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CONTENTS

EVALUATION OF THE CONSERVATIVE AGRICULTURE BENEFITS ON SOIL PROPERTIES AND HARVESTS IN CROP ROTATION WITH LEGUMES

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Abstract

The experimental results regarding the changes in the properties of degraded arable ordinary chernozem from southern zone of Moldova and agricultural crops harvests in 5-field crop rotation with incorporation into the soil of one and two harvests of vetch green mass as organic fertilizer are presented. The results carried out in 2015-2019 showed that the introduction in the first agricultural year by disking into the soil of two green mass of vetch, led to restoration of the physico-chemical properties of the arable layer 0-20 cm and increased crop productions. The bulk density of 0-20 cm soil layer from unfavorable state became very favorable, the resistance to penetration from high and very high, became extremely low and low, which contributed to the easy penetration into soil of plant roots. The soil structure became agronomical favorable. The hydrostability of soil aggregates not soil layers 0-10 and 0–20 cm did not change, that is explained by the texture peculiarities of ordinary chernozem (loamy-dusty with high fine sand content). The porosity values correlate with the bulk density are favorable for a normal regime of soil aeration. The humus content increased by 0.16-0.26% in five years. The money value of the 4-year harvest increase was 18 080 MDL or 1090$. The results conducted in 2015-2019 confirmed that the preventive restoration of the quality state of the degraded arable soils is absolutely necessary to be carried out until the implementation or in the process of using the conservative agriculture system, based on No-till or Minimum-till technologies.

Key words: benefits, conservative agriculture, crop rotation, legumes, soil properties

Effective sustainable agriculture, based on the conservative technologies, can be designed in a system of long-term protection and preservation of soil quality and production capacity. The classic tillage system used in agriculture of the Republic of Moldova from 1950 to 1993, has led to the degradation of agricultural land, decreased fertility and soil production capacity: decreasing the organic matter and nutrients content in the soils, deteriorating the soil structure, increasing the compaction of the arable layer (Cerbari V., 2010**)**.

At the same time, the existence in the post-privatization period of an unbalanced correlation between the volume used of chemical and organic fertilizers did not ensure the increase of the soil production capacity. The chernozems of Moldova are characterized by fine textures and not always favorable correlation of the granulometric fractions. The high content of clay in the arable layer of soils without resistance to compaction, led to the strong compaction of the lower part of this layer in 1-2 years after the transition to the No-till or minimum-till. As result of compaction, when implementing conservative soil tillage systems, the lower part of the arable layer is not penetrated by plant roots, which leads to decrease in the volume of physiologically active soil and crop yields (Cerbari V., 2015; Leah T., 2018).

The reduction of the secondary compaction of the arable soil layer in the first 5-7 years of implementation of the conservative agriculture system, based on no-till or mini-till, can be performed by using phytoameliorative and agrotechnical procedures. These processes, by increasing the flow of organic matter and performing the subsoil periodically, can contribute to the restoration of the structure and the gradual loosening of the compacted postarable layer (Berca M., 2011; Canarache A., 1990).

At the moment, the restoration of the quality state of the arable layer is possible only by introducing in the soil the green fertilizers and the secondary production of the agricultural crops, simultaneously with the mechanical loosening of the former arable layer 0-35 cm once in 3 years by subsoiling with chisel (Wiesmeier M. *et al*, 2015.

The implementation in Moldova of various basic tillage systems that protect the soil depends on the initial properties of the soil, providing the

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territory with rainfall and the technical possibilities of farmers (Florea N *et al*, 1987; Cerbari V., 2011).

The research aimed was the preventive restoration of the degraded properties of the former arable soil layer 0-30 cm, recently compacted, through the systemic use of green manures and agrotechnical procedures of No-till.

MATERIAL AND METHOD

The researches were carried out on the agricultural lands of SRL Natcubii-Agro, Larga Nouă commune, Cahul District, South zone of Moldova. The land is a quasi-horizontal surface of the last (and highest) terrace of the Prut River. The absolute altitude of the soil profiles location is 120 m. The experimental soil was researched in order to assess the initial state of quality after its tillage two years according to No-till technology. The land is not affected by erosion processes.

The soil cover of the terrace is made up of ordinary chernozems with a moderately deep humiferous profile, clayey, post-excavated about 40 years ago and again used in arable land after the agrarian reform. The soils are typical for southern Moldova. The parental rock on the high terrace of the Prut River is composed by loessoid deposits of wind origin. Both the global subaeral process for the formation of loessoid deposits and the local process of accumulation of wind deposits from the primary bed of the Prut River participated in the formation of these deposits (Cerbari V., 2010). As a result of the combination of these two processes, the deposits of the Prut river terraces are characterized by a coarser texture than that of the analogy deposits on the surrounding plateaus

The assessment of the quality status and production capacity of degraded ordinary chernozems in Southern Moldova was made as a result of incorporation into the soil as organic fertilizer the green mass of two vetch crops in the 5-fields crop rotation. Alternation of crops in rotation in the 2015-2019 yrs: vetch (which was incorporated into the soil) → winter barley → rapeseed → winter wheat → sunflower.

RESULTS AND DISCUSSIONS

The initial assessment of the No-till work system on the quality status of ordinary chernozems in Southern Moldova was performed by comparison with soils worked according to conventional technology. It was established that the former arable layer of soil worked No-till two years was divided into three layers: 0-5 cm - very loose, consisting of mulch and soil aggregates as result of passing the No-till seed drill; 5-10 cm - with monolithic structure, weakly cracked; 10-30 cm - with massive structure. Thus, under the No-till system the strongly compacted post-arable layer (0-10 cm) was formed (Cerbari V., 2015; Cerbari V., Rusu A., 2019; Leah T., 2016a).

The texture is a virtually unchangeable feature of the soil, so agricultural technologies must be adapted to the structural specifics of each soil type. The soil properties depend on the content of different particle size fractions. The ordinary chernozems on the high terrace of the Prut River are characterized by a homogeneous clayey-dusty texture with a high content of fine sand (Leah T., 2016a). Regarding the soil tillage, the texture is one of the most favorable properties at the implementation of No-till technology. At the same time, being comparatively coarse (rough), the texture ensures a drier thermal regime in the soil, a greater possibility of mineralization of humus and organic residues, and water evaporation from soil.

Research has established that prolonged use in arable, the 0-30/35 cm soil layer of ordinary chernozems has dehumidified and the natural crumb-grained structure has deteriorated. Thus, the arable layer of the researched chernozems lost the resistance to secondary compaction (Leah T., 2018; Leah T., Cerbari V., 2015). The physical and chemical properties of conventionally and No-till soil worked are presented in *table 1*.

Table 1

The average values of the soil properties worked conventionally and No-till, 0-10 cm

Soil properties	Conventi-onal tillage	No-tillage 2 years
Hygroscopic water, %	4.1	4.3
Hygroscopic coefficient, %	6.0	6.2
Density, g/cm^3	2.65	2.60
Bulk density, g/cm^3	1.11	1.22
Total porosity, %	58.1	54.4
Penetration resistance, kgf/cm^2	7	14
Water field capacity, %	6.1	6.2
Wilting coefficient, %	9.0	9.1
$CaCO_3$, %	1.3	1.7
Humus, %	2.49	2.62
Mobile phosphorus, mg/100 g	1.46	1.75
Exchangeable potassium, mg/100 g soil	23	26
Nitrates ($N\text{-}NO_3$), mg/100 g	0.42	0.31

The hygroscopic water content, hygroscopic and wilting coefficients for soil layers 0-10, 10-30 cm are practically analogous. This is explained by texture homogeneity and poor differentiation in humus content of these layers. The wilting coefficient are medium, which indicates that the inaccessible water reserves for plants are comparatively small. At the time of research, the water field capacity of the conventionally cultivated soil was very low. A tendency to keep water reserves in No-till worked soils is due to the

mulch layer. Bulk density is a main feature of the physical quality of the soil.

As result of the total loss of resistance to secondary compaction of the arable layer worked No-till two years, was strongly compacted starting with a depth of 5 cm from the soil's surface.

The ordinary chernozems on the high terrace of the Prut are weakly carbonate and are characterized by weakly alkaline reaction. These properties do not negatively affect the quality of chernozem. According to the humus content, the researched soils are moderately humiferous, which in the absence of organic fertilization, become destructured and loss the resistance to compaction of the arable layer. At the No-till, an increase of the organic matter content in the layer of 0-10 cm was obtained as a result of the humidification of the organic residues of secondary production left on the soil surface.

The experimental strip was organized at the end of September 2014 and was sown with a mixture of winter vetch (80 kg/ha) and winter wheat (50 kg/ha). The total area sown was 1.15 ha. One hectare of winter vetch was sown for seed production. The experimental strip occupied 0.15 ha. The winter vetch was incorporated into the soil in early of May by disking. On the same day, spring vetch was sown again. and incorporated into the soil as green manure in late of September.

Autumn vetch for seed was harvested in July. Vetch straw in the seed harvesting process was spread on the soil surface. The fallen vetch grains sprouted and formed a new green cover of vetch at the end of September, the average wet mass was about 8-10 t/ha.

Wheat straw and 8-10 t/ha of new green mass of vetch were incorporated into the soil by disking as organic fertilizer at the end of September. At the beginning of October 2015, winter wheat was sown as basic agricultural crop.

Data on the mass and composition of two autumn and spring vetch crops, sown on the experimental plot and incorporated into the soil as green manure are presented in *table 2*.

Table 2

Harvests of vetch on ordinary chernozem (vetch strip was founded on 30.09.2014)

Harvest	Green mass, t/ha	Humidity, % of wet mass	Dry mass, t/ha	Ash	N	P_2O_5	K_2O	C
				% of dry mass				
Green mass of autumn vetch, incorporated in the soil, 12.05.2015								
Main harvest	26.0	81.6	4.8	10.5	3.9	0.6	4.2	41.6
Roots, total mass in 0-30 cm			1.9	10.2	1.7	0.5	1.6	40.6
Total organic residues and roots			6.7	10.4	3.3	0.6	3.5	41.1
Green mass of spring vetch, incorporated in the soil, 30.09.2015								
Main harvest	17.0	67.9	5.5	10.9	3.1	0.7	1.5	41.2
Roots, total mass in 0-30 cm			2.1	10.6	1.6	0.5	1.3	41.6
Total organic residues and roots			7.6	10.7	2.7	0.6	1.4	41.4
Total organic residues and roots of two vetch crops incorporated in the soil			14.3	10.5	3.0	0.6	2.4	41.2

Note: *Humidity coefficient of vetch mass is 0.25. From 14.3 t/ha of absolutely dry aerial and underground vegetal mass of vetch, incorporated in the soil in April and August of 2015, about 3.6 t/ha of humus will be synthesized. 14.3 t/ha of dry organic vetch residues contain about 429 kg/ha of biological nitrogen, 60% of which (about 250 kg/ha) are of symbiotic origin (fixed from the atmosphere). The C: N ratio in the total aerial plant mass and pea roots is 41.2: 3 = 13.7.*

Data on the quantity of organic residues and green mass of vetch incorporated in the soil are presented in *table 3*. On average, the dry mass of organic vetch residue, consisting from the straw of the vetch sown for grain and the green mass of vetch shaken at the harvesting of the first crop, is practically equal to the mass of an average crop of vetch. At the end of September, the experimental strip was sown with winter barley.

Table 3

The quantity of organic residues (straw) and green mass of vetch incorporated in the soil

Harvest	Green mass, t/ha	Humidity, % of wet mass	Dry mass, t/ha	Ash	N	P_2O_5	K_2O	C
				% of dry mass				
Mass of straw and roots vetch, incorporated into the soil, 28.08.2015								
Vetch straw	6.0	45.6	2.9	10.2	2.1	0.6	2.6	41.8
Roots, total mass in 0-30 cm			1.9	10.2	1.7	0.5	1.6	40.6
Total organic residues and roots			4.8	10.2	1.9	0.6	2.2	41.3
Main harvest	8.0	77.9	1.7	10.9	4.1	0.6	1.5	41.2
Roots, total mass in 0-30 cm			0.7	10.6	1.6	0.5	1.3	41.6
Total organic residues and roots			2.4	10.7	3.4	0.6	1.4	41.3
Total organic residues and roots of two vetch crops incorporated in the soil			7.2	10.5	2.4	0.6	1.9	41.3

Note: *Humidity coefficient of vetch plant mass - 0.25. From 7.2 t/ha of absolutely dry aerial and underground vegetal mass of vetch, incorporated in the soil, about 1.8 - 2 t/ha of humus will be synthesized. In the 7.2 t/ha of dried organic vetch residues contain about 173 kg/ha of biological nitrogen, 60% of which (about 104 kg/ha) are fixed from the atmosphere. The C: N ratio in the total aerial plant mass and of vetch roots is 41.3: 2.4 = 17.2.*

Field research on changes in the quality status of the arable layer of soils under the action of green mass of peas, incorporated into the soil or started in mid-June, when the apparent density of the arable layer become balanced. The research was repeated every agricultural year - in 2016, 2017, 2018 and 2019.

In *table 4* are presented the data that characterize the values in dynamics for main properties of the researched soils for appreciation the changes in their quality state as a result of the incorporation in the soil as organic fertilizer the green mass of vetch.

The incorporation of the green mass of vetch led to the positive changes of some indicators of the physical quality of soil layer 0-10/12 cm and 10-20 cm. More significantly, the state of physical quality (apparent density, resistance to penetration) changes was in the 0-20 cm layer in result of the incorporation into the soil two vetch green mass.

The structure of the soil layers 0–10 cm, where one green mass of vetch was introduced and 0-20 cm, where two green mass of vetch was introduced, became agronomical favorable.

However, the hydrostability of the structure of these layers into which the green mass of vetch was introduced changed very little.

The insignificant change in hydrostability is due to the peculiarities of the texture of these soils. The ordinary chernozems investigated are characterized by a clayey-dusty texture with a high content of fine sand, coarse dust and comparatively low clay content, which ensures poor cohesion between the elementary soil particles within the existing structural aggregates (in wet conditions these structural aggregates are easily destroyed).

The content of organic matter in the soil layers where the vetch green mass was introduced increased by 0.16-0.26%. It is necessary to note that this organic mass with high nitrogen content, as a result of microbiological processes in the soil, partially turns into labile humus. Unstable humus is not closely related to the mineral part of the soil and is relatively easily mineralized as a result of microbiological processes. However, the process of mineralization of labile humus takes place slowly, over several years, which ensures a normal activity of microbiological processes in the soil over a period of 4-5 years (Cerbari V., Leah C., 2016; Leah T., Cerbari V., 2019).

