, the distribution of this income and the price of raw materials. Accessibility also depends on social, institutional, commercial, protection and social assistance rights.

Food utility is how individuals use food and it depends on their quality, stock, production and basic nutritional principles. Food utility is influenced by endemic diseases, poor hygiene or age or sex.

Food stability is the reliability and stability in the food distribution chain from one year to the next. This notion refers to both the stability of production and the stability of access.

For the second year in a row, Singapore, Ireland and the United States have retained their top three food security leaders.

Table 1

**Top 5 food security leaders**

| Top five countries | Food security score (out of 100 points) |
|---|---|
| 1. Singapore | 87.4 |
| 2. Ireland | 84.0 |
| 3. United States | 83.7 |
| 4. Switzerland | 83.1 |
| 5. Finland | 82.9 |
| 6. Norway | 82.9 |

For the first time in the history of this index, Singapore occupies the first position in GFSI 2018. Singapore is here partly due to the growth of about 30% of GDP per capita in the period 2012-2018, as well as the share of only 6.9% of the average expenditure allocated by a household for the purchase of food - the accessibility of food is very high. Beyond GDP growth, Singapore, of all the countries analyzed by this index, has the lowest tariffs on agricultural imports.

GFSI 2019 reveals that almost all countries in the index (88%) have a sufficient source of food for their population. However, according to the Food and Agriculture Organization's report on the state of food security and nutrition in the world, more than 820 million people in the world are hungry.

This is a problem not only in a few selected countries, but also in many countries around the world: more than a third of GDP countries show that more than 10% of their population is malnourished.

The Global Food Security Index 2019 also showed an increase in global food prices, with the strongest increases observed in Venezuela and Syria, stressing the need for greater efforts to make nutritious and quality food more affordable. accessible to lower-income populations.

In 2019, Romania ranks 38th in the world, with a total score of 70.2 out of 113 countries included in the Global Food Security Index (GFSI), a report written by the research division The Economist Intelligent Unit and supported by Corteva Agriscience.

The 38th place in the world is due to access to food, food quality and food insecurity prevention programs. Romania ranks 38th in the Global Food Security Index 2018 (GFSI) ranking, with a total score of 68.9 points - an improvement of one point compared to 2017, among the three criteria analyzed, our country obtaining the best score for Food quality and safety (32nd place in the world), followed by Food Availability (35th place) and Accessibility (43rd place). According to the report for 2019, in Romania there is an increase in food standards, the existence of a guide for a healthy diet and the presence of a plan to improve national quality and food safety standards, as well as a relatively low level of food waste. We have potential for the development of food infrastructure and irrigation capacity, but we do not have favorable scores in terms of agricultural research and the development of local infrastructure for which few funds are allocated. At the level of 2016, Romania was on the 42nd place in the world with a total score of 65.5, while 2017 and 2018 marked the rise and maintenance on the 38th place with the general scores of 75.2 for 2017, respectively 74.5 for 2018 (FAO, 2018). Food stability through food security policies at sectoral level has seen a major change, represented by the continuous reporting to the Common Agricultural Policy. Romania's food security is affected by a series of risks and threats, unmanaged economic crises, diminishing vital economic resources due to the lack of projects for the reconstruction of critical infrastructures or the tendency to monopolize substantial parts of natural resources (Table 2).

Poverty or social exclusion is another potential trigger for food insecurity, soil degradation, climate change. Agri-food stability is also influenced by the evolution of international markets, there is a trade disadvantage compared to EU products, as there is a dependence on imports. Romania's foreign security is already affected not by the lack of food but by the increase in imports, the decrease in the level of consumption in domestic production and the lack of a coherent strategy for sustainable development. I believe that Romania has all the chances to be among the countries with a precarious food security through low agricultural production, the constant increase of prices superimposed on a low purchasing power, which makes the massive segments of the population not afford to monthly income to

provide the necessary food for a quality life.We have the potential for the development of food infrastructure and irrigation capacity, but we do not have favorable scores in terms of agricultural research and the development of local infrastructure for which few funds are allocated.

Table 2

**Food security ranking**

| Ranking | Country | 2019 | | | |
|---|---|---|---|---|---|
| | | Overall Score | Accessibility | Availability | Quality and Safety |
| 1 | Ireland | 84 | 90.5 | 76.8 | 87.7 |
| 2 | Switzerland | 83.1 | 83.8 | 84.3 | 78.2 |
| =3 | Finland | 82.9 | 84.1 | 78.6 | 91.8 |
| =3 | Norway | 82.9 | 81.9 | 81 | 90.5 |
| 5 | Sweden | 82.7 | 85 | 78.1 | 89.4 |
| 6 | Netherlands | 82 | 85.6 | 76.2 | 88.9 |
| 7 | Austria | 81.7 | 85.4 | 78.6 | 81.1 |
| 8 | Germany | 81.5 | 84.9 | 79.1 | 79.8 |
| 9 | Denmark | 81 | 85.4 | 74.8 | 87.2 |
| 10 | Belgium | 80.7 | 84.4 | 76.2 | 83.9 |
| 11 | France | 80.4 | 83.8 | 74.8 | 87.1 |
| 12 | UK | 79.1 | 83.6 | 74.4 | 80.9 |
| 13 | Portugal | 77.8 | 81.3 | 70.9 | 88 |
| 14 | Italy | 75.8 | 82.5 | 68.3 | 79.7 |
| 15 | Poland | 75.6 | 81.1 | 69.3 | 79.5 |
| 16 | Spain | 75.5 | 82.3 | 65.9 | 84.7 |
| 17 | Greece | 73.4 | 77.8 | 64.9 | 86 |
| 18 | Czech Republic | 73.1 | 82.6 | 66.3 | 68.1 |
| 19 | Hungary | 72.7 | 80.8 | 66.1 | 70.5 |
| 20 | Belarus | 70.9 | 76 | 62.9 | 80.2 |
| 21 | Romania | 70.2 | 79.3 | 64.3 | 64.1 |
| 22 | Russia | 69.7 | 79.8 | 60.1 | 70.9 |
| 23 | Slovakia | 68.3 | 78.6 | 62.1 | 59.4 |
| 24 | Bulgaria | 66.2 | 79 | 54.2 | 66.8 |
| 25 | Serbia | 62.8 | 73.9 | 53 | 61.8 |
| 26 | Ukraine | 57.1 | 63.9 | 50 | 59.6 |

*Source: FAO Food Security Index*

At the level of 2016, Romania was on the 42nd place in the world with a total score of 65.5, while 2017 and 2018 marked the rise and maintenance on the 38th place with the general scores of 75.2 for 2017, respectively 74.5 for 2018.