Table 4

Modification of the average values of the physical and chemical properties of the soils on the experimental variants in the 2016-2019 years

Layer, cm	No-till	The application of one vetch harvest in the soil				The application of two vetch harvests in the soil			
	2015	2016	2017	2018	2019	2016	2017	2018	2019
Content of agronomically favorable structural aggregates 10-0,25 mm, dry sieving , %									
0-10	65.0	73.9	72.2	77.4	75.9	74.5	75.1	77.6	75.1
10-20	48.8	57.5	44.0	40.8	42.5	77.7	77.7	71.0	70.4
20-30	42.7	49.0	47.8	48.2	50.8	45.1	45.1	44.3	40.0
Content of favorable hydrostable agronomic structural aggregates, wet sieving, %									
0-10	24.3	31.6	21.6	23.2	25.6	31.4	27.3	29.8	29.2
10-20	14.7	23.9	19.4	26.4	26.2	23.6	25.5	28.0	24.2
20-30	13.3	14.1	18.2	19.4	17.0	13.4	14.6	15.0	14.4
The mean values of apparent density, g/cm^3									
0-10	1.24	1.12	1.21	1.22	1.24	1.18	1.24	1.22	1.23
10-20	1.48	1.44	1.48	1.46	1.47	1.21	1.26	1.28	1.37
20-30	1.49	1.49	1.49	1.45	1.48	1.50	1.44	1.45	1.47
The average values of total porosity , %									
0-10	52.9	56.9	54.0	55.1	53.2	54.6	52.9	53.2	53,6
10-20	44.5	45.7	44.6	44.9	45.4	54.3	52.8	51.7	48,7
20-30	44.4	44.2	44.4	45.7	44.8	43.8	46.3	45.3	45,2
Average values of resistance to penetration, kgf/cm^2									
0-10	13	7	8	6	6	6	11	6	5
10-20	20	17	19	19	19	7	12	15	10
20-30	20	20	20	23	22	21	16	22	21
Average of humus content, %									
0-10	2.63	2.79	2.85	2.78	2.82	2.89	2.85	2.85	2.86
10-20	2.52	2.67	2.71	2.65	2.69	2.84	2.83	2.81	2.82
20-30	2.45	2.47	2.49	2.47	2.47	2.49	2.52	2.50	2.51

This process can cause the appearance of "nitrogen hunger" which is influenced by the low nitrogen content of mineralized soil in the organic residues of previous crops. The negative action of vetch straw could have been avoided if 100-150 kg/ha of ammonium saltpetre or urea had been introduced on the control plot immediately after the rapeseed harvest, which would have intensified

the process of mineralization of the organic remains of the rapeseed low nitrogen content.

Another strategic problem is the need to restore the mobile phosphorus content in agricultural soils; the decrease of phosphorus reserves in the arable layer becomes catastrophic.

The use of green mass of vetch as an organic fertilizer largely solves the problem of nitrogen in the soil, but not of phosphorus (Leah T., 2015, 2016b, 2016c).

The basic criteria on assessing the positive changes in the quality of the soil is the harvest of the crops sown after the application in the soil of the vetch green mass (*table 5*).

Table 5

The harvest of agricultural crops obtained on the variants of the experience located on the ordinary chernozem

2016 **Experimental Variant**	Average barley harvest, t/ha (humidity - 8%)	Harvest increase, t/ha / %
Control	4.9	-
After incorporation into the soil - one crop of vetch green mass	6.3	1.4 28.6
After incorporation into the soil - two crops of vetch green mass	7.1	2.2 44.9
2017 **Experimental Variant**	Average rapeseed harvest, t/ha (humidity - 8%)	Harvest increase, t / ha /%
Control	3.1	-
After incorporation into the soil - one crop of vetch green mass	3.6	0.5 16.1
After incorporation into the soil - two crops of vetch green mass	4.1	1.0 32.3
2018 **Experimental Variant**	Average wheat harvest, t/ha (humidity - 5%)	Harvest increase, t / ha /%
Control	3.8	-
After incorporation into the soil - one crop of vetch green mass	3.9	0.1 2.6
After incorporation into the soil - two crops of vetch green mass	4.6	0.8 21.0
2019 **Experimental Variant**	Average sunflower harvest, t/ha (humidity - 5%)	Harvest increase, t / ha /%
Control	2.8	-
After incorporation into the soil - one crop of vetch green mass	3.0	0.2 7.1
After incorporation into the soil - two crops of vetch green mass	3.3	0.5 17.8

In the second year (2016) of the 5-field crop rotation, the autumn barley was cultivated. The average harvest on the control plot was 4.9 t/ha of barley. On the plot where a green mass crop of vetch was incorporated into the soil by disking, the barley harvest increased by 1.4 t/ha and formed 6.3 t/ha, and on the plot where two crops of vetch green mass introduced into the soil, the barley harvest increase was 2.2 t/ha, the total harvest was 7.1 t/ha. Experience data confirm a 2-time increase in the barley harvest under the action of green manure (vetch green mass).

Research conducted in 2015-2019 yrs. showed that the introduction in the agricultural year 2014-2015 in the soil one and two crops of vetch green mass by disking, as an intermediate crop, led to the positive recovery of soil properties of layers 0-20 cm and increase crop production.

Crop yield after application of one vetch green mass was:

• 2016: the winter barley harvest - 6.3 t/ha, the increase - 1.4 t/ha/year, the monetary value of the harvest increase: 3080 lei or 229$.

• 2017: the rapeseed harvest - 3.6 t/ha, the increase - 0.5 t/ ha/year, the monetary value of the harvest increase: 3550 lei or 214$.

• 2018: the winter wheat harvest - 3.9 t/ha, the increase - 0.1 t/ha/year, the monetary value of the harvest increase: 330 lei or 20$.

• 2019: the sunflower harvest 3.0 t/ha, the increase - 0.2 t/ha/year, the monetary value of the harvest increase: 1400 lei or 84$.

Harvest of agricultural crops after the application of two green masses of vetch was:

• 2016: the winter barley - 7.1 t/ha, the increase - 2.2 t/ha/year, the monetary value of the harvest increase: 4840 lei or 292$.

• 2017: the rapeseed harvest - 4.1 t/ ha, the increase - 1.0 t/ha/year, the monetary value of the harvest increase: 7100 lei or 428$.

• 2018: the winter wheat harvest - 4.6 t/ha, the increase - 0.8 t/ha/year, the monetary value of the harvest increase: 2640 lei or 159$.

• 2019: the sunflower harvest - 3.3 t/ha, the increase 0.5 t/ha/year, the monetary value of the harvest increase: 3500 lei or 211$.

The recommended method of preventive restoration the quality status of the arable soil layer led to the remediation of soil properties, to the increase of crop production and created premises for successful implementation of the conservative agriculture system, based on No-till technologies.

Soil regeneration take place only if it is worked properly, it is not overexploited until depletion, the conditions of protection and conservation are respected and it is ensured in a permanent flow of qualitative organic matter in its arable layer. Restoring the destroyed soil cover is very difficult, requires a long time and high costs.

In this context, the permanent monitoring of changes in soil quality is necessary for the timely implementation the measures to combat or reduce the land degradation.

CONCLUSIONS

The implementation of the conservative agriculture system, based on the No-till technology increased crop yields in the first two years as a result of more efficient use of soil moisture due to the layer of mulch formed on its surface and balanced application of fertilizers. The physical quality of soils worked No-till two years has worsened, the soil become strongly compacted and with high resistance to penetration from depth of 5 cm from the soil's surface.

The researche confirmed that the preventive restoration of the quality status of the dehumificated, destructured and without resistance to compaction of arable layer is absolutely necessary to be carried out until the implementation of the conservative agriculture, based on No-till technology. The preventive restoration method of the arable soil layer state, based on the use of legume crops as green organic fertilizer, led to the remediation of the physical and chemical properties, increase soil production capacity, created premises for the successful implementation of No-till technology.

The implementation in the Republic of Moldova the conservative agriculture, based on the use of green fertilizers in combination with No-till or Mini-till tillage technologies will contribute to the establishment of a permanent of organic matter flow and the gradual restoration of soil quality, increasing the harvest of agricultural crops by 20-30%, reducing the need for nitrogen fertilizers by at least 50%. Currently it is necessary to organize the system of use of green fertilizers in the agricultural sector of the Republic of Moldova and to create the seed base of legumes.

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ASPECTS REGARDING THE ELECTRICAL COMMAND OF DIESEL INJECTION

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Abstract

The paper presents the preliminary tests for a new method of controlling diesel injection at the injector of a compression ignition engine. The purpose of the paper is to verify the possibility of obtaining certain quantities of fuel, sprayed by injector by this method. It was also verified the possibility of changing the value amount of diesel sprayed by injector according to certain parameters. Unlike conventional injection systems, in this method the injector receives the fuel from an electrically operated piston pump element via an electromagnet. The entry into service of the electromagnet is controlled by an electrical circuit equipped with a capacitor battery. The capacitor battery is designed to store electricity and restore it to the action control of the electromagnet. In this way, the actuation time of the piston pump element is very short. The opening time of the injector can also be easily modified. The tests presented in the work are carried out using a prototype, which has been tested only on a stand designed by the author and not on a running engine. At this preliminary testing stage it was followed whether the proposed method allows fuel injection through the injector. It was also monitored if there was a possibility of changing the dose of injected fuel. It was looked which of the constructive and functional factors influence the modification of the injected dose.

Key words: diesel, fuel, injection

In compression-ignition engines, the fuel is introduced into the engine cylinder via an injector. It usually introduces, at each operating cycle, a diesel quantity of 10...200 cubic millimetres/cycle (Danciu A., 2013; Rakosi E. 2013; Roșca R., 2015). Expressed in millilitres these quantities are between 0.01 and 0.2.

A new idea in terms of pumping fuel to the injector is the electromagnetic drive of the pumping element. This proposal aims to reduce the injection time. An advantage of this method is the possibility to slightly change the injection advance.

MATERIAL AND METHOD

The proposed method for the electric control of diesel injection is based on the use of a capacitor bank. This provides the energy needed to operate an electromagnet whose movable core is rigidly attached to the piston rod of a piston pump element. Changing the position of the electromagnet core will change the position of the pump element piston.

The fuel is located inside the pump element at a preset working pressure. By moving the piston, the diesel is transmitted to a conventional injector, which sprays it.

The injector is mounted at a short distance from the pump element.

The tests performed at this stage of the study looked at whether the proposed method for electrical control of the diesel injection allows certain amounts of fuel to be sprayed by the injector. It was also monitored at whether the amount of diesel sprayed can be changed.

The tests were not carried out on a compression-ignition engine, but on a simple stand designed by the author. The components of the test stand are shown in *figure 1*.

The fuel from the tank (1) is sent by the manually operated pump (2) into the pump element (5), at a pressure lower than that of the injector opening (6). The manually operated pump was chosen to make it easier to adjust the pressure in the pump element (5).

The supply pressure of the pump element (5) is monitored by means of the manometer (3).

The valve (4) allows the flow of fuel in only one direction, from the manually operated pump (2) to the pump element (5). This avoids reversing the flow direction of the fuel when the pump element (5) starts operating.

When the supply pressure of the pump element has reached the test value, the electromagnet (8) is switched on. This will move the piston pump element (5), which will increase the fuel pressure to the injector opening value.

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The fuel sprayed by the injector is collected in a graduated cylinder. It allows the measurement of the amount of fuel sprayed by the injector.

The return of the pump element piston (5) to the initial position is due to the pressure of the fuel sent by the manually operated pump.

The amount of fuel sprayed through the injector is small. In order to prevent measurement errors, in the case of the proposed test stand, it was accepted that the measurement of the amount of fuel, sprayed by the injector, under conditions of a certain supply pressure and a certain charging time of the condenser bank, should be done by collecting in the graduated cylinder the quantities obtained for one hundred successive tests.

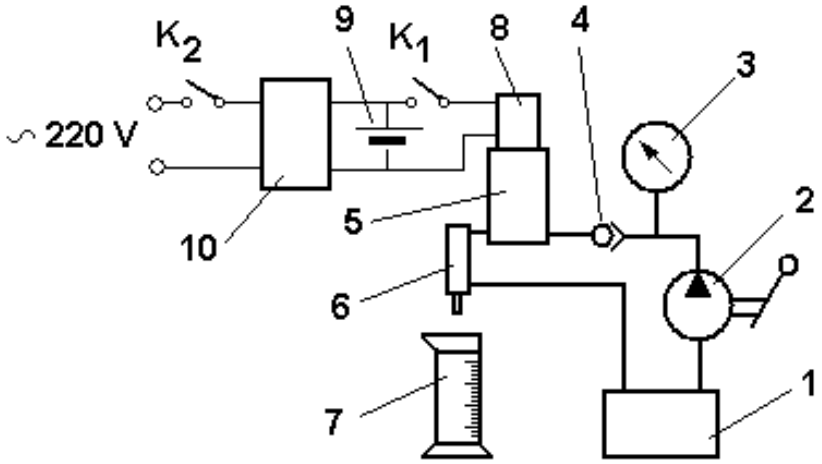

Figure 1 **Composition of the test stand**
1- tank; 2 – hand-operated pump; 3 – manometer; 4 – sense valve; 5 – pump element; 6 – injector; 7 – graduated cylinder; 8 – electromagnet; 9 – capacitor bank; 10 – rectifier deckK1; K2 – electrical switches.

As can be seen from Figure 1, the electromagnet (8) is powered by an electrical circuit which also includes the capacitor bank.

The electrical circuit is connected to a 220 Volt AC power source with a frequency of 50 Hz. A capacitor bank is charged by this source by means of a rectifier bridge. An electrical resistor has been installed on the supply circuit of the rectifier bridge, which has the role of limiting the current at its level.

In the first stage, the capacitor bank is charged. For this, switch K2 is in the closed position and switch K1 is in the open position. After charging the battery, switch K2 opens. When the electromagnet has to start, switch K1 switches to the closed position. In this way the current from the capacitor bank will reach the electromagnet.

When the capacitor bank is charging , switch K1 is kept open to prevent it from discharging.

It was decided to use a co-capacitor bank, because this solution allows to obtain a high activation energy of the electromagnet and allows to achieve a short actuation time.

The pump element (5) consists of a cylinder and a piston of the type used in the construction of in-line injection pumps, which equip the engines of U 650 tractors. The cylinder and the piston are mounted in a body with a threaded cap.

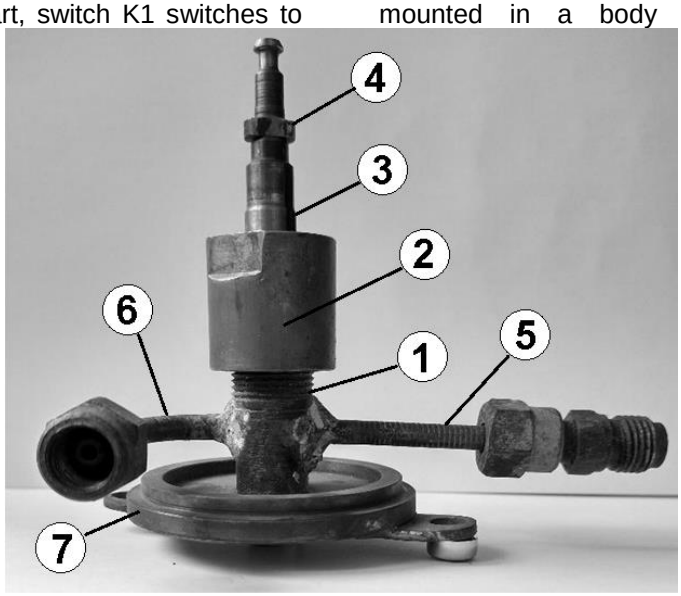

Figure 2 **Overview of the pump element (5)**
1- body; 2 – threaded cap; 3 – cylinder; 4 - piston; 5 – supply line; 6 – injector connecting pipe; 7 – support.

The body of the pump element (5) is provided with a supply line and a connection line with the injector. An overview of the pump element (5) is shown in *figure 2*.

The piston stroke can be adjusted by means of a limiter.

At the top of the piston rod is mounted a plate that has the role of taking over the pushing force created by the electromagnet.

A housing is used to fix the described components.

The piston rod of the pump element is set in motion on the active stroke by an electromagnet. Two types of electromagnets (Figure 3) were used for the tests at this stage.

The Type 1 electromagnet is an electromagnet taken from the IEPS 2140 starter of the engine that equips the Dacia 1300. Its power supply voltage is 12 volts. The Type 2 electromagnet (DISH50) is taken from the SAVIEM starter. Its power supply voltage is 24 volts.

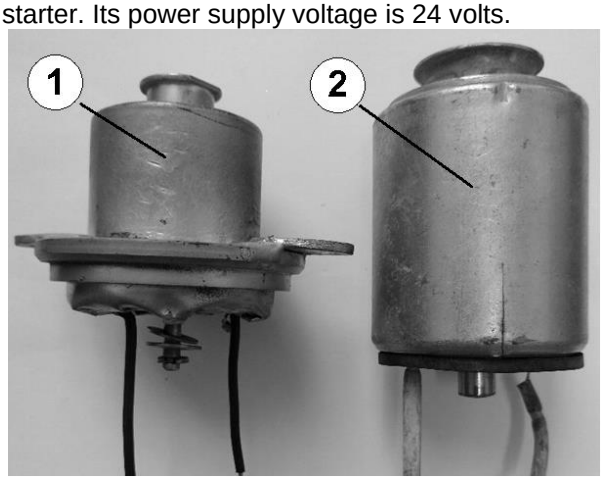

Figure 3 **Electromagnets used on the test stand**
1- Type 1 electromagnet; 2 – Type 2 electromagnet.

Two types of injector sprayers (*figure 4*) were used during the tests.

Injector A is a monojet type. Such an injector is equipped with a sprayer type RO DN 0 SD 21.

Injector B is multijet. The sprayer used by it is RO DLLA 145 S 448.

In both types of injectors, the sprayer needle opens due to the pressure of the diesel.

The test stand allows the power pressure of the pump element to be adjusted (5), the capacitor bank charging time and capacity adjust.

RESULTS AND DISCUTIONS

In the first stage of the tests, the quantities of diesel, passing through the RO DLLA 145 S448 sprayer, were compared for the use of the Type 1 electromagnet and for the use of the Type 2 electromagnet.

For tests carried out with each type of electromagnet, two values were used for the capacitor bank capacity. These values were 1000μF and 2000μF.

Five values were analyzed for the capacitor battery charge time, namely: 1 second, 2 seconds, 3 seconds, 4 seconds and 5 seconds. Another parameter that was taken into account in the case of these tests was the pump element power pressure. The power pressure values used during the tests were 2,5 MPa, 5 MPa, 7,5 MPa, 10 MPa and 12 MPa.

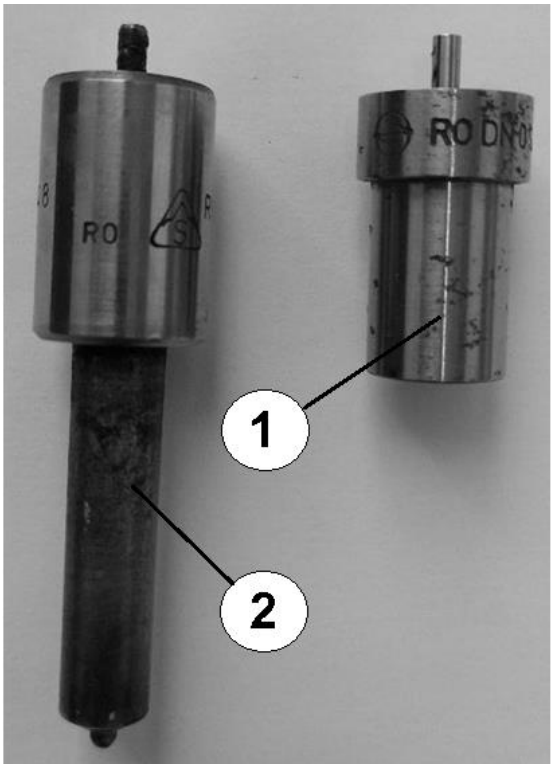

Figure 4 **Injector sprayers used on the test stand**
1- Type A sprayer; 2 sprayer – Type B.

The measurement of the amount of fuel passing through the sprayer, for the preset values of the capacitor bank capacity, its charging time and the pump element supply pressure, was made by collecting in the graduated cylinder the quantities of fuel sprayed in 100 consecutive tests.

In the case of tests carried out with the Type 1 electromagnet, the results are shown in *table 1*, and for those carried out with the Type 2 electromagnet, are shown in Table 2.

From the data in Table 1, it is noted that a capacitor bank charge time of more than 2 seconds does not affect the amount of fuel sprayed by the injector.

It is also noted that for the power pressures of the pump element with values of 2,5 MPa and 5 MPa and for capacitor battery charging times of more than 2 seconds, the quantities of fuel sprayed by the injector are maintained at the same value.

The largest quantities of fuel sprayed by the injector were obtained for the pressure value, 12MPa pump element supply and capacitor battery charging times of more than 2 seconds.

For most pump element power pressure values and capacitor battery charging times of more than 3 seconds, it is noted that the capacitor bank capacity value does not affect the amount of fuel sprayed by the injector.

And in the case of the data in *table 2*, it is noted that a capacitor bank charge of more than 2 seconds does not affect the amount of fuel sprayed by the injector.

Also, for capacitor battery charge time values of more than 2 seconds, the capacitor battery capacity value does not affect the amount of fuel sprayed by the injector.

In the case of *table 2*, it is also noted that the largest quantities of fuel sprayed by the injector were obtained for the pressure value, the power of the pump element, of 12MPa.

Comparing Table 1 with Table 2, it is noted that in the case of the use of the Type 2 electromagnet the quantities of fuel sprayed by the injector are higher than in the case of the use of the Type 1 electromagnet.

Table 1

Quantities of fuel, in millilitres, passing through the Type B sprayer, when using the Type 1 electromagnet

Power pressure (MPa)	Capacitor bank capacity (μF)	Capacitor battery charging time (s)				
		1	2	3	4	5
2.5	1000	4.0	4.0	4.0	4.0	4.0
	2000	2.0	4.0	4.0	4.0	4.0
5.0	1000	3.6	4.0	4.0	4.0	4.0
	2000	2.0	4.0	4.0	4.0	4.0
7.5	1000	3.2	5.0	5.0	5.0	5.0
	2000	2.0	4.0	4.0	4.0	4.0
10.0	1000	3.2	6.0	7.0	7.0	7.0
	2000	4.0	7.0	7.0	7.0	7.0
12.0	1000	4.0	7.0	8.0	8.0	8.0
	2000	4.0	8.0	8.0	8.0	8.0

Table 2

Quantities of fuel, in millilitres, passing through the Type B sprayer, when using the Type 2 electromagnet

Power pressure (MPa)	Capacitor bank capacity (μF)	Capacitor battery charging time (s)				
		1	2	3	4	5
2.5	1000	4.0	6.0	6.0	6.0	6.0
	2000	4.0	6.0	6.0	6.0	6.0
5.0	1000	7.0	8.0	8.0	8.0	8.0
	2000	6.0	8.0	8.0	8.0	8.0
7.5	1000	9.0	9.0	10.0	10.0	10.0
	2000	9.0	10.0	10.0	10.0	10.0
10.0	1000	12.0	12.0	12.0	12.0	12.0
	2000	12.0	12.0	12.0	12.0	12.0
12.0	1000	14.0	14.0	14.0	14.0	14.0
	2000	14.0	14.0	14.0	14.0	14.0

In the case of the supply pressure of 12 MPa and for the value of the capacitor battery capacity of 2000 μF this increase is 42.8%.

Another aspect that was followed during the tests was related to the quantities of fuel sprayed by the injector when using the two types of sprayers (Type A and Type B).

The opening pressure for the Type A spray injector is 12 MPa and for the Type B spray injector is 13 MPa.

Table 3 shows the results of the tests with these types of sprayers.

The results of the tests with the two types of sprayers are shown in Table 3.Another aspect that was followed during the tests was related to the quantities of fuel sprayed by the injector when using the two types of sprayers (Type A and Type B).

The opening pressure for the Type A spray injector is 12 MPa and for the Type B spray injector is 13 MPa.

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The results of the tests with the two types of sprayers are shown in Table 3.

According to this table, both types of sprayers spray fuel within the same limits (between 4 and 14 millilitres for 100 consecutive cycles).

The amount of fuel sprayed through the Type B sprayer is less influenced by the capacitor battery charge time than in the case of the Type A sprayer for pump supply pressures between 2.5 and 10 MPa.

Table 3

Quantities of fuel, in millilitres, passing through the Type A sprayer and type B sprayer, in the case of the use of the Type 2 electromagnet,

Power pressure (MPa)	Capacitor bank capacity (μF)	Injector sprayer type	Capacitor battery charging time (s)				
			1	2	3	4	5
2.5	1000	Type A	4.0	4.0	5.0	5.0	6.0
		Type B	4.0	6.0	6.0	6.0	6.0
	2000	Type A	4.0	6.0	8.0	8.4	8.4
		Type B	4.0	6.0	6.0	6.0	6.0
5.0	1000	Type A	6.0	6.0	6.0	7.0	7.0
		Type B	7.0	8.0	8.0	8.0	8.0
	2000	Type A	4.0	6.0	8.4	8.4	8.4
		Type B	6.0	8.0	8.0	8.0	8.0
7.5	1000	Type A	7.0	7.0	8.0	8.0	8.0
		Type B	9.0	9.0	10.0	10.0	10.0
	2000	Type A	6.0	8.0	10.0	10.0	10.2
		Type B	9.0	10.0	10.0	10.0	10.0
10.0	1000	Type A	8.0	8.0	10.0	10.0	10.0
		Type B	12.0	12.0	12.0	12.0	12.0
	2000	Type A	10.0	10.0	12.1	12.0	12.0
		Type B	11.0	12.0	12.0	12.0	12.0
11.5	1000	Type A	10.0	10.0	10.0	10.0	10.0
	2000	Type A	14.0	14.0	14.0	14.0	14.0
12.0	1000	Type B	14.0	14.0	14.0	14.0	14.0
	2000	Type B	14.0	14.0	14.0	14.0	14.0

For maximum test pressures, the battery charge time of capacitors does not affect the amount of fuel sprayed by the sprayer.

It is noted that for power pressures of the pump element, greater than 5 MPa and for capacitor battery charging times greater than 2 seconds, the amount of fuel sprayed is no longer influenced by the battery charging time of the capacitors.

It is also noted that for power pressures greater than 2,5 MPa and for the value of the battery capacity of 1000 μF accumulators, the quantities of fuel sprayed by the Type B sprayer are greater than those sprayed by type A.

For the value of the 2000 μF capacitor bank capacity, for charging times greater than 2 seconds and for power pressures greater than 5 MPa, both types of sprayers behave the same way.

CONCLUSIONS

The preliminary tests carried out using the test stand in Figure 1 show the following conclusions:

- the proposed method for the electrical control of the diesel injection corresponds to the intended purpose;
- the prototype pum element made corresponds to the intended purpose
- the proposed method allows a cyclic dose necessary for the operation of a compression-ignition engine;
- the proposed method allows the amount of fuel sprayed by the injector to be modified;
- increasing the supply pressure of the pump element leads to an increase in the amount of fuel injected;
- the charging time of the capacitor bank does not affect the amount of fuel injected by the sprayer at a pressure of 11.5 and 12 MPa;
- the charging time of the capacitor bank does not affect the amount of fuel injected through the Type B sprayer at the supply pressure of the pump element, of 11,5 and 12 MPa;
- in the case of a type B sprayer at the supply pressure of the pump element, the capacity of the capacitor bank does not affect the amount of fuel injected through the sprayer;
- at the next stage of the tests, it is necessary to use an electromagnet that operates at a higher frequency, a capacitor bank to charge in a shorter time and a more evolved test stand.

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RESEARCH ON STRUCTURAL AND FUNCTIONAL STATUS OF SUPPLY CHANNELS IN IRRIGATION SYSTEMS

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Abstract

Irrigation systems in Romania were built 40-60 years ago, and those that are still in operation have varying degrees of infrastructure degradation. The degradation of the structural components of the irrigation system determined the appearance of water losses and the decrease of the exploitation efficiency. Research conducted over about 15 years has shown the state of advanced degradation of the supply channels and a significant decrease in their operating yields up to 40-60%. The absence of maintenance, repair and rehabilitation works determined the structural degradation of the canals. The degradation phenomena are represented by clogging, compaction, erosion of the slab sealing joint, cracking - breaking - movement of the slabs on the perimeter of the canal, etc. Important degradations are highlighted in the constructions on the canals: hydrotechnical derivation nodes, underpasses of roads, water intake of the pumping stations, etc. All this causes a large part of the volume of water transported by the canals to be lost through infiltration. The current structural and functional state of the irrigation canals requires the immediate application of rehabilitation works.

Key words: hydraulic efficiency, flow section, water leaks, waterproofing

Irrigation systems in Romania were created to supplement the moisture deficit and ensure the development environment of agricultural and horticultural crops in the climate conditions specific to Romania. In 1989, Romania had irrigation facilities with a technical level corresponding to the existing technologies and execution materials at national and international level.