We have potential for the development of food infrastructure and irrigation capacity, but we do not have favorable scores in terms of agricultural research and the development of local infrastructure for which few funds are allocated

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## CONCLUSIONS

Food insecurity is a prolonged lack of "sufficient safe, nutritious food to maintain a healthy and active life" (FAO, 1996) and is generally caused by extreme poverty. According to INS calculations, it is estimated that Romania's population will decrease, which will bring with it serious problems related to labor force and production capacity. In our country 45.7% of the population lives in rural areas and 30% of the population works in agriculture compared to the EU, which has a rural population of 23.6% and an employed population of up to 14%.

## REFERENCES

**Brown Lester, 2000 -** *Probleme Globale ale Omenirii,* Editura Tehnică, București

**Bulgaru Mircea, 1996** - *Dreptul de a mânca*, Editura Economică, București,

**Istudor N., Ion R.A., Petrescu I.E., Hrebenciuc A., 2019** - *Agriculture and the Twofold Relationship between Food Security and Climate Change. Evidence from Romania*. Amfiteatru Economic, 21(51), pp. 285-293.

*****FAO, 1996** - *World Food Summit*

*****FAO, *Global Food Security Index* 2017, 2018, 2019** avalable at https://foodsecurityindex.eiu.com/788.

# UNDERSTANDING THE PROFESSIONAL DEVELOPMENT OF TEACHERS IN DIGITAL AGE

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**Abstract**

The present paper analyzes the importance of quality education and focuses on preparing teachers to delivery it. Today's society is characterized by its constant technological change. Today's students are increasingly aware of the world of technologies; That is why educators see the need to take advantage of this new source of intrinsic motivation using tools of this type and incorporate them in the development of activities that encourage students to take an active part in their learning processes. The use of these teaching mechanisms allows increasing the possibility of promoting new forms of learning oriented to the development of thinking strategies and interaction with other individuals while stimulating their level of personal activity. The use of technologies allows information to be acquired, processed, stored and disseminated, which contributes to the training of people so that they can adapt to new social challenges. In this sense, it is considered that educator training should be aimed at generating reflections on processes aimed at promoting the pedagogical use of tools, resources, programs, services and environments characterized by the use of technology. The 21st century teacher needs much more than a superficial or mechanical understanding of the fundamental ideas of a discipline. It must also penetrate the deep structures of knowledge and their relationships, as well as the methods of testing, evaluating and expanding them. They need pedagogical skills to make flexible use of knowledge, as this is how they can pay attention to the ideas that arise in the course of the learning process.

**Key words**: teacher's competences, digital skills, LKT tools

According to ISTE (2018), the main objective of the NET's standard is to establish guidelines for educators to design, implement, and evaluate educational experiences to engage students and improve learning, enrich professional practice, and provide positive models. by all actors in the educational context (ISTE, 2018).

In this sense, we will refer to main indicators of the teacher's professional development: 1) Facilitate and inspire student learning and creativity: the use of subject knowledge, teaching processes and technology is promoted to facilitate student learning, creativity and innovation in virtual environments; 2) Design and develop learning experiences and consultancies in the new digital era: the design, development and evaluation of learning experiences is established through the incorporation of contemporary tools and resources; 3) Model work and learning in the new digital age: teachers must exhibit knowledge, skills and work processes characteristic of an innovative professional in a global and digital society; 4) Promote and model citizenship and digital responsibility: an understanding of the resources of local and global societies is sought, as well as the responsibility of incorporating digital culture through ethical and legal behavior in their professional practices; 5) Participate in professional growth and leadership: the improvement of the professional practice of teachers is stimulated, through permanent growth and the exhibition of leadership and in the school and community to which they belong, promoting the effective use of the digital resources (ISTE, 2018).

The new era, which is a consequence of technological evolution in recent decades, has significantly influenced higher education, not only because it has improved administrative processes, but also because it has opened the doors to new forms of training and spaces for learning (Ertmer, *et al*, 2014; Bernard *et al*, 2014; Uceda *et al*, 2010). The foregoing results in the decentralization of knowledge (Niebles *et al*, 2016), because technology, due to its great influence, has changed our ways of doing daily activities, which, applied to a pedagogical environment, causes that technology is not only a means of training students, but also becomes a virtual environment for interdisciplinary interaction (Badilla, 2007).

This makes us invoke a balanced definition of ICT as follows: a set of techniques developed

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and applied to technological devices that bring together processing, storage and transmission functionalities (Luz, 2018). Similarly, in general it can be said that ICTs are developed mainly in technologies that have the quality of transmitting data anywhere and at any time, regardless of the period of time in which the electronic device was created (Cacheiro, 2018) . The integration of ICT in the educational environment, both basic and advanced, is a subject that is in constant debate due to the multiple points of view that exist on this subject, however, the efforts to integrate these technologies in educational environments have been important in relation to the objective that the student can use them in their academic training and in the critical exercise of their citizenship (Bustos and Román, 2016).

Developing digital competence in the education system requires a correct integration of the use of ICT in classrooms and that teachers have the necessary training for that competence. It is probably the latter the most important factor for the development of a digital culture in the classroom and the harmony of the educational system with the new "network society". The connectivity and equipment will reach all classrooms, but it will be more difficult if there is a sufficient generalized level of digital competence teacher that allows their generalized accreditation (not as something optional or reserved for those with hobbies and computing devices) and develop a plan of coherent training with a proposal of evaluable indicators that allow to reinforce one of the worst areas of teacher professionalization attended in initial training (INTEF, 2013). Acquiring digital competence, integrated into specific teaching competencies, it is rather a process of development that has to be carried out over time to be able to integrate adequately in the repertoire of actions of the teaching staff; a process that goes from the establishment and identification of the educational problem to be solved with the ICT support in its broadest sense, and that goes through other cognitive processes complexes in which they are identified, analyzed, organized, evaluated and critically selected, among other processes, the most technological systems relevant to solve the educational problem or pedagogical situation in a context and moment.