Before 1989, a wide range of watering methods were used: sprinkler watering, furrow watering, bivalent watering, drip watering, etc. Irrigation systems consisted of irrigation plots, which was the basic unit of the system. Each system had a general infrastructure for capturing, transporting and supplying water to irrigation plots (Cazacu E. *et al*, 1982). Irrigation water is taken from surface sources (mainly the Danube River, rivers and lakes) and underground sources (Blidaru V. *et al*, 1982).

Much of the irrigation systems were dismantled after 1990 due to changes in land ownership and government decisions. At present, a small number of irrigation systems built before 1989 are in operation. Most of these systems were built in 1970-1985. In general, the infrastructure of large irrigation systems (catchment, basic pumping stations, pumping stations, supply channels, discharge pipes, etc.) is operated by the territorial administrations of land improvements. The exploitation of irrigation plots is done by private units that own the irrigated lands (Nicolaescu I. *et al*, 2005).

Irrigation systems built before 1990 were structured on the following components: water intake construction, pumping stations (basic, re-pumping) for raising water at various heights, water transport channels (supply, distribution), water stations pumping and commissioning of the pipeline network, hydrotechnical nodes with constructions and water diversion installations, protection and control installations of the exploitation process, etc. (Cazacu E. *et al*, 1982, Pleșa I., Burchiu V., 1986). The predominantly current watering method is sprinkler watering (Cismaru C., 2004, Luca M., 2012, Luca M. *et al*, 2016).

Research conducted in the last period of time has highlighted the state of advanced degradation of the network of channels (supply, secondary and, distribution channels). The state of degradation of the canals causes large water losses through infiltration and a significant decrease in operating yields (Luca M., 2015).

The objective of the paper is the synthetic analysis of the current state of degradation of the network of canals with the role of supply and water supply of irrigation plots from irrigation systems in operation in the eastern part of Romania.

MATERIAL AND METHOD

The study and research material is represented by the irrigation systems located in the

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eastern part of Romania. The research considered the irrigation systems located in the meadow area of the Prut River and located in the counties of Iaşi and Vaslui (*figure 1*).

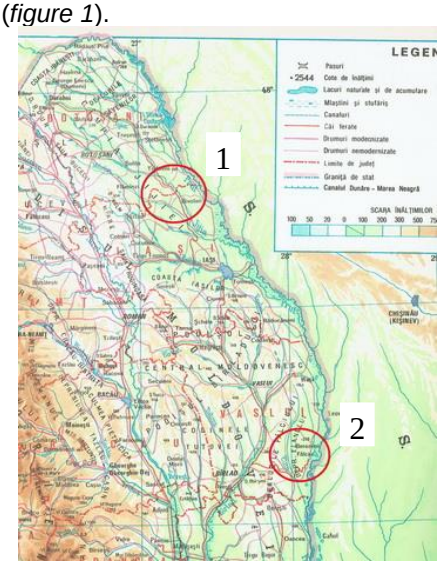

Figure 1 **Areas of study and research: 1 - South Soloneţ irrigation system; 2 - Complex Irrigation and Drainage Development Albiţa - Fălciu.**

The current paper presents the results of research conducted in irrigation systems in the structure "Complex Arrangement of Irrigation and Drainage Albiţa - Fălciu". The first analyzed systems are located in the meadow area of the Prut River (*figure 2*).

The "Complex Arrangement of Irrigation and Drainage Albiţa - Fălciu" currently has a landscaped area of 16,973 ha. The entire surface arranged with irrigation and drainage systems is located in the Prut river meadow. The arrangement was designed by the I.S.P.I.F. Bucharest in 1977 and was executed between 1977 and 1978 (Luca M., 2015). After 1990, the irrigation infrastructure of the arrangement (water pumping stations taken from the Prut River, supply and distribution channels) is operated by the Territorial Branch of Land Improvements South Moldova. The irrigation plots were taken over and managed in a private system by OUAI in the location area. The arrangement contains a number of irrigation plots / blocks equipped with pressure pumping stations (SPP) and monofilament pumping stations (SPPM). All pumping stations are powered by a network of channels.

For each irrigation system considered in the analysis, a technical documentation was prepared. Technical expertise was performed for a series of irrigation plots. Through documentation, the state of the structural components was analyzed based on known and accessible data. The data obtained through the technical expertises allowed the analysis of the current state of the constructive structure of the canals and the hydrotechnical constructions related to them (socket of the pumping stations, hydrotechnical derivation nodes, bridges, etc.).

It should be mentioned that the network of channels has been in operation for about 40 years.

The research method is the one used to carry out technical expertise for land improvement objectives and in particular for irrigation systems with water distribution at pumping stations using a network of canals.

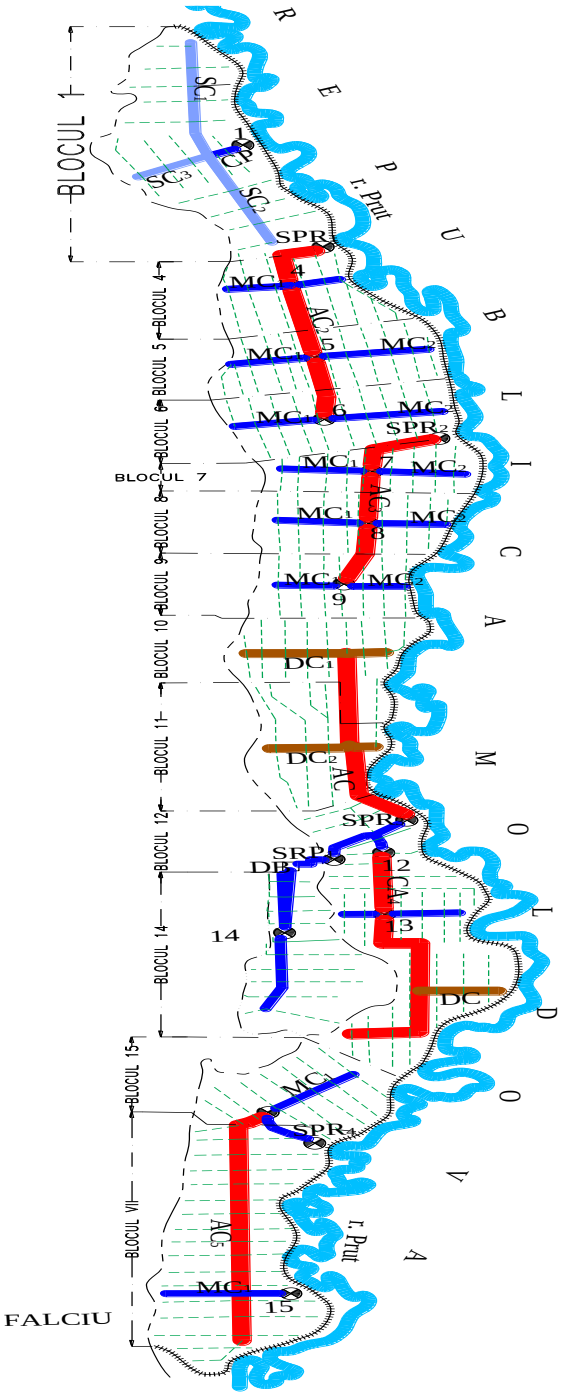

Figure 2 **Complex Irrigation and Drainage Development Albiţa Fălciu (meadow area): AC - supply channel; DC - distribution channel; CS - Secondary channel; CP - main pipe; SPR - basic pumping station; SPP - pumping and pressurization station; BR - discharge basin (Luca M., 2020)**.

For some irrigation plots, the updated topographic plans of the irrigation systems in operation were used. The field research took photographic surveys and video images. The data processing followed the methodology used in the technical and scientific analyzes developed for irrigation systems with canal and pipeline networks.

RESULTS AND DISCUSSIONS

Irrigation systems in Romania were realized in the years 1970 -1980 based on well-developed standard projects. Irrigation systems located in the meadow and plain area have an infrastructure based on a network of canals with different sizes depending on the flow transported. Pumping stations take water from the source (rivers, streams, lakes) and pump it into the adduction channel and further into the main and secondary channels (Cazacu E. et al, 1982).

The networks of canals located in the plain area are made in excavation and semi-embankment (*figure 3*). The channel flow section has a trapezoidal shape. The watered perimeter is waterproofed with large reinforced concrete slabs, or small plain concrete slabs. The joint between the tiles is filled with cement mortar or bituminous mastic (Nicolau C. et al, 1977).

Figure 3 **Irrigation canal made in semi-embankment with water intakes for pumping and pressurization stations, SPP (Ghelase I., 2000)**

The irrigation plots in Romania were designed for watering an area of 500 - 2500 ha. The pipeline network of the plot is supplied by a pumping and pressurizing station (SPP), or by a number of monofilament pumping stations (SPPM). The supply of the pumping stations (SPP, SPPM) is made from a channel (Stăncescu L. *et al*, 1984).

The canal network of the irrigation systems in operation has a long service life. The absence of maintenance and repair works and the obsolete life of the materials determined the degradation of the structural components of the canals, the hydrotechnical derivation nodes and the hydraulic installations on the canals (Luca M., 2016).

The irrigation plots in the „Albiţa - Fălciu Complex Irrigation and Drainage Development" are fed from the Prut River through four basic pumping stations (SPR1 Pogănești, SPR2 Săratu, SPR3 Bumbăta, SPR4 Berezeni). Pumping stations discharge water into adduction channels that supply irrigation plots / blocks. The adduction channels have the code CA2, CA3, CA4 and CA5. The distribution channels (CD) are fed from the adduction channels. Some of the adduction and distribution channels were analyzed within the available data and field investigations.

The CA2 adduction channel is fed by SPR1 and distributes water to the SPP4, SPP5 and SPP6 irrigation plots. The CA2 channel was put into operation in 1977 and has the following characteristics (Luca, 2020):

1. Structural characteristics: total length: 8,060 m; trapezoidal section in the excavation with width at the bottom b = 1.0 m, construction height H = 2.20 m, slope inclination 1: 2; channel bottom slope, i = 0.01%; surface with large reinforced concrete tiles, S_d = 60,410 m^2.
2. Functional characteristics: transported flow, Q = 1.35 m^3/s.
3. Constructions on the canal: four bridges.

The CA3 supply channel is fed by SPR2 and distributes water to SPP7, SPP8 and SPP9. The CA3 channel was put into operation in 1977 and has the following characteristics:

1. Structural characteristics: total length: 8,630 m; trapezoidal section in the excavation with width at the bottom b = 1.0 m, construction height H = 2.20 m, slope inclination 1: 2; channel bottom slope, i = 0.01%; surface with large reinforced concrete slabs, S_d = 56,420 m^2.
2. Functional characteristics: transported flow, Q = 1.60 m^3/s.
3. Constructions on the canal: four bridges and a dam.

The AC adduction channel takes water from SPR3 and distributes the water to two distribution channels CD1 and CD2. Channel CD1 supplies the single-wire irrigation block 10. Channel CD2 supplies the single-wire irrigation block 11. The AC adduction channel was put into operation in 1977 and has the following characteristics:

1. Structural characteristics: total length: 4081 m; trapezoidal section in the excavation with the width at the bottom b = 1.0 m, construction height H = 1.66 m, slope inclination 1:1.50; channel bottom slope, i = 0.02%; the perimeter of the canal is waterproofed with large tiles.
2. Functional characteristics: transported flow, Q = 1.35 m^3/s.
3. Constructions on the canal: bridges.

The distribution channel CD1 carries a flow Q = 1.15 m^3/s and has the characteristics: L = 2750 m, trapezoidal section in the flow with b = 1.0 m, H = 1.66 m, i = 0.03%, slope inclination 1:1.50. Bridges and a dam are located on the canal.

The secondary channel CS38 is fed by SRP3 and SPR1, and the water is distributed to the irrigation plot SPP14. The secondary channel

CS38 carries a flow Q = 0.75 m^3/s and has the characteristics: L = 1190 m, trapezoidal section in the excavation with b = 0.50 m, H = 1.35 m, i = 0.03%, inclination slope 1:1.50. Bridges and a dam are located on the canal.

The CA4 adduction channel is fed by SPR3 and distributes water to the SPP12 and SPP8 irrigation plots, as well as to a CD distribution channel. The CD channel feeds the single-wire block 15. The CA4 and CD channels were put into operation in 1977. The CA4 channel has a trapezoidal section with a bottom width b = 1.0 m and is made of excavation.

The CA5 adduction channel is fed by SPR4 and distributes water to the SPP16 irrigation plot and to the SPPM17 / VII single-wire block. The CA5 channel was put into operation in 1977 and has the following characteristics (Luca, 2016):

1. Structural characteristics: total length: 11,850 m; trapezoidal section in the excavation with the width at the bottom b = 2.0 m, construction height H = 2.85 m, slope inclination 1:2; channel bottom slope, i = 0.01%; surface with large reinforced concrete tiles, S_d = 60,410 m2.

2. Functional characteristics: initial transported flow, Q = 2.0 m^3/s.

3. Canal construction: bridges and dams.

After 1990, there were exchanges of land, but also of property, through which the structural components of the irrigation systems were modified. The surface of the plots, the length of the channels and pipes, the supply flows, etc. they have changed continuously over time.

The canals in the structure of an irrigation system need a series of annual maintenance and repair works, which are highlighted (Pleşa I., Burchiu V., 1986, Ghelase I., 2000):

- unclogging the flow section;
- cleaning and restoring the structure of the joints between the waterproofing tiles of the flow section;
- structural restoration of the slabs by removing the broken ones and assembling / pouring new concrete slabs;
- repair works on the structure and hydraulic installations of the dams;
- restoration of the entrance, flow and exit sections of the bridges;
- canal canopy restoration works, etc.

The research was carried out between 2014 and 2020 by field analysis of the structural condition of the components of irrigation systems in operation (Luca M., 2015, Luca M., 2016, Luca M., 2020).

The current constructive and functional state of the supply channels of the irrigation plots for the study area is represented by the supply channel CA3 from „Albiţa - Fălciu Complex Irrigation and Drainage Development". The research conducted on this channel in 2019 highlighted the following aspects (Luca M., 2019):

A. General data on the operating process: structural and functional conditions

- the CA3 adduction channel has been in operation for about 43 years, during which time it underwent a complex of natural and anthropic actions differentiated in time;
- since 1990, the ownership regime over the structural components of the irrigation system has changed; the basic pumping stations and the canal network remained in the state administration; irrigation plots were taken over by companies / private associations;
- before 1990, annual maintenance and repair works were carried out regularly (clearing, restoration of joints between tiles, structural restoration of tiles, repair of dams, restoration of bridge drainage sections, etc.);
- the pace of application of maintenance and repair work on canals after 1990 has decreased considerably, and in some canal sectors they have completely disappeared.

B. Current structural condition of the canal and hydrotechnical constructions:

- the channel shows a degradation of the structure in length by settlements, collapses and swellings of the slope, modification of the geodesic slope, etc. (*figure 4*);

Figure 4 **General structural condition of the CA3 channel between the SPP8 and SPP9 pumping stations (Luca M., 2020)**

- the cleared alluvium was deposited on the canopy of the canal, a situation that determines the return to the section of the canal under the action of climatic factors;
- large reinforced concrete slabs used to waterproof the channel flow section are degraded in a proportion of 80 - 100%; this situation changed the geometric and hydraulic parameters of the channel flow section;
- the joint between the slabs filled with cement mortar was completely destroyed, which

favoured the penetration of water under the slabs and the destruction of the support layer; in the joints a vegetation developed that increased the roughness coefficient (*figure 5*);

Figure 5 **General structural conditions of the joints between the tiles of the CA3 channel (Luca M., 2020)**

- a large part of the tiles are cracked, displaced or missing (*figure 6a*);

- the absence of tile maintenance and repair works determined the growth of vegetation of various species (grass, shrubs, trees, etc.) and dimensions in the flow section (*figure 6b*); vegetation contributed to the dislocation of the tiles, their movement and fracture;

- the canal areas where the irrigation water is captured by the pumping stations (SPP) is in a state of advanced degradation; the section of the channel is deformed due to the movement of the slabs and the hydrodynamic erosion (*figure 6b*);

- the water intake taps / pipes located in the canal slope are protected with gratings made of cast iron; the grills are displaced, corroded and unstable; this situation allows the access of large alluvium in the hydromechanical installation of the pumping station (*figure 7*);

a

b

Figure 6 - **State of structural degradation of the CA3 supply channel: a - geometric modification of the flow section by moving and fracturing the slabs; b - the presence of arboreal vegetation in the flow section (Luca M., 2020).**

a

b

Figure 7 **- The state of structural degradation of the CA3 supply channel in the SPP catchment area: a - general view of the catchment area for SPP8 Oţetoaia; b - the state of degradation of the grilles on the suction pipes (Luca M., 2020).**

- the channel in the area of the SPP pumping stations is equipped with a dam to create water levels for the sockets / suction pipes (*figure 8a*);

- the construction and installation of the dam is degraded in proportion of 80 - 90%, and its operation is deficient (*figure 8b*); the metal

constructions of the dam have exceeded the operating period and no longer provide functional parameters (tight closing, controlled flow transit);

a

b

Figure 8 - **Degradation state of the CA3 channel in the dam area from SPP8: a - general view of the channel section; b - detail regarding the condition of the dam (Luca M., 2020)**

- the bridges used at the intersection of the canal with the road of exploitation are degraded in proportion of 60 - 90%; the construction of the bridges was modified in time by the interventions for repair works (*figure 9*);

- the completely degraded bridges were replaced with temporary constructions (PREMO tubes);

- a part of the adduction channels of the irrigation plots from „Irrigation Systems Albița – Fălciu" are clogged in excess, and in time an abundant vegetation represented by reeds has developed (*figure 10*);

Figure 9 - **General view of the CA3 canal and a modified bridge at the intersection with an exploitation road (Luca M., 2020)**

C. Synthetic elements regarding the functional state of the supply channel:

- the current structural condition of the canal no longer allows the fulfilment of the functional parameters according to the technical execution project (SPP supply flow, water depths in the area of the suction pipes, irrigation water quality, limitation of water losses, etc.);

Figure 10 - **Condition of the CA5 adduction channel with clogged sections and the presence of reed vegetation (Luca M., 2020)**

- the transported flow is reduced along the length of the canal due to the large water losses by infiltration caused by the totally unsatisfactory condition of the waterproofing system;

- an important influence on the transported flow is presented by the increased value of the roughness of the wet perimeter of the canal; the value of the roughness coefficient after Manning increased from 0.014 - 0.015 to 0.030 - 0.045 depending on the degree of degradation of the concrete slabs and the presence of vegetation on the wet perimeter;

- the water losses allowed for the CA3 channel protected with reinforced concrete slabs jointed with cement mortar are of maximum 5%;

water losses at the current stage reach 40 - 60% and involve high costs to ensure the volume of water for irrigation;

- the operating efficiency of the canal has decreased significantly, from 90 - 95% at commissioning, to 55 - 60% at the current stage, due to the degradation of the waterproofing system;

- the efficiency of a canal in an irrigation system is determined by the relationship (Pleşa and Burchiu, 1986):

$$\eta_r = \frac{Q_i - Q_p}{Q_i} 100 \ (\%),(1)$$

where where Q_i is the flow introduced into the network; Q_p - lost network flow; the use of the relationship requires the measurement of the water flow introduced into the network and the lost flows, an aspect that is not currently achieved in irrigation systems;

- on long-length canals, a clogging phenomenon differentiated in length was achieved; alluvium was deposited along the length of the channel depending on the diameter and specific gravity; the volume of alluvium decreased along the length of the canal, being influenced by their takeover by the pumping stations;

- the large amount of alluvium present in the water transported by the CA3 canal and in general in the irrigation systems from „Irrigation Systems Albița – Fălciu" is taken over by the pumping stations and deposited in the network of pipes that supply the irrigation equipment (Luca, 2020);

- the process of clogging the channels is particularly intense, but differentiated on sections; the analysis performed on CA3 showed the thickness of the alluvium layer of 0.30 - 1.20 m; the SPP operating personnel intervene in some situations to clear the section of the canal and ensure the suction quotas;

- transport of alluvium that influences the quality of irrigation water, which causes faster degradation of sprinklers in irrigation systems;

- the alluvium from the irrigation water generates a negative impact on the mechanical characteristics of the pumping units (accentuated wear of the rotor at the pumps) and determines the increase of the energy consumption at the pumping stations fed from the canals.

The researches carried out on supply and distribution channels from the „Brăila Terrace Irrigation System" (Ghelase I., 2000) highlighted the negative impact of alluvium in the operation of SPP type pumping stations. The research showed the role and functional characteristics of alluvial access limitation installations in the pump suction line. Without works to stop the access of alluvium to the outlet of the base stations of the irrigation system, a favourable operating efficiency of the supply channels and pumping stations cannot be ensured.

For the efficient operation of the SPP pumps, as well as of the pipeline network within the irrigation plot, a series of installations are proposed that limit the access of alluvium in the suction of the pumping stations (Ghelase, 2000).

Every year there is a reduction of the irrigated area due to the degraded technical condition of the main infrastructure of the irrigation systems. The study found the state of degradation in various stages of the basic pumping stations (SPR1 Pogănești, SPR2 Săratu, SPR3 Bumbăta, SPR4 Berezeni) and the adduction channels CA2, CA3, existing CA, CA5, distribution channel CD1 and channel secondary CS38 etc.

Some canals are not waterproofed along their entire length, a situation in which water losses through infiltrations cause a decrease in efficiency. Also, the water losses from the canals cause a high consumption of electricity, with a share of about 80-90% in the irrigation water tariff.

In the last period of time, the importance of the rehabilitation works of the main infrastructure from the existing irrigation systems has been realized and attempts are being made, for the time being at a low pace, for the maintenance and rehabilitation of some components of it. Some private operators have approached the development of irrigation infrastructure on their own, although in other countries it is a government activity (Blidaru V. *et all*, 1982, Cismaru C., 2004).

The increase in operating costs and the low yields of the supply, distribution and secondary canals for the supply of irrigation plots necessitate the rehabilitation of the canal network.

The rehabilitation of the canal network of the irrigation system is done in the first stage by drawing up a technical expertise. This expertise substantiates the technical project; acre will be approved by a project verifier in the field of land improvements. The technical design may provide for a partial or total change of the duct waterproofing system by using modern solutions. The hydraulic systems on the channels must be completely changed, as their service life is exceeded (Luca M., 2020).

The absence of the complete rehabilitation of the canal network determines the intensification of water losses on the old canal sections, which have exceeded the exploitation period. The absence of the rehabilitation of the constructions on the network of canals (hydrotechnical nodes, bridges, water intakes, dams, etc.) determines the

increase of the number of damages and implicitly of the water losses (Chirica St. *et al*, 2018).

The efficiency of the canal network is not currently assessed by the irrigation systems operation services. This activity should be intensified with the adoption of measures to reduce water loss and energy consumption.

CONCLUSIONS

The main infrastructure of irrigation systems still operating in Romania is the least rehabilitated and modernized component after 1990.

The research carried out in the „Complex Development of Irrigation and Drainage Albița – Fălciu" in the period 2014 - 2010 showed that the network of supply and distribution channels of irrigation systems must be rehabilitated in view of exceeding the service life of most components (construction structure, system waterproofing, dams, bridges, etc. catchment outlets, etc.) and large water losses recorded in the operation process.

The waterproofing system of the channels (large concrete slabs with joints filled with cement mortar) has an advanced state of degradation, a situation that causes high water losses, but also a high consumption of electricity to pump the volume of water required by operation of the irrigation system.

Hydrotechnical constructions and installations located on canals are in an advanced state of degradation, even unusable, given the exceeding of the service life.

The network of canals has a high degree of clogging, a situation that influences the value of the transported flow and the achievement of water levels on the canal imposed by the suction of pumping stations.

Irrigation water has a high degree of turbidity, a situation that causes a negative impact on the operation of pumps, the network of pipes and irrigation equipment.

The lowest hydraulic efficiency takes place on the network of transmission and distribution channels, where there are the highest water losses (about 40-60% of the water volume), given the absence of rehabilitation works in the last 30 years.

Bringing the infrastructure of the irrigation system to the level of current technology requires the realization of an extensive program of rehabilitation and modernization of the canal network, as well as the related constructions and installations.

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STUDIES AND RESEARCH ON WATER LOSSES FROM IRRIGATION SYSTEMS

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Abstract

The advanced degree of wear of the irrigation system infrastructure determines the occurrence and maintenance of water losses. The research was conducted in irrigation systems located in the eastern part of Romania and which have different periods of operation, but all performed before 1990. The research highlighted the complexity of the process of degradation of structural elements and the development of water loss. The structural degradation of the canals and pipes under the action of natural and anthropogenic factors determined the appearance of water losses and, implicitly, the decrease of the hydraulic efficiency. The research highlighted a degree of degradation of the supply and distribution channels of about 40-60%. An important influence in the degradation action was the absence of maintenance and repair works. Significant water losses are recorded in the pipelines. Their value reaches 18 - 27% of the transported flow, being determined by the wear of the material and the aging of the components of the hydraulic installations. Water losses are of the visible, hidden and background type. The use of European funds to rehabilitate irrigation systems requires reducing water losses.

Key words: basins, canals, hydraulic efficiency, monitoring, water leaks

At the level of 1989, Romania had a series of irrigation systems with a technical level corresponding to the existing technologies and execution materials at national and international level. Irrigation systems have been designed to complete the water supply for the development of agricultural and horticultural crops in the climatic conditions of Romania (Blidaru V. *et al*, 1981, Cazacu E. *et al*, 1982).

After 1990, most of the existing irrigation systems in Romania were abolished for various reasons; the change of ownership of the land and government decisions was the main causes. At present, a small number of irrigation systems built before 1989 are in operation. The irrigation systems in operation have degradation processes at the construction structure and at the installations that serve the operation process. (Luca M. *et al*, 2016).

Irrigation systems built before 1990 were composed of water source, pumping stations that raised water at various levels, transport channels, pressure stations or bivalent watering, conduits, hydrotechnical bypass nodes protection and control facilities and so on (Blidaru V. *et al*, 1981, Cismaru C., 2004).

Water losses from the network of canals and pipes are permanently present in the process of operation of irrigation systems. Water losses influence the hydraulic efficiency of the components of the irrigation system, but also the operating costs in a negative way. Water losses have been present since the establishment of the system, and their value varies over time.

The infrastructure of the irrigation systems (water intake, basic pumping and re-pumping stations, discharge pipes and supply and distribution channels, etc.) is managed by the Romanian state. The irrigation plots were taken over by the private operating system. The researches show that the irrigation systems in operation show degradation processes of the constructive structure and the hydraulic installations for water transport (Luca M., 2012, Luca M., 2015, Luca M., 2020).

The network of pipelines and canals was executed between 1975 and 1978 and has exceeded its operating time. This situation currently causes a large number of damages during the operation process. The use of European funds in the rehabilitation of irrigation systems requires the reduction of water losses (Cismaru C., 2004, Luca M. *et al*, 2017).

The objective of the paper is to analyze the types of water loss present in the infrastructure of irrigation systems currently in operation and how to monitor them.

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MATERIAL AND METHOD

The research area belongs to the arid climate zone of Romania (*figure 1*). The material used in the research consists of a series of irrigation plots located in the eastern part of Romania, respectively in Iaşi and Vaslui counties (figure 2).

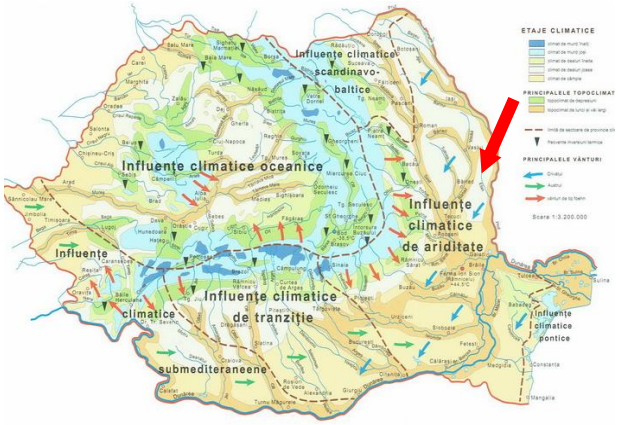


Figure 1 **Location of the researched area in the climatic zones on the Romanian territory**

The irrigation systems analyzed are fed from the Prut River. Irrigation plots are located in the meadow and terrace areas of the Prut River (*figure 2)*. The basic pumping stations (SPB) take water from the Prut River and discharge it through pipes into the canals in the meadow area. The terrace area is fed through the discharge pipes of SPB and SRP (pumping stations), which are connected to the supply and distribution channels. The pumping and pressurization stations (SPP) of the irrigation plots are fed from the canals (Luca M., 2015, Luca M., 2016, Luca M., 2020).