## MATERIAL AND METHOD

This paperwork focuses on theoretical research, investigating the conceptual features, and the empirical aims on professional development of teachers. Analyzing three models of integration ICT in educational process and acquiring digital competences based on presented models, will emphasize the best practices to apply on.

## RESULTS AND DISCUSSIONS

The most important models of preparing teachers establishes a series of standardized ICT competencies best known internationally by UNESCO. A model with a strictly organizational vision, which is taking into account both the didactic advantages and issues such as the inclusion of ICT in the curricula or in the professional training of teachers is presented in *figure 1*, and is based on the establishment of pedagogical practices that favor the significant construction of students' knowledge through the integration of ICT; in such a way that it gathers the necessary competences for the design, implementation and evaluation of these educational exercises.

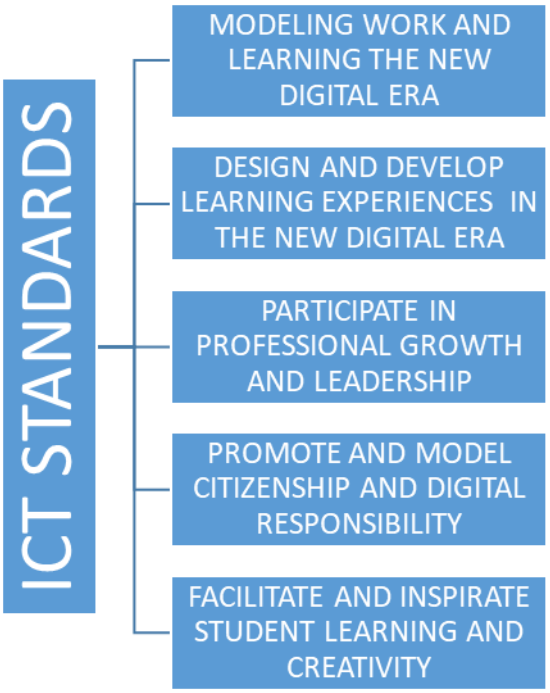



Figure 1 **Model of performance indicators for teachers in digital era**

As can be seen, the UNESCO model (*figure 2*) is based on the development of levels of ICT ownership which, in turn, are broken down into three elements in order to promote the good use of information technologies, which is sought is to get teachers to establish their level of competence according to the standards set, in order to establish training and professional growth plans in relation to the subject in question (UNESCO, 2018). On the other hand, in Europe, the Joint Research Center (JRC) of the European Commission (European Commission), proposes the European Framework

for Digital Competence of Teachers (DigCompEdu), which is based on related elements with the environment and professional commitment of educators, the importance of ICT in the teaching-learning process or return to self-taught students in the development of their digital competence as citizens.

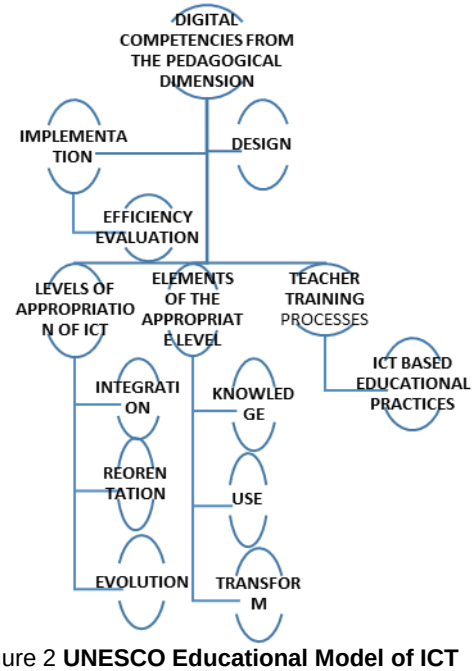



Figure 2 **UNESCO Educational Model of ICT**

As can be seen in *figure 3*, the model includes various types of skills related to its application, as well as: professional commitment, digital resources, digital pedagogy, evaluation and feedback, empowerment, and facilitating the digital student competence; in turn, these aspects can be developed according to the different levels of progression, such as: awareness, exploration, integration, mastery, leadership, and finally innovation. According to the proposed guidelines, the establishment of educational programs adaptable to the different learning environments is sought in order to achieve an adequate appropriation of technological resources (European Commission, 2018).

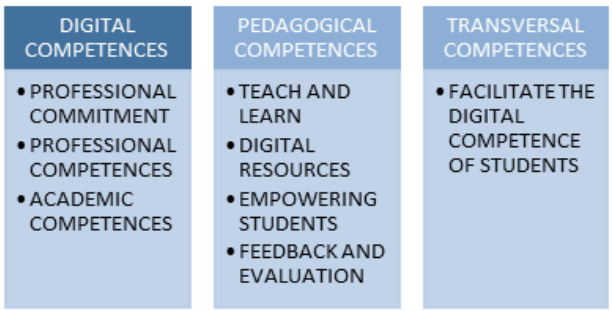



Figure 3 **Concept of evaluation digital competence in teachers** (Adapted from European Commission, 2018)

For the design of strategic educational plans of different countries or institutions, guidelines such as that of UNESCO (2011) have been taken as a basis. The ISTE model has been used in several investigations regarding the level of digital skills of active and training teachers.

Many of the teachers do not have the training to apply ICT tools and produce an innovative and enriching methodology for students. In view of this, the Learning and Knowledge Technologies (LKT) are focused more on formative than informative use, in order to learn more and better. That is to say, in the event that a teacher does not know how to implement an ICT tool, the LKT's come into action, which aim not only to learn how to use and control ICTs, but also to make the most of them for teaching, training and knowledge (Gil, 2017). That is, defined in a simpler way, LKT's are technology tools that help achieve objectives within the framework of educational programs, which have evolved from the already known ICT (Vivanco, 2015).

From the student's point of view, ICTs should be useful tools for motivating and stimulating the learning process (Njoku, 2015), contributing to the process of integration with reality, and allowing to observe the results of this interaction, the development of critical and creative thinking skills, as well as increased skills for information retention, meaningful learning and the development of useful skills in their performance in society.

There is a high self-perception in teachers regarding the application of the evaluated digital skills, however, in a minority in some of them it was observed that they are sometimes or even almost never or never applied; the one that showed the greatest flaw was the design of activities with ICT. This highlights the relevance of actively reflecting on the causes for which the use of ICT is being limited in teaching processes from the perspective of digital skills.

But some of leadership actions could improve the integration and use of ICT such as: taking strategic resource decisions; planning, coordinating and evaluating teaching and the curriculum; promoting and participating in teacher learning and development; and ensuring an orderly and supportive environment (Robinson, 2008).

Overall, the closer educational leaders get to the core business of teaching and learning, the more likely they are to have a positive impact on students' outcomes.

Digital competences associated with the use of ICT to increase professional productivity, the promotion of its ethical, legal and safe use and the training and information revealed that, in all cases,

teachers have applied them at least once, which makes it clear that they are taken into account at all times in the teaching processes (Instefjord, 2017).

Based on the literature review, it is pertinent to initiate reflection processes on the current development that teachers have in the field of digital competences, and it is necessary to highlight that the accompaniment in the training of ICT, supported by LKT tools, should be a joint commitment, between the teacher and the institution, that facilitates the implementation of these tools and trains students in digital citizenship issues. Likewise, it is recommended that within the curricular programs at the university level training in digital competencies be taken into account, beyond an instrumental vision of application, in such a way that it achieves a significant impact on the productivity and professional practice of the teacher.

## CONCLUSIONS

After reviewing the literature and based on the models, some conclusive ideas can be drawn:
a) It is relevant to use proven and recognized models for the management of teaching digital competencies, given that this cannot be random;
b) Training in this area must be articulated with educational policies issued by the State and higher education institutions;
c) There are difficulties in the ethical, legal and safe use of ICT in training spaces, therefore, training in this area must be notably strengthened;
d) Teachers require significant support in the management of information and the design of activities with ICT since, in some cases, they do not have the necessary elements to carry out these processes in a fluid manner.

The ICT boom has not only created new conditions for the emergence of knowledge societies, but rather new scenarios of social, political, educational, economic, cultural, educational performance, etc.
With that, the contexts where trainers carry out their professional activity and where their students will have to perform personally and professionally, they have also been deeply transformed, formative performance scenarios where new scenarios and digital teaching skills:
Towards the professionalization of teachers with ICT socio-cultural practices make up both the teaching staff and the students, interacting and building knowledge, giving rise to new possibilities and modalities for training, without distinction of time or space.

## REFERENCES


**Badilla S.E., 2007** - *Descentralizar el Aprendizaje: Nuevos Retos para la Educación*. Revista Electrónica Actualidades Investigativas en Educación, 7 (4), DOI: 10.15517/aie.v7i4.9299.

**Bustos A., Román M.**, **2016 -** *La Importancia de Evaluar la Incorporación y el Uso de las TIC en Educación.* Revista Iberoamericana de Evaluación Educativa, 4(2).

**Cacheiro G., 2018** - *Educación y Tecnología: Estrategias Didácticas para la Integración de las TIC*. Editorial UNED Madrid, España.

**Ertmer P., Ottenbreit-Leftwich A., Tondeur J., 2015 -** *Teachers' Beliefs and Uses of Technology to Support 21st-Century Teaching and Learning.* In: International handbook of research on teacher beliefs, 403-419.

**European Commission**, **2018** - *Digital Competence Framework for Educators* (DigCompEdu**),** available on-line at:
https://ec.europa.eu/jrc/en/digcompedu.

**Gil J.J.S., 2017 -** *From ICT to LKT: An approach to 3D Modeling and Printing in Higher Education.* Rev Educ Cienc Salud, 14(1), 23-29.

**Instefjord E.J., Munthe E.**, **2017** - *Educating digitally competent teachers: A study of integration of professional digital competence in teacher education.* Teaching and Teacher Education, 67, 37-45 (2017).

**International Society for Technology in Education (ISTE)., 2018 -** *ISTE Standards for educators*, available on-line at: *https://www.iste.org/standards/for-educators*.

**Luz C.G.M**.,**2018** - *Educación y Tecnología: Estrategias Didácticas para la Integración de las TIC.* Editorial.

**Njoku C., 2015 -** *Information and Communication Technologies to Raise Quality of Teaching and Learning in Higher Education Institutions*. International Journal of Education and Development using ICT, 11(1), pp. 122-147.

**Robinson V.M.J., Lloyd C.A., Rowe K.J., 2008 -** *The impact of leadership on student outcomes: An analysis of the differential effects of leadership types.* Educational administration quarterly, Vol. 44, No. 5, pp. 635--74.

**Uceda J., S. Barro, Llorens F., Franco J., 2010** - *Evolución de las TIC en el Sistema Universitario Español 2006-2010.* Madrid: CRUE.

**Vivanco, G., 2015** - *Educación y Tecnologías de la Información y la Comunicación*, Revista Brasileira de Educação, 20(61*).*

# THE CURRENT SPREAD OF SOME INVASIVE NEOPHYTES ALONG THE LOWER COURSE OF THE SIRET RIVER

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**Abstract**

In this paper, we present new data on eight species of neophytes of North American origin (*i.e., Bidens frondosa, Euphorbia glyptosperma, Fraxinus pennsylvanica, Lepidium densiflorum, Oenothera depressa, O. suaveolens, Oxalis dillenii*, and *Parthenocissus inserta*), whose spread in the lower course of the Siret river proved to be much wider than was previously known in the literature. All of these species are invasive in natural and anthropogenic habitats, on both banks of the river. Two of them were introduced deliberately in Romania, as ornamental plants (*Fraxinus pennsylvanica* and *Parthenocissus inserta*), while the other 6 species were introduced accidentally. *Euphorbia glyptosperma* and *Oenothera suaveolens* are reported here for the first time in the historical province of Muntenia, and other species are floristic novelties for counties of Vrancea (*Bidens frondosa, Fraxinus pennsylvanica, Oenothera depressa*) and Brăila (*Fraxinus pennsylvanica* and *Oxalis dillenii*). In addition to current spread of these species along the lower course of the Siret River, the paper provides data on the types of habitats invaded by each of them.