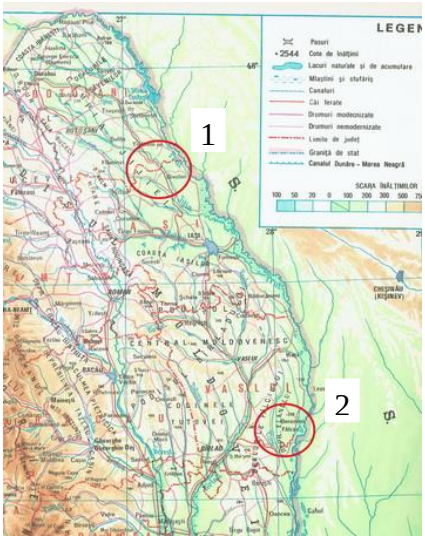


Figure 2 **Areas of study and research: 1 - South Soloneţ irrigation system; 2 - Albiţa Fălciu Complex Irrigation and Drainage Development**.

The research method is similar to that of technical expertise for irrigation systems. The field research analyzed the structural and functional state of the components of the irrigation system with influence on water losses.

Through documentation, the state of the structural components was analyzed based on known and accessible data. For each irrigation system, the initial topographic plans were used, but also those updated at the time of the research. The field research took photographic surveys and video images.

The data processing followed the methodology used in the technical and scientific analyzes developed for irrigation systems with transmission and distribution networks from canals and pressure pipes. The primary data collected were processed through specialized analysis programs in the field of irrigation research.

RESULTS AND DISCUSSIONS

The initiation and evolution of water losses in the structural components of irrigation systems are generated by natural and anthropogenic risk factors. Risk factors are generated from the design and execution phases. Also, water losses can be generated by new risk factors that appeared during the operation phase of the irrigation system.

The risk factors that initiate and develop water losses in the structure of the irrigation system come from the following situations (Luca M., 2020; Chirica Ș., Luca M., 2017):

- the quality and the way of elaborating the design studies (topographic, geotechnical, hydrogeological, climatic, seismic, etc.); the quality of studies is dependent on the professional quality of the staff of the company that elaborates the studies;

- technical quality of the project at various stages of implementation (feasibility study, technical project, execution details, specifications, etc.); the technical quality of the project must be correlated with the professional quality of the design team for the components of the irrigation system;

- natural and anthropogenic risk factors are introduced in the design stages through the activities: a - analysis of the geo-physical data of the site; b - designing the structure of the irrigation system; c - definition of flows, pressures, water heights in canals; d - choice of materials and technologies for the execution of water transport and storage components; e - calculation of constructive and functional parameters, etc.;

- the professional quality of the execution team highlighted by the materials and technologies of execution of the system (installation conditions for pipes and channels, the quality of joints and

joints, the waterproofing technology of channels and basins, etc.);

- the professional quality of the operation team of the irrigation system highlighted by the management of water losses (detection method, equipment, monitoring methods, intervention measures, etc.);

- the management of the user of the irrigation system through the characteristics of the exploitation process, with reference to the rehabilitation and modernization works of some components of the system.

Water losses in irrigation systems are composed of the following components (Blidaru V. *et al*, 1981, Stăncescu L. *et al*, 1984):

- evaporation losses at the water surface, E_v (mm), expressed by the relation:

$$E_v = 15R_o d_u(1 + 0{,}20V_v),(1)$$

where R_v is a correction coefficient; d_u - moisture deficit, in mm Hg; V_v - wind speed, in m/s;

- water losses by evaporation produced on the network of canals and in suction, discharge, storage tanks; q_{ev} (m^3/s); they are calculated with the relation:

$$q_{ev} = 0{,}001E_v S_e ,(2)$$

where S_e is the surface of the water gloss of the canals / basins, in m^2; E_v - value of 5-10% of evaporation losses, in mm;

- water losses in the system operation process, q_{ex} (m^3/s); they are produced by water emissions from the network of unused canals and pipes and volumes; operating losses are assessed in relation to:

$$q_{ex} = \frac{N_u + V_r}{T_p} + q_v L_v ,(3)$$

where N_u is no number of waterings during the vegetation period; V_r - the volume of water left unused on the network at a single watering, m^3; T_p - during the vegetation period, in s; q_v water losses caused by leaking valves, in $m^3/s/m$; L_v - the length of the wet perimeters of the taps, in m;

- water losses produced at hydraulic installations, especially at taps and hydrants, q_v ($m^3/s/m$); these were evaluated by research at values of 0.0001 - 0.0002 $m^3/s/m$ depending on the quality of the sealing works; losses are valued with empirical relationships, or assimilated with similar relationships; the structure of the calculation relationship is:

$$q_v = f(l, d, s, p, \ldots),(4)$$

where l is the length on which the water emission takes place; d - diameter; s - the size of the emission space; p - service pressure;

- water losses by infiltration from unlined or lined canals, but with significant degradations of the waterproofing layer located on the perimeter of the canal, q_i, ($m^3/s/m$); infiltration losses are evaluated with relationships obtained through research and have the following form:

$$q_i = f(l, b, m, h, k, B, \ldots),(5)$$

where l is the infiltration length; b - the width of the bottom of the channel; m –the slope coefficient of the slope; h - water depth; k - hydraulic conductivity of the land; B - width of water gloss, etc.; in the specialized literature are presented relations and calculation diagrams.

In the sprinkler irrigation plots, water losses are allowed according to the values imposed by the operating norms. The value of losses is specified according to the place of production and limited to the following values (Stăncescu L. *et al*, 1984):

A - Characteristics of the irrigation plot (ISPIF, 1987a):

- branched pipeline network consisting of main pipelines - CP, secondary pipelines - CS and tertiary pipelines - A:

- central type pumping and pressurizing station (SPP);

- single-wire pumping and pressurizing station (SPPM);

- watering equipment for sprinkler watering.

B - Allowed values (percentages) for water losses from the total volume of water transported (Stăncescu *et al*, 1984):

- in the pipeline network about 5%;

- in the supply channel protected with a waterproof clothing about 5%;

- when watering in the field about 10%.

The degradation of the network of pipes and canals within the irrigation system initiates and develops large water losses. This situation determines the progressive increase of the number of damages and the increase of energy consumption (Cismaru V., 2004; Luca M., 2012, Luca M., 2020).

Water leaks from an irrigation system can be present in the following forms:

- substantive losses that occur in the operation of the structural components of the system in the operation process;

- unavoidable / planned losses in the operation process (e.g. emptying the pipeline network);

- diffuse water losses, which manifest themselves in the forms:

a. losses through pores formed in the pipe wall made of various materials (steel, cast iron, reinforced concrete);

b. losses through microcracks/small cracks in the wall of PVC, HDPE, cast iron, composite materials, etc .;

c. losses at the fittings for joining the pipe sections (elbows, branches, reductions, special parts, etc.);

- concentrated water losses, which are manifested by the forms:

a. losses caused by damage through cracks, breaking areas, material ruptures, etc.;

b. losses arising from the expulsion of the gasket at the connection of the valves, fittings and equipment in the hydraulic installation mounted in the manholes of the pipeline network;

c. losses occurring at the joint of the pipe sections, fittings and fittings in the hydraulic installation mounted in pumping stations;

e. losses formed during the total degradation or blockage of the hydraulic shock protection installations within the pipeline network and of the pumping stations (installations for aeration, hydraulic shock, emptying, etc.);

e. losses formed at the total degradation of the canal structure by breaking it, spilling the canopy, blocking the canal protection installations (eg clogging of the siphon spill).

Water losses are initiated and evolve over time in the structure of each component of the irrigation system. Water losses can be classified according to their position:

1. Losses from "water abstraction" from the source, determined by the structural condition of the intake constructions, the hydraulic installation and the take-up / pumping equipment.

2. Water losses caused by the state of the constructive structure of the “pumping / re-pumping station” on the supply and distribution route; losses occur at suction and discharge tanks, in the hydraulic installation, in the protection equipment, etc.

3. Water losses produced by the constructive structure of the supply and distribution channels made of earth or waterproofed with various materials.

4. Water losses produced by the components of the pipeline network with the role of supply and distribution to the irrigation plots. The leaks take place through the pipe wall, at the joint of the pipe sections, at the hydraulic installation in the manholes, etc.

5. Water losses produced by the constructive structure of the pumping station infrastructure (suction basin, wet tank, manholes with hydraulic installations, etc.).

6. Water losses produced by the components of the hydraulic installations in the irrigation plots (network of pipes, hydrants).

7. Water leaks caused by watering equipment components.

Limiting the water losses produced in the components of the irrigation system require a series of measures and rehabilitation works. These may include:

- periodic inspection of the structural state of the components of the irrigation system to highlight water losses;

- monitoring the volumes of water taken from the source, stored in canals and pipe networks, as well as drawing up a balance of the volumes of water consumed and lost;

- regular inspection of hydraulic drainage, overflow installations and of the separation and control valves on the pipelines;

- regular inspection of hydraulic protection installations (overflow-siphon), bypass dam, automatic control dam on channel networks.

Water loss management must consider the temporary mode of operation of the irrigation system. Irrigation systems in Romania have a functioning for certain periods of time (spring, summer and autumn), after which they enter conservation (winter and part of spring / autumn). When the operation process is interrupted (usually in autumn), the network of pipes and canals is emptied, a situation that determines a planned water loss. Water loss management also means reducing troubleshooting times, identifying flow areas and limiting the amount of water lost (Chirica Ș., 2019).

The network of pipes within an irrigation system is made with materials that respect the characteristics of the site (external loads, aggressiveness of the terrain), physical and chemical parameters of the transported water (temperature, clean or alluvial water and chemical conductivity) and hydraulic parameters (flows, speeds, pressures). The type of connection of the pipe sections is a main factor in the formation and evolution of water losses. The components of the joints, which structure and achieve the tightness of the pipe, withstand mechanical actions, degradation and aging phenomena over time (ISPIF, 1987b). These actions cause displacement and expulsion of the joint material.

Degradation over time of the joint between the waterproofing tiles of the channels, as well as the cracking / cracking of the tiles determines the appearance of water losses.

Physical water losses have existed in all the structural components of the irrigation system since its inception. They are classified according to

their type and size:

1. Visible water losses, where they occur at or to the surface of the land and can be located immediately. Visible water losses are caused by the following situations:

- damage to the pipes or to the joints of the pipe sections;
- structural degradation of hydraulic installations in manholes with taps and pumping stations;
- structural degradation of hydraulic installations in pumping stations;
- structural degradation of irrigation hydrants;
- degradation of the waterproofing layers made on the perimeter of the canals;
- structural degradation of canals made in embankment and semi-embankment.

2. Hidden water losses, which do not manifest themselves on the surface of the land and are difficult to detect. These are caused by the degradation of the structural elements of the components of the irrigation system below the ground surface. Hidden water losses are caused by the seepage of water from the canals, the seepage from the suction and discharge basins, the degradation of the plugs at the irrigation pipes, etc. The detection of these losses involves special measurements and equipment for their detection.

3. Substantial losses, which occur with low flows from the underground infrastructure of the irrigation system. These losses cannot be detected using current technical methods.

The studies and researches carried out within the "Complex Management of Irrigation and Drainage Albiţa Fălciu", in the "Irrigation System North - Soloneţ" and "Irrigation System Terasa Brăilei" highlighted the presence and special influence of water losses on the exploitation yields of the channels and pipes (Luca M., 2012, Luca M., 2014; Luca M., 2015; Luca M., 2016; Luca M., 2020).

The research carried out in 2019 in the "SPP 8 Oţetoaia Irrigation Plot" and the "SPP 9 Oţetoaia Irrigation Plot" from the Albiţa Fălciu Irrigation System (*figure 2*) highlighted the following very high water losses (Luca M., 2020):

- water losses on the adduction channel network (AC and CD) of the pressurization stations (SPP) produced by the advanced state of degradation of the constructive structure: degradation of the joint between the concrete slabs; breaking and moving the tiles on the slope, washing the support layer of the tiles, compacting the slope from the ground, etc. (*figure 3*); the value of water losses is estimated at about 35% - 45% of the volume of water introduced into the canal;

Figure 3 **The state of degradation of the canals in the SPP Irrigation Plot 8 Oțetoaia with factors to increase water losses (Luca M., 2020)**

- water losses on the pipe network of the irrigation plot (main pipes - CP, secondary pipes - CS and tertiary pipes - A); the main pipes made of steel were degraded by chemical corrosion on some sections, a situation that caused large water losses (*figure 4*); the water losses evaluated on the main pipe are about 17 - 24% of the pumped flow, a situation that determined the replacement of the degraded sections.

Figure 4 **Degradation status of the main steel pipes in the SPP Irrigation Plot 8 Oțetoaia with water loss increase factors (Luca M., 2020)**

The absence of the complete rehabilitation of the pipeline network determines the intensification of water losses on the old pipeline sections, which have exceeded the operation period. The absence of the rehabilitation of the manholes on the network of pipes, constructions and hydraulic installations, determines the increase of the number of damages and implicitly of the water losses.

The problem of water losses in the pressure pipelines (P = 6.0 - 8.0 bar) in the irrigation plots must be considered in the rehabilitation process.

Water losses influence the efficiency of the pipeline network and implicitly the operating efficiency of the irrigation plot.

The efficiency of the pipeline network for the case of current operation can be determined by the relationship (Stăncescu L. *et al*, 1985):

$$\eta_c = \frac{\alpha * Q_{inst} * T_1 - \sum p_I * T}{\alpha * Q_{inst} * T_1} * 100 \ [\%] \qquad (6)$$

where: α is the ratio between the average daily flow achieved and the installed flow at the SPP; Q_{inst} - the installed flow of the SPP; p_i - the sum of water losses in the irrigation season (percentage of the total volume of water pumped); T_1 - number of days of operation of the SPP; T - the duration of the irrigation campaign in which the network was full of water.

In order to identify and remedy the defects that have appeared in the irrigation systems, a series of specific steps are taken in this field. The first step is to define on the ground the sectors of the canal or pipeline networks are water losses. Each sector is divided into mini-sectors on distinct structures (canal sections, pipe sections, hydraulic installations in manholes, etc.). In the second stage, a system of permanent monitoring of the mini-sectors with water losses is realized. In the third stage, the areas with losses are located and their cause is defined: damages, disturbances, advanced wear of the components, exceeding the functional parameters (flows, pressures, water heights), etc.

In the third stage, the way of tracking the losses, measuring the parameters and making remedial decisions is initialized. All the basic data of the components of the irrigation system, the history of damages on structural components, functional parameters, the value of water losses, remediation works, etc. are introduced in a monitoring program. The Land Improvement Administration must be equipped with a department specialized in the field of water loss monitoring. This department must be equipped with equipment and qualified personnel for this very important field in water management in the transmission and distribution network of the irrigation system. The management of water losses in the network of canals and pipes of the irrigation system can also be performed by specialized companies (Cassa A.M. *et al*, 2010).