**Key words**: alien flora, Romania, EUNIS habitat types

Invasive alien (non-native) species have been identified worldwide as the second cause affecting the biological diversity, after habitat deterioration or loss (Genovesi P., Shine C., 2004; Wittenberg R., Cock M.J.W., 2001).

As a result of their high degree of disturbance induced by various natural and anthropogenic factors, riverine ecosystems are particularly vulnerable to invasion (Anđelković A.A. *et al*. 2016; Castro-Díez P., Alonso Á., 2017; Miyawaki Sh., Washitani I., 2004; Nobis A. *et al*, 2018; Planty-Tabacchi A.M. *et al*, 1996; Pyšek P., Prach K., 1993; Rejmánek M. *et al*. 2013; Zedler J.B., Kercher S., 2004).

Due to their aggressive expansion abilities and rapid growth, many invasive alien plants may develop dense, mono-dominant stands, which substitute the primary plant communities in riparian or aquatic habitats. This may drive radical alterations on natural biodiversity and the structure and functions of river ecosystems (Richardson D.M. *et al*, 2007; Stohlgren T.J. *et al*, 1998; Zedler J.B., Kercher S., 2004). On their turn, riparian habitats invaded by alien plants function as important centers for subsequent invasions in adjacent areas (Nobis A. *et al*, 2018).

The interest in assessing neophyte invasion in riverine habitats is increasing in Romania, and some general assessments of neophyte invasions and their ecological impact on this types of habitats has been published in recent time (*e.g.* Anastasiu P. *et al*, 2008; Goia I. *et al*, 2008; Sîrbu C. *et al*, 2012; Kucsicsa G. *et al*, 2018 etc.).

Our study was conducted along the lower course of the Siret River, which is of particular interest for the study of alien plants invasion, given that along it two large sites of Community interest have been designated, namely ROSCI0162 and ROSPA0071 (both with the same name - "Lunca Siretului inferior"), these including other five smaller sites of European or national interest (*e.g.* ROSCI0072 - "Dunele de Nisip de la Hanul Conachi", to mention only the best known one of them).

## MATERIAL AND METHOD

Species and habitats were recorded as a result of our field works (2018-2020), along the lower course of the Siret river. Voucher specimens were deposited in the Herbarium of the University of Agricultural Sciences and Veterinary Medicine Iaşi (IASI). For species identification and nomenclature, we used the following standard floras: Ciocârlan V., 2000; Sârbu I. *et al*, 2013; Tutin T.G. *et al* (eds), 1964-1980.

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Names and abbreviations of natural and anthropogenic habitats follow the EUNIS classification (Janssen J.A.M. *et al*, 2016; Schaminee J.H.J. *et al*, 2012).

For neophytes (i.e. alien plant species introduced after the year 1500) and their invasive status we followed the terminology and definitions recommended by Richardson D.M. *et al*, (2000) and Pyšek P. *et al* (2004).

## RESULTS AND DISCUSSIONS

Of the alien plants identified by us along the lower course of the Siret river between the years 2018 and 2020, we have selected a number of 8 species to be presented here. All of these species are invasive neophytes, native to North America, whose spread in this territory proved to be much wider than was previously known in the literature. Two of them were introduced deliberately in Romania, as ornamental plants (*Fraxinus pennsylvanica* Marshall and *Parthenocissus inserta* (A. Kerner) Fritsch), while the other 6 species were introduced accidentally (*Bidens frondosa* L., *Euphorbia glyptosperma* Engelm., *Lepidium densiflorum* Schrad., *Oenothera depressa* E. Greene, *Oenothera suaveolens* Person, and *Oxalis dillenii* Jacq.).

Two species are reported here for the first time in the historical province of Muntenia (*Euphorbia glyptosperma* and *Oenothera suaveolens*), and others are floristic novelties for counties of Vrancea (*Bidens frondosa*, *Fraxinus pennsylvanica*, *Oenothera depressa*) and Brăila (*Fraxinus pennsylvanica* and *Oxalis dillenii*).

***Bidens frondosa*** L. The first report of this species in Romania has been made by Vicol (1970), who identified it in the Danube Delta. In a short time, the species proved to be quite widespread both in the Danube Delta and along the entire river valley (Todor I. *et al*, 1971; Ţopa E., 1976), and subsequently it has been also reported along several inland rivers from the southern regions of the country (Negrean G., Constantin N., 1998; Sanda V., Popescu A., 1997-1998; Ciocârlan V., 2000 etc.], as well as in Transylvania (Schneider-Binder E., 1979; Drăgulescu C., 2003), Maramureș (Oprea A., Sîrbu C., 2006), Crișana (Negrean G., 2012) and Moldova (Sîrbu C., 2006). According to data published by Sîrbu C. & Oprea A. (2011), *B. frondosa* has been reported in over 125 localities throughout the country, thus having a pronounced invasive character.

In the lower course of the Siret river, this species has been known so far from only 4 localities (Galaţi, Barboşi, Movileni-Șendreni and Șerbeștii Vechi) (Sîrbu C., Oprea A. 2011). We have identified it in other 11 localities in this territory, as follows: Bilieşti, Suraia, Călienii Vechi, Năneşti, Pufeşti (Vrancea county), Bucești, Condrea, Cosmești, Ionășești, Movileni and Braniştea at Balta Potcoava (Galați county).

The habitats invaded by *B. frondosa* in the studied territory are the following ones (names and abbreviations according to the EUNIS classification): Dried fluvial deposits with sparse vegetation [C3.55, C3.6], Wet fluvial deposits with pioneer vegetation [C3.5], Tall-helophyte beds [C5.1a] and Small-helophyte beds [C5.1b].

***Euphorbia glyptosperma*** Engelm. This species has been recently reported for the first time in Romania by the last and first author of this paper (Sîrbu C., Șușnia I., 2018), from three localities situated along the lower course of the Siret river (Galați, Movileni-Șendreni and Șerbeștii Vechi). During our recent field works we also identified it in other 13 localities, from the counties of Brăila (Vameșu, and between Cantemir and Cotul Mihalea), Vrancea (Bilieşti, Doaga, Suraia and Șendreni) and Galați (Bucești, Condrea, Cosmești, Ionășești, Lungoci, Movileni, and downstream of Lungoci). In addition, we also found this species outside the study area, in the city of Focșani. In these localities, *E. glyptosperma* invades a quite wide range of habitats, such as: Dried fluvial deposits with sparse vegetation [C3.55, C3.6], Trampled habitats [E1.E, H5.6], Anthropogenic herb stands (ruderal habitats) [E5.1], Inland cliffs and outcrops [H3], Extractive industrial sites [J3] and Transport networks [J4].

***Fraxinus pennsylvanica*** Marshall. Introduced into the country probably at the beginning of last century (Sîrbu C., Oprea A. 2011), being widely planted in scientific collections, parks, forest plantations and along roads, after a few decades this North American tree became naturalized in Romania, being reported as sub-spontaneous first by Borza Al. (1947), in Transylvania. Meanwhile, the number of localities across the whole country in which it has been identified in the wild state has steadily increased, thus being included in the list of invasive plants of the country (Anastasiu P., Negrean G., 2007; Sîrbu C., Oprea A., 2011).

In the lower course of the Siret river, it has been previously reported only from 3 localities of the Galați county, namely (Sîrbu C., Oprea A. 2011): Galaţi Movileni-Șendreni and Șerbeștii Vechi. Between 2018-2020, we identified it in other 11 localities, on both banks of the Siret river, in the counties of Brăila (Cantemir, between Cantemir and Cotul Mihalea, Cotu Mihalea), Galați (Hanu Conachi, Braniştea at Balta Potcoava), and Vrancea (Adjud, Călimănești, Haret, Mărășești, Năneşti, Pufeşti).

In the study area it invades some natural habitats such as Pontic sandy steppe [E1.1a] (in the nature reserve Hanu Conachi), but especially the anthropogenic habitats on sandy soils: Anthropogenic herb stands (ruderal habitats) [E5.1], Broad-leaved forestry plantations [G1.C], Extractive industrial sites [J3] and Transport networks [J4].

***Lepidium densiflorum*** Schrad. Collected in Romania towards the end of the 19th century (1893), but identified erroneous as *L. virginicum*, this species has been reported for the first time in our flora by Negrean G. (1980), at approx. 100 years since the first collection. According to the literature (see Sîrbu C., Oprea A., 2011; Sîrbu C. *et al*, 2014), *L. densiflorum* is nowadays widespread throughout the country, but especially in the eastern regions.

At the 8 localities from which it has been previously reported in the lower course of the Siret River (Sîrbu C., Oprea A. 2011), we now add another 13 presence points from the counties of Brăila (between Cantemir and Cotul Mihalea, Vameșu), Vrancea (Adjud, Mărășești, Biliești, Suraia, Doaga) and Galați (Bucești, Cosmești Vale, Ionășești, Mălureni, Movileni and downstream of Lungoci).

In the study area, *L. densiflorum* copiously grows on sandy soils, both in natural and anthropogenic habitats, as follows: Dried fluvial deposits with sparse vegetation [C3.55 & C3.6], Pontic sandy steppe [E1.1a], Inland cliffs and outcrops [H3], Trampled habitats [E1.E & H5.6], Anthropogenic herb stands (ruderal habitats) [E5.1], Extractive industrial sites [J3], Transport networks [J4].

***Oenothera depressa*** E. Greene has been recently reported for the first time in Romania, by Sîrbu C., Oprea A. (2017), from three localities situated in the lower course of the Siret river, Galați county (Şerbeştii Vechi, Buceşti and Movileni), on the fluvial sands. During our field works (2018-2020), we found that this species is in fact much more spread on the both banks of the river, another 7 points of presence being added to those previously reported ones: Biliești, Suraia (Vrancea county), Condrea, Cosmești, Lungoci, Mălureni, and downstream of Lungoci (Galați county).

On both banks of the river, *O. depressa* invades especially sandy grounds of both natural and anthropogenic habitats such as (respectively): Dried fluvial deposits with sparse vegetation [C3.55 & C3.6], Riparian scrubs [F9.1b], Inland cliffs and outcrops [H3]; Extractive industrial sites [J3], Broad-leaved forestry plantations [G1.C], Trampled habitats [E1.E & H5.6].

***Oenothera suaveolens*** Person. Like the previous congeneric species, *O. suaveolens* has been reported for the first time in Romania, by Sîrbu C., Oprea A. (2017). In the lower course of the Siret river, the cited authors reported this species on the fluvial sands from two localities on the left bank of the river, Galați county (Şerbeştii Vechi and Bucești). Other 3 presence points are added now, as a result of our field works, namely: between Cantemir and Cotu Mihalea, Vameșu (Brăila county), and downstream of Lungoci (Galați county). Although the current data shows that *O. suaveolens* is less widespread in the study area than *O. depressa*, however, its local populations are denser and extensive.

Similar to *O. depressa*, this species invades fluvial sands or other sandy grounds in both natural and anthropogenic habitats, such as: Dried fluvial deposits with sparse vegetation [C3.55 & C3.6]; Anthropogenic herb stands (ruderal habitats) [E5.1], Broad-leaved forestry plantations [G1.C].

***Oxalis dillenii*** Jacq. Although known in Romania only since the second half of the last century (Dihoru Gh., 1968), this species (often confused in the literature with other congeneric species) is currently widespread in all provinces of the country, cumulating over 60 presence points (Sîrbu C., Oprea A., 2011).

In the lower course of the Siret river, *O. dillenii* was first collected in 1993, being reported so far from 9 localities bordering the river, as follows: Doaga (Coroi M., 2001), Cosmești - at the bridge (Coroi M., 2001), Cosmești - village, Hanu Conachi, Salcia (Sîrbu C., 2006), Barboși, Galați, Movileni-Șendreni, Şerbeştii Vechi (Sîrbu C., Oprea A., 2011). To these we now add another 13 points of presence, located on both banks of the river, namely: between Cantemir and Cotu Mihalea, Cotu Mihalea, Vameșu (Brăila county), Biliești, Nănești, Suraia (Vrancea county), Bucești, Condrea, Cosmești-Vale, Ionășești, Mălureni, Movileni, and downstream of Lungoci (Galați county).