Through the process of monitoring the sectors and mini-sectors, a series of data is obtained, which establish the investigation areas in detail for the identification of defects on the network of channels and pipelines (Chirica Ș. *et al.*, 2018).

In the third stage (location of damages / defects) the search area for structural defects is restricted by using equipment and devices to indicate possible losses. Among the most used equipment are noise loggers.

Water leaks from the pressure pipes cause vibrations in the pipe walls (*figure 5*). These vibrations can be recorded with the help of loggers. The equipment detects both the noise produced by the fault and the frequency. Based on these factors, the probability of a network fault can be determined, as well as its relative position in relation to other loggers mounted in the system (Chirica Ș., 2019).

Figure 5 **Noise loggers for monitoring and acoustic detection of water leaks in pipes (Chirica Ș., 2019)**

Loggers record the sounds produced on the network by the presence of water emission zones. The loggers are mounted on different areas of the inspected pipe sector. so that the result is not influenced by other noises. Depending on the values obtained, it is established whether detailed investigations are necessary or another area is inspected.

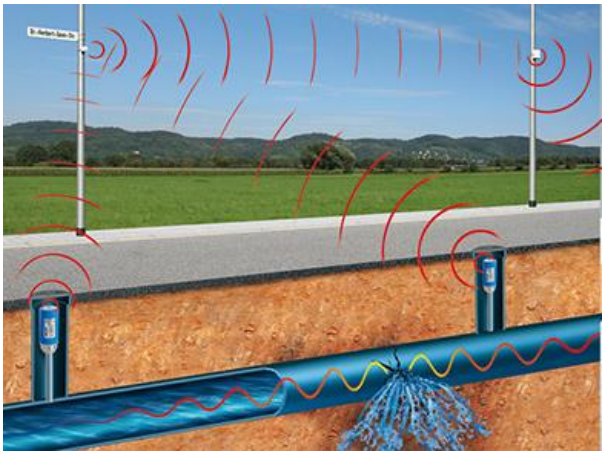


Figure 6 **Flow and pressure loggers for monitoring and acoustic detection of water leaks in pipes (Chirica Ș., 2019)**

It is widely used by flow and pressure loggers, which are robust and compact devices that are mounted on the pipeline network (*figure 6*). They transmit information about the flows and pressures in the water supply pipes. The equipment can be equipped with alarm systems, which signal

to the operator in real time the appearance of significant changes in the values of flows and pressures (Chirica Ș., 2019).

After the restriction of the inspection area, the location of the damages is done by using acoustic and non-acoustic equipment. The most used acoustic equipment is the type of ground microphones and noise correlators. Non-acoustic equipment involves the use of a tracer gas or georadar.

Acoustic monitoring of the network can be permanent, by installing a network of loggers to transmit data daily, or occasionally, when flow measurements show the existence of a fault on the network. The main advantage of using a network of loggers is the reduction of fault location times, thus minimizing lost water volumes.

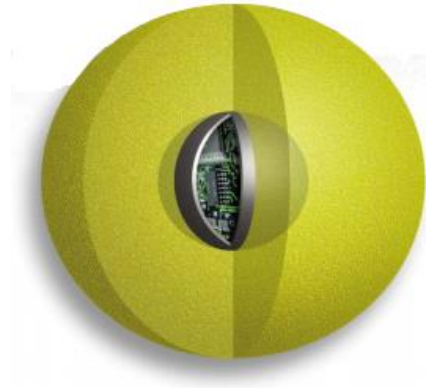
Ground microphones are mechanical or electronic equipment (*figure 7*). Microphones use sound amplification devices produced by vibrations caused by damage to pipes. The microphones have noise filtering devices so that the recorded results are relevant to the leak detection activity. The efficiency of the investigation method is largely based on the professional experience of the operator.

a b

Figure 7. **Ground microphones: a - equipment with digital signal processing technology; b - equipment with integrated sensor (Chirica Ș., 2019).**

A state-of-the-art technology is "Smart Ball", which determines the noises produced by the phenomenon of "water loss" in a working pipe. This technology uses a polyurethane foam ball with an aluminium core in which a sensor is inserted to detect noise from water leaks in pipes (*figure 8*).

The detection sensor is inserted into the pipe through an access point and extracted through another pipe control point. The sensor floats freely along the pipe and collects data on the functional state of the pipe. The technology can record the collected data for up to 12 hours. After completing the preset route, the sensor is removed from the pipe using a recovery net. The collected data is processed and centralized in the pipeline network monitoring program.



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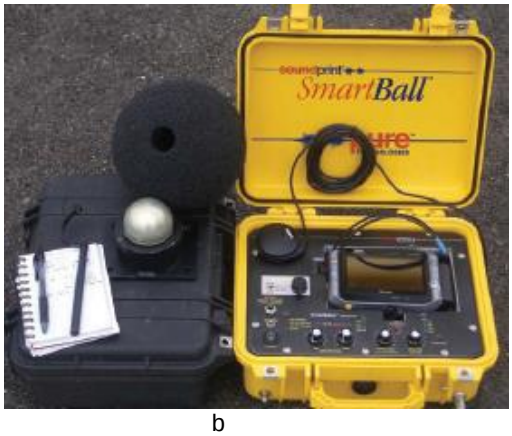

b

Figure 8. **Technology for detecting water loss from Smart Ball pipes: a - section through the parameter detection sensor; b - complete water loss detection equipment (Chirica Ș., 2019).**

For the investigation of old pipelines and in the absence of initial situation plans, the "Georadar" can be used (*figure 9*).

Figure 9. **Pipe detection equipment type Georadar**

Georadar uses radio waves (electromagnetic waves) to investigate construction elements and underground installations. The technology has been adapted to locate water leaks in buried pipes and investigate the condition of underground

networks. Leaks are identified due to differences in the density of the land in which the pipes are embedded and its water content.

The penetration power of the equipment depends on the length of the radiation wave and the electrical permittivity of the rock in the site. The use of this technology requires knowledge of the geotechnical properties of the site and especially its electrical conductivity.

Water loss detection can be done with the help of satellite technology (Ganea D., 2015). This is based on the identification of the spectral footprint of water. Satellite-mounted sensors identify water leaks from a pipeline network. The main advantage of this technology is the ability to obtain information on the entire operating system with a single use. Satellite detection covers areas of thousands of square kilometres and indicates the position of losses in an area with a diameter of 6 meters.

CONCLUSIONS

1. Water losses have been present since the establishment of the irrigation system, and their value varies over time depending on the technical characteristics of the operation process.
2. The irrigation systems in Romania, which are still in operation, have a long service life, and the absence of maintenance and rehabilitation works of the network of canals and pipes has determined the progressive increase of water losses.
3. The irrigation systems analyzed in the eastern part of Romania show background water losses from the supply and distribution channels due to their structural degradation.
4. The field analysis revealed significant background water losses to the system's supply pipes, as well as to the network of pipes of the irrigation plots due to exceeding the service life of the execution material.
5. At the present stage, a system for tracking water losses must be developed with the use of modern reversal technologies and monitoring programs over time.
6. Water losses adversely affect the hydraulic efficiency of the components of the irrigation system, energy costs and in general the operating costs of the irrigation system.

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ENGINEERING MEASURES FOR SOIL EROSION CONTROL ON AGRICULTURAL LAND IN THE PODOLENII DE SUS AREA, COZMESTI COMMUNE, IASI COUNTY

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Abstract

Lands requiring improvement are placed on slopes larger than 15%, located Cozmesti commune, in Iaşi County. The total area of the perimeter is 50.4 ha and is located in the extravilan area. The categories of use in the area are agricultural, stretching over 22.96 ha, namely degraded pasture, very poorly productive and 27.44 hectares now become non-agricultural, of which 1.44 ha are roads operating damaged, impracticable and 26 ha unproductive due to excessive surface erosion, of the formations in depth, permanent excess moisture and vineyards aging, degraded, with destroyed biocenosis. Thus, it was proposed redevelopment the agricultural technological roads, grubbing up of vineyards the abandoned and degraded , to execute marginal and evacuation channels in order to protect the agricultural technological roads, leveling and modeling the lands on the slopes, creation of terraces on the arable , fertilization improvement, works of deep loosening, deep plowing, panting, disking and the application of measures erosion control specific to the land in slope with arable land use category. The fitting of slopes affected by surface erosion, depth erosion and landslides, with hydrotechnical works to control leakage and consolidation, grasslands and the improvement of degraded land contributes to the stabilization and creation of conditions for the evolution of soils, vegetation, biocenoses in ground.

Key words: erosion control, unproductive lands, Iasi County, hydrotechnical and agrotechnical works

The areas of the Podolenii de Sus improvement perimeter in area of 50.40 hectares are located in the outlying area, being delimited to the north by the right slope of the Valley of the Fund, to the east of the current degraded vineyards, to the south of the agricultural exploitation road situated on the Hill the Rotar, which connects with the localities Podoleni de Sus and Lower Podleseni; to the west of the Leurda Forest.

The development of the perimeter of the improvement area consists of a complex of hydrotechnical and agrotechnical works, elaborated according to the natural conditions, the intensity of the degradation processes of the lands and the requirements of the prospective development of the study area, proposed for the improvement of the lands affected by erosion, landslides and excess moisture.

Through the realization of the works exhibited, this, ensures the avoidance of the expansion of the areas out from the productive circuit and the exacerbation of the agricultural land degradation will be avoided on 22.96 ha due to very strong and excessive surface erosion and depth erosion. At the same time, 26.08 ha of non-agricultural land will be reintroduced into the productive agricultural circuit, and fertility will be increased to the corresponding parameters of the agricultural lands currently strongly and very strongly degraded, which will lead to the restoration, their production for agricultural crops (*figure 1*).

Figure 1 **Pasture degraded by slope processes**

Hydrographic, the surface is located in the Siret River basin, and access to the area is made from DN 28A, Targu Frumos-Pascani, to Blăgeşti and then on a road on the left bank of the Siret River.

From the geological point of view, the perimeter belongs to the Sarmatian (Basarabian), superior (Khersonian) and Meotian Sarmatian,

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and from the lithological point of view, slope, up to an altitude of about 250 m, is made up of Khersonian deposits, formed of clays and sands with structure crossed with limestone concretions at the top. Most of the slope is made up of Meotian deposits with the following succession:

- at the base, emeritus benches, with intercalation of weak sandy clays;
- to the middle and upper part, a complex of cross-sands, sandy clays and clays.

Intersections of sands and sandy clays favor erosion in depth, and marms or clays frequent on the slope create the danger of slipping.

From a hydrogeological point of view, groundwater has a level generally at depths greater than 5 m and has a low flow rate due to the reduced receiving basin. Their daily occurrence was detected on a small area.

- the annual average temperature exceeds 9.5°C, with an annual amplitude of 24.8°C;
- absolute maximum temperatures exceeding 35°C are recorded from May to September, with the average freezing period being 181 days;
- average annual rainfall is about 523 - 550 mm;
- summer rains have a torrential character, causing acceleration of soil erosion;

For the pedological characterization of the studied perimeter, the County Office of Pedological and Agrochemical Studies Iaşi has developed detailed studies that have highlighted the following soil types:

- brown soil, typical weak-moderate clay - iluvial, formed on alternations of clays, marms, sandy clays and sands, with a low content of humus;
- loose soil, moles - clay - iluvial soil, from strong to excessively eroded, formed on clay - marmous deposits with low humus content.

MATERIAL AND METHOD

In order The detailed mapping carried out in the Podolenii de Sus perimeter led to the identification and localization of physico-geological processes, such as active, semi-active and stabilized landslides, ravines, surface with the excess moisture.

As a working methodology, was used the inventory of agricutural lands in the studied area, as they were recorded in the cadastral registers of Iasi County, on administrative units, on the most recent topographic maps and even with the help of the GoogleEarth site.

The agrotechnical, pedological and improved districting, according to the I.C.P.A. classification, was elaborated with the classification of the lands into categories of suitability on the criterion of the limiting factors and of the intensity of their manifestation. The grouping of the lands was made by classes and subclasses of suitability with the highlighting of the necessary hydrotechnical and agrotechnical works and measures.

Class II, includes land with good suitability and reduced limitations for agricultural crops, on the surface of 2.20 ha (4.40%), imposed by the slope, the degree of erosion and the level of supply with nutrients, which are manifests with low intensity. The soils of this class are spread on sloping slopes.

Class III, lands with medium suitability and moderate limitations for agricultural crops, on the surface of 25.20 ha (50.00%) given by erosion, slope, unevenness of the land, texture and supply with nutrients, whose manifestation is moderate - weak.

Class IV - lands with low suitability and severe limitations for agricultural crops on the surface of 14.90 ha (29.5%) offered by slope (15 - 20%), strong erosion, unevenness of the land and poor supply with nutrients. There are soils spread on slopes with higher slopes (10-20%) and semi-stabilized landslides.

Class V - land with very severe limitations, slope data (20 - 25%), very strong erosion, very uneven terrain, texture and supply of nutrients, which are manifested with low intensity. It occupies the slopes with eastern and northern exposure with an area of 5.30 ha (10.50%) and are unprepossessed land for agricultural crops, but suitable for meadows after applying the necessary improvement measures.

Class VI- lands with extremely severe limitations, which cannot be used for agricultural crops in the absence of specific anti-erosion planning works, on the area of 2.80 ha (5.60%), comprising deep erosion formations (gulies and ditches) and land with high erosion

In order to know the complex problems of the quality of the ground-land units in terms of the sustainable use of land resources, a study was carried out on the current state of the land and land improvement works in the Podolenii de Sus area; at OSPA Iasi, APIA Iasi, North-East Region ANIF, Agricultural Chamber from Cozmesti County. Soil maps were also used at stairs 1: 200 000 and 1:100 000.

RESULTS AND DISCUSSIONS

In the paper are presented a series of engineering measures, namely hydrotechnical and agrotechnical improvements, which aim to highlight degraded and non-productive land.

The improvement of the improvement perimeter Podolenii de Sus, includes a set of agrotechnical and hydrotechnical improvement works, elaborated according to the natural conditions, the intensity of the land degradation processes and the requirements of the perspective

development of the studied area, proposed for the improvement of the lands affected by erosion. , landslides and excess moisture.

Thus, it is proposed to redevelop agricultural technological roads, deforestation of abandoned and degraded vineyards, executing marginal and exhaust channels in order to protect of agricultural technological roads, leveling works - modeling the lands on the slopes, establishment of banquet terraces on the arable land, realization of spring catches, improved fertilization, deep tilling works, deep tillage, sowing, disking and the application of specific anti-erosion measures on the slopes with the use category, arable.