According to our data, *O. dillenii* invades a wide range of habitats in the lower course of the Siret river, both natural and anthropogenic, such as (respectively): Dried fluvial deposits with sparse vegetation [C3.55 & C3.6], Riparian scrubs [F9.1b], Inland cliffs and outcrops [H3]; Trampled habitats [E1.E & H5.6], Anthropogenic herb stands (ruderal habitats) [E5.1], Broad-leaved forestry plantations [G1.C], Arable land and market gardens [I1]; Extractive industrial sites [J3], Transport networks [J4].

***Parthenocissus inserta*** (A. Kerner) Fritsch. This neophyte, highly appreciated as ornamental in gardens and parks, has been noticed in a sub-

spontaneous state on the Romanian territory since the middle of the 19th century (Drăgulescu C., 2003), and it is currently registered as an invasive species throughout the country (Sîrbu C., Oprea A., 2011).

In the lower course of the Siret river, it has been recently identified (Sîrbu C., Oprea A., 2011), being reported so far from 3 localities of the Galati county (Galați, Barboși, and Movileni-Șendreni). Between 2018-2020 we also identified it in Braniștea, Bucești, Șerbeștii Vechi and Vameș (Galați county), in various habitats such as: natural habitats: Broad-leaved forestry plantations [G1.C], Inland cliffs and outcrops [H3], Wet tall-herb fringes [E5.4], Temperate thickets [F3.1e], Riparian *Salix* woodlands [G1.1], Riparian *Alnus* and mixed woodlands [G1.2a & G1.2b], Thermophilous deciduous woodlands [G1.7a]; anthropogenic habitats: Anthropogenic herb stands (ruderal habitats) [E5.1], Trampled habitats [E1.E & H5.6], Extractive industrial sites [J3], Transport networks [J4].

## CONCLUSIONS

In this paper, we present new data on eight species of neophytes, of North American origin (*Bidens frondosa, Euphorbia glyptosperma, Fraxinus pennsylvanica, Lepidium densiflorum, Oenothera depressa, O. suaveolens, Oxalis dillenii,* and *Parthenocissus inserta*), which invade natural and anthropogenic habitats along the lower course of the Siret river;

Two of these species (*Fraxinus pennsylvanica* and *Parthenocissus inserta*) were introduced deliberately in Romania, as ornamental plants, and the other 6 species were introduced accidentally;

*Euphorbia glyptosperma* and *Oenothera suaveolens* are reported here for the first time in the historical province of Muntenia; other species are floristic novelties for counties of Vrancea (*Bidens frondosa, Fraxinus pennsylvanica, Oenothera depressa*) and Brăila (*Fraxinus pennsylvanica* and *Oxalis dillenii*).

## REFERENCES


**Anastasiu P., Negrean G., Basnou C., Sîrbu C., Oprea A., 2008** - A preliminary study on the neophytes of wetlands in Romania. In: Rabitsch W., Essl F., Klingenstein F. (eds.), *Biological Invasions – from Ecology to Conservation. NEOBIOTA*, 7: 181-192.

**Anastasiu P., Negrean G., 2007 -** *Invadatori vegetali în România*. Edit. Univ. Bucureşti, pp. 81.

**Anđelković A.A., Živković M.M., Cvijanović D.L., Novković M.Z., Marisavljević D.P., Pavlović D.M., Radulović S.B. 2016** - The contemporary records of aquatic plants invasion through the Danubian floodplain corridor in Serbia. *Aquatic Invasions*, 11(4): 381-395.

**Borza Al., 1947** - *Conspectus Florae Romaniae, Regionumque affinium*. Cluj: Edit. Cartea Românească, 360 pp.

**Castro-Díez P., Alonso Á., 2017** - Effects of non-native riparian plants in riparian and fluvial ecosystems: a review for the Iberian Peninsula. *Limnetica*, 36 (2): 525-541.

**Ciocârlan V., 2000** - *Flora ilustrată a României. Pteridophyta et Spermatophyta* (ed. II). Bucureşti: Edit. Ceres, 1138 pp.

**Coroi M., 2001** - *Flora şi vegetaţia din Bazinul râului Şuşiţa*. Iaşi: Edit. Tehnopress. 398 pp.

**Dihoru Gh., 1968** - Precizări floristice (IV) (*Oxalis*, *Trinia*, *Gypsophila*). *Studii şi Cercetări de Biologie, Ser. Botanică*, 20(6): 473-480.

**Drăgulescu C., 2003** - *Cormoflora judeţului Sibiu*. Brașov : Edit. Pelecanus, pp. 533.

**Genovesi P., Shine C., 2004** - *European strategy on invasive alien species*. Strasbourg: Council of Europe Publishing, Nature and environment, No. 137, 68 pp.

**Goia I., Groza Gh., Oprea A., Beldean M., Niculescu M., 2008 -** Alien species from the Lower Prut Floodplain Natural Park. *Проблемы биогеохимии и геохимической экологии*, 1(5): 54-61.

**Janssen J.A.M., Rodwell J.S., García Criado M., Gubbay S., Haynes T., *et al*, 2016** - *European Red List of Habitats, Part 2. Terrestrial and freshwater habitats*. Luxembourg: Publications Office of the European Union.

**Kucsicsa G., Grigorescu I., Dumitraşcu M., Doroftei M., Năstase M., Herlo G., 2018** - Assessing the potential distribution of invasive alien species *Amorpha fruticosa* (Mill.) in the Mureş Floodplain Natural Park (Romania) using GIS and logistic regression. *Nature Conservation*, 30: 41–67.

**Miyawaki Sh., Washitani I., 2004** - Invasive alien plant species in riparian areas of Japan: the contribution of agricultural weeds, revegetation species and aquacultural species. *Global Environmental Research*, 8(1): 89-101.

**Negrean G., 1980** - *Lepidium densiflorum* şi *Lepidium neglectum* în România. *Studii și Comunicări, Muzeul Satu Mare*, 4: 435-439.

**Negrean G., 2012** - Addenda to "*Flora Romaniae*" volumes 1-12. Newly published plants, nomenclature, taxonomy, chorology and commentaries (Part 2). *Kanitzia*, 19: 195-233.

**Negrean G., Constantin N., 1999** - Noi plante adventive în flora Bucureştiului. *Acta Horti Botanici Bucurestiensis,* **27**: 143-146.

**Nobis A., Nowak A., Rola K., 2018** - Do invasive alien plants really threaten river bank vegetation? A case study based on plant communities typical for *Chenopodium ficifolium* - An indicator of large river valleys. *PLOS ONE* / https://doi.org/10.1371/journal.pone.0194473:1-15.

**Oprea A., Sîrbu C., 2006** - Research regarding alien flora from the left bank of the Tisa river, between Valea Vişeului and Piatra (Romania). *Kanitzia*, 14: 45-56

**Planty-Tabacchi A.M., Tabacchi E., Naiman R.J., DeFerrari C., Décamps H., 1996** - Invasibility of species-rich communities in riparian zones. *Conservation Biology*, 10: 598-607.

**Pyšek P., Prach K., 1993** - Plant invasions and the role of riparian habitats - a comparison of four species alien to central Europe. – *Journal of Biogeography,* 20: 413-420.

**Pyšek P., Richardson D.M., Rejmánek M., Webster G.L., Williamson M., Kirschner J., 2004** - Alien plants in checklists and floras: towards better communication between taxonomists and ecologists. *Taxon*, 51(1): 131-143.

**Rejmánek M., Richardson D.M. & Pyšek P. 2013** - Plant invasions and invasibility of plant communities. Pp. 387-424, In: Van der Maarel E., Franklin J. (eds), *Vegetation Ecology*, 2nd ed., Wiley-Blackwell (John Wiley & Sons, Ltd.), Chichester, UK, 556 pp.

**Richardson D.M., Holmes P.M., Esler K.J., Galatowitsch S.M, Stromberg J.C., Kirkman S.P., Pysek P., Hobbs R.J. 2007** - Riparian vegetation: degradation, alien plant invasions, and restoration prospects. *Diversity and Distributions*, 13: 126-139.

**Richardson D.M., Pyšek P., Rejmánek M., Barbour M.G., Panetta F.D., West C.J., 2000** - Naturalization and invasion of alien plants: concepts and definitions. *Diversity and Distribution*, 6: 93-107.

**Sanda V., Popescu A. 1998** - Beiträge zur Kenntnis der Flora und der Vegetation im Osten der Rumänischen Ebene. *Contribuții Botanice, Cluj-Napoca*, /1997-1998/(2): 89-98.

**Schaminee J.H.J., Chytry M., Hennekens S.M., Mucina L., Rodwell J.S., Tichý L., 2012** - Development of vegetation syntaxa crosswalks to EUNIS habitat classification and related data sets (EEA Report; No. EEA/NSV/12/001). Wageningen: Alterra.

**Schneider-Binder E., 1979** - Analiza florei din Depresiunea Sibiului şi dealurile marginale. *Studii și Comunicări, Muzeul Brukenthal*, *Sibiu*, 23: 99-119.

**Sîrbu C., 2006** - Floristic and chorological contributions from Moldavia and Muntenia (Romania). *Analele Ştiințifice ale Universității "Alexandru Ioan Cuza" Iaşi*, *ser. II, a. Biologie vegetală*, 52: 92-98.

**Sîrbu C., Oprea A, Patriche C.V., Samuil C., Vîntu V., 2014** - Alien species of *Lepidium* in the flora of Romania: history of invasion and habitat preference. *Notulae Botanici Horti Agrobotanici Cluj-Napoca*, 42(1): 239-247.

**Sîrbu C., Oprea A., 2011** - *Plante adventive în flora României*. Iași: Edit. "Ion Ionescu de la Brad", 733 pp.

**Sîrbu C., Oprea A., 2017** - Notes on the genus *Oenothera*, section *Oenothera*, subsection *Oenothera* in Romania. *Acta Horti Botanici Bucurestiensis*, 44: 33-56.

**Sîrbu C., Oprea A., Samuil C., Tănase C. 2012** - Neophyte invasion in Moldavia (Eastern Romania) in different habitat types. *Folia Geobotanica*, 47: 215-229.

**Sîrbu C., Șușnia (Tone) I., 2018** - New records in the alien flora of Romania: *Euphorbia serpens* and *E. glyptosperma*. *Journal of Plant Development*, 25: 135-144.

**Stohlgren T.J., Bull K.A., Otsuki Y., Villa C.A., Lee M., 1998** - Riparian zones as havens for exotic plant species in the central grasslands. *Plant Ecology*, 138: 113-125.

**Tutin T.G., Heywood V.H., Burges N.A., Moore D.M., Valentine D.H., Walters S.M., Webb D.A. (eds.) (1964-1980),** *Flora Europaea*, 1-5. 1st ed., Cambridge: Cambridge University Press, 464 pp., 455 pp., 370 pp., 523 pp., 467 pp.

**Todor I., Gergely I., Bârcă C., 1971 -** Contribuţii la cunoaşterea florei şi vegetaţiei din zona Defileului Dunării, între oraşul Moldova Veche şi comuna Pojejena (jud. Caraş-Severin). *Contribuții Botanice*, Cluj-Napoca, /1971/: 203-256.

**Ţopa E., 1976** - Noi contribuţii la cunoaşterea florei Dobrogei. *Peuce*, *Tulcea, /1976/*: 315-320.

**Wittenberg R., Cock M.J.W. 2001** - *Invasive alien species. How to address one of the greatest threats to biodiversity: A toolkit of best prevention and management practices*. CAB International, Wallingford, Oxon.

**Zedler J.B., Kercher S., 2004** - Causes and consequences of invasive plants in wetlands: opportunities, oppotrunists, and outcomes. – *Critical Reviews in Plant Sciences*, 23(5): 431-452.

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