The arrangement of the slopes affected by surface erosion, deep erosion and landslides, with hydrotechnical works for leakage control and consolidation, the establishment of meadows and the improvement of degraded lands, contributes to the stabilization and creation of the conditions of evolution of soils, vegetation, biocenoses. ground. These can be transformed into new, balanced and stable biotypes, able to edify ecosystems with their own flora and vegetation, only if the arrangements made in accordance with all the existing ecological conditions and factors, will be maintained permanently and periodically supplemented with specific works (*figure 2*).

Figure 2 **Formation of deep erosion and removed from the agricultural land**

In order to restore / improve the productive potential of the land, it is necessary to realize a complex of works and measures hydrotechnical and agrotechnical, consisting of:

- specific works to combat surface soil erosion, depth erosion and the removal of excess moisture due to coastal springs;
- improved fertilization on the entire area provided in perspective with categories of agricultural use;
- scarification in order for loosening the soils with small porosity to increase their capacity for water and air; on surfaces with large slopes, this operation will be replace with the ploughing deep;
- sowing with perennial herbs for permanent grazing on the surfaces that will be arranged as meadows and the banquet terrace patios;
- the application of specific measures on land use in a slope with arable land use; antierosional agrotechnics, by performing agricultural works on the level curve; antierosional crop system and protective overflows with additional application of crops in strips; terraced lands.

I. Hydrotechnical improvement works. Specific works are foreseen for an area of 50.40 ha, consisting of:

1. Redevelopment of agricultural technological roads. In order to avoid the accentuation of the phenomenon of ravines and to ensure the access to the agricultural exploitation and the maintenance of the development works, it has been provided for the redevelopment of the anti- erosion work of 3,77 km of roads in the technological, and the leveling of the drainage and gully as formed along on their route.

2. Dismantling existing roads and paths on an area of 0.73 ha. Current agricultural roads and paths that are no longer maintained, especially those from degraded vineyards, will be dismantled and transformed into agricultural - arable, leveling, scarification, deep plowing and fertilization.

3. Deforestation, namely mechanical and manual deforestation of the old vineyards, deserted, degraded, partially invaded by bushes and destroyed biocenosis, on an area of 12 ha. After deforestation up and removing the stumps, these areas will turn into farmland and meadows.

4. Marginal and exhaust channels in order to protect of agricultural technological roads and for the interception and directed evacuation of excess water from the slopes, it was provided for the arrangement of 3.32 km marginal and evacuation channels.

5. Levelling works-land modeling. Were proposed on a total area of 12.20 ha, of which:

- <u>leveling - modeling works</u> on 6,20 ha area. In order to achieve one continuous and as far as possible uniform slopes of the slope, avoiding the concentration of surface leakage that favors the soil washing and ensuring the mechanized execution in optimal conditions of the agricultural works on the level curves;
- <u>leveling-modeling works of land with microelief of landslides</u>, located on old landslides semistabilized in area of 5.80 ha, in order to correct the slope of the land with attenuation of its kneading, talusing unstable exits, elimination of microdepressions in which water puddles and clogging cracks; by doing this, a continuous slope of the land and a system of gullies that allow regularization of surface leaks, avoiding the rapid infiltration of water in the depth and create conditions for the execution of works for the capture of springs and exploitation of the land by categories of agricultural use;

- levelling of pipes and fields in the area of 0,20 ha.

On an area of about 4.50 hectares, arranged with terraces within the old vineyard plantation, the leveling works will be done by keeping / reconstructing the existing terraces, in which purpose the slopes will be restored where degradations occurred, drains and gullies, and executes terraces in the area of ruined paths and roads.

6. Banquet terraces on arable. On an area of 13.70 ha of arable land with an average slope of about 14-15%, there were provided a terraces with the purpose of ensuring a surface leakage control. These terraces must provide a reduction of drainage speeds below the non-erosion limit.

7. Spring catch. It was foreseen to capture 4 coastal springs that appear up-to-date at the base of the cornices or on the slope, consisting of:

❖ **springs capture chambers -** The water is collected by the capture chamber and through by the interception - capture drains , placed on both sides of the chamber in the direction of the level curves, being taken up by the collecting drains and discharged into the emissary.

❖ **interception drains-capture,** with a length of 0.81 km, with dual purpose of interception and taking over groundwater that feeds the slips, but also removing excess moisture from the soil profile.

❖ **collector drains, with a length of 0.61 km,** which ensures the take-over by the capture chambers or visiting rooms on the flows captured and transported by the interception - capture drains and their discharge into the emissary, respectively the exhaust channels through the reinforced exhaust vents.

❖ **visiting chambers,** 9 pieces, provided on collector drains when connecting with interception - capture drains, and changes of direction or slope.

❖ **exhaust ports,** for discharging the collector drains into the emissary.

II. Agrotechnical improvement. In order to improve the unproductive and degraded agricultural land in order to be transformed into a higher useable category, arable and meadows respectively, to ensure the transformation of the non-agricultural use categories into agricultural use, and the increase of the production capacity of the agricultural lands as a result of the improvement of the hydrotechnical works the following agro-technical works and measures were foreseen:

1. Improved fertilization with organic and chemical fertilizers on the entire surface of the perimeter foreseen to be transformed into agricultural on 49.04 ha;

2. Deep loosening works (scarification) 50-60 cm, on an area of 4.88 ha, to improve soil permeability for water and air, which will be achieved in two ways.

3. Deep plowing with basement, on 16,78 hectares for settling soils and small porosity, on the areas where the big slopes over 12% can not be scarified and the depth is 32,26 ha**.**

4. Sowing and overseeding with perennial herbs, on 6.25 ha, of which 4.88 ha for the establishment of grasslands and 1.37 ha for the consolidation of the embankment terrace.

5. Disking on 49.04 ha, work that will be performed twice.

6. Application of specific anti-erosion measures on arable land with:

- agrotechnical antierosion, by performing all the cultural works only on the level curve, on 27.38 ha;
- system of anti-erosion and protection crops, including, besides carrying out all the cultural works on the level curve, the use of crops in strips and a small share of hoeing crops on 3,08 ha;
- terraces on 13.70 ha area.

7. Use in the first 2 years of meadows set up or improved only as pasture, until a well-made herbaceous carpet is built and only after this period is used where necessary as pasture.

By realizing the complex of hydrotechnical and agrotechnical works for the improvement of Podoleni de Sus perimeter, first of all, it is ensured the exploitation of unproductive or strong and very strongly degraded lands, by rebuilding or increasing their production capacity for agricultural crops. At the same time, there will be an improvement in environmental conditions, with beneficial effects on the rural community in the area.

The proposed works for the improvement of the perimeter of improvement are aimed at the protection and restoration of the degraded lands that will contribute to the establishment of a natural, currently degraded natural balance.

By carrying out the exposed works, thus, it is ensured to avoid the extension of the surfaces removed from the productive circuit and to accentuate the degradation of the agricultural lands on 22.96 ha due to the very strong and excessive surface erosion and the deep erosion. At the same time, 26.08 hectares of currently non-agricultural land will be reintroduced into the agricultural productive circuit and the fertility rate will be increased at the corresponding parameters of the currently heavily and very strongly

degraded agricultural lands, which will lead to the restoration, respectively the increase of the capacity of their production for agricultural crops.

Thus, through planned development work, ecological changes are expected in wider spaces, including climate, flora and fauna.

Meadows with a rich herbaceous carpet also contribute to the braking of leaks, the maintenance of fertile soil in the perimeter and the cessation of landslides

CONCLUSIONS

The realization of the proposed hydroameliorative and agropedoameliorative works is aimed at valorising the water regime and improving the environmental conditions of the degraded or non-productive land in the perimeter of improvement.

The investment is necessary to ensure that the expansion of the set-aside land and the degradation of the other 95.75 hectares of agricultural land due to surface erosion, the expansion of deep erosion formations and the excess moisture at the base of the slope.

By improving the degraded lands, the appearance of the currently desolder perimeter will become more pleasant, the microclimate will change positively and biocenosis will improve with great complexity and stability with the gradual restoration of the local flora and fauna as a result of the new conditions resulting from the modification of the water regime and optimal development of meadows with a well-rounded herbaceous carpet.

ACKNOWLEDGEMENTS

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*** Soil surveys, at 1:10 ,000 and 1:200 000 scale, carried out by O.S.P.A. Iași

EVALUATION OF THE PRODUCTION AND QUALITY POTENTIAL OF MUSCAT OTTONEL AND CABERNET SAUVIGNON VARIETIES IN RELATION TO CLIMATIC FACTORS IN DEALU MARE VINEYARD

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Abstract

The varieties taken into study were Muscat Ottonel and Cabernet Sauvignon, part of the basic assortment for the production of quality wines, typical for Dealu Mare vineyard, which are very valuable in view of the oenological aspect. The experimental results obtained showed that under the ecoclimatic conditions specific to 2019 year, characterized by a high heliothermic regime, on the background of low water resources, especially during the veraison-ripening period of the grapes when the ripeness of the grapes was slow. Under conditions of water stress (precipitation reduced by 40.8 mm compared to the normal value of 124.9 mm), the growth rate of the berry weight being 1.28 g/day (Muscat Ottonel) and 0.93 g/ day (Cabernet Sauvignon) and sugar accumulation of 1.59 g/l/day (Muscat Ottonel) and 1.00 g/l/day (Cabernet Sauvignon). The total acidity of the must had very low values, 5.8 g/l tartaric acid in the Muscat Ottonel variety and 6.5 g/l in the Cabernet Sauvignon variety, which resulted in a large increase of the glucoacidimetric index, far exceeding the optimal value required for the production of wines with a high degree of quality and typicality.

Key words: grapevine, water stress, glucoacidimetric index

The increase of temperatures in recent years have influenced the quality of grapes and implicitly obtaining wines with high alcohol content.

The factors determining the alcohol content of wines are: varieties of vines; the soil on which the vine is grown (calcareous soils generally giving the most alcohol-rich wines); the climate of the vineyard and the way climatic factors evolve during the year; technological conditions and especially fermentation of must (Dokoozlian N., 1996; Tardea C., 2007).

The concentration and composition of phenolics in a wide range of environmental and management factors such as climate, soil conditions, canopy management factor (Jackson D. I., Lombard P. B., 1993; Sanchez P., 2007).

MATERIAL AND METHODS

The research was carried out in 2019 on the Muscat Ottonel and Cabernet Sauvignon varieties, grafted on the Kober 5BB rootstock.

The planting distances are 2 x 1 m and the driving form Bilateral cordon, with the fruit load distributed on fruit links consisting of ropes with a length of 8-10 eyes and replacement plugs (2 eyes). The dynamics of grape ripening were followed and the anthocyanins were determined by spectrophotometric evaluation of the color variation at the addition of sulfur dioxide (Ribereau-Gayon P., 2006).

RESULTS AND DISCUSSIONS

From an ecoclimatic point of view, the year 2019 was characterized by a moderate heliothermal regime, against the background of rich water resources, especially in April and May, when the multiannual averages were exceeded.

The vegetation period (April) started with higher average temperatures than the multiannual average (12.6ºC compared to 11.2ºC), compared to the multiannual averages.

The average air temperatures recorded during the ripening period of the grapes show positive oscillations between 0.2% (August) and 2.1% (September) compared to the multiannual average, as well as negative oscillations of -6.2% in July.

The volume of rainfall during the ripening period of the grapes (July, August, September) was deficient by 123.6 mm, well below the normal multiannual averages of 209.0 mm, which determined the appearance of the phenomenon of pedological drought. In the ripening phase of the grapes (August - September 2019) the rainfall is 40.8 mm lower than the normal value of 124.9 mm, favoring the ripening of the grapes (*table 1*).

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Table 1

The viticultural climate of the vegetation period

Month	Air temperature			Rainfall (mm)	Huglin index
	Average temperature (ºC)	Minimum temperature (ºC)	Maximum temperature (ºC)		
April	11.2	6.0	16.8	74.8	120.0
May	17.0	11.9	22.5	190.6	302.3
June	23.6	18.2	29.6	85.6	498.0
July	22.7	16.7	28.9	44.6	489.8
August	24.2	18.2	31.5	37.0	530.1
September	19.1	13.8	26.3	3.8	381.3

In 2019 the ripeness of the grapes was slow, the growth rate of the berry weight being 1.28 g/day (Muscat Ottonel) and 0.93 g/day (Cabernet Sauvignon) and the accumulation of sugars of 1.59 g/l/day (Muscat Ottonel) and 1.00 g/l/day (Cabernet Sauvignon) (*figure 1 and 2*). The full ripeness of the grapes was registered on September 19

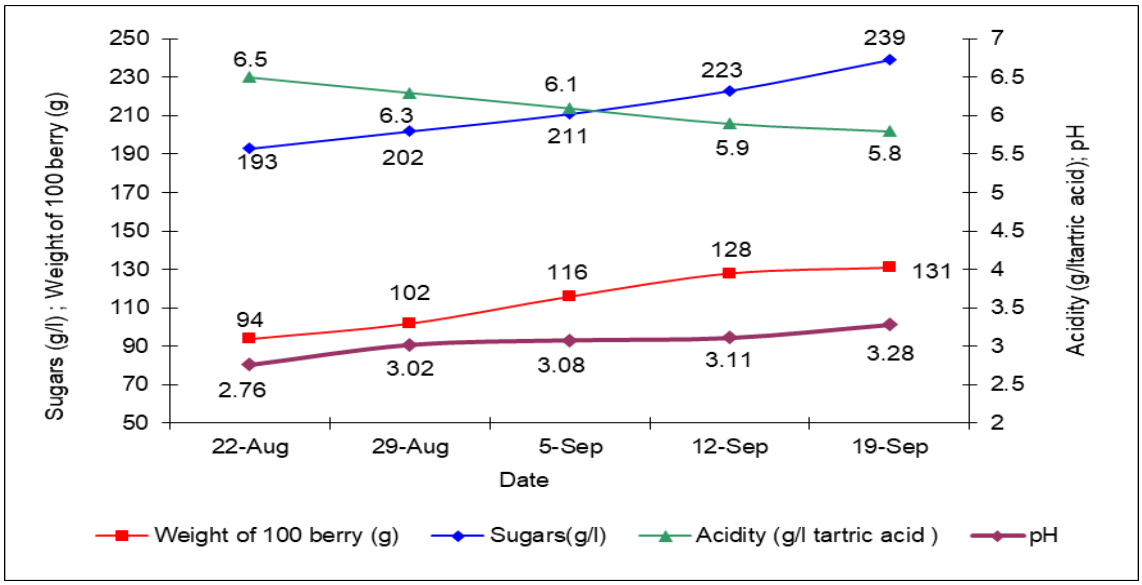

Figure 1 **Grape ripening dynamics at Muscat Ottonel varirty**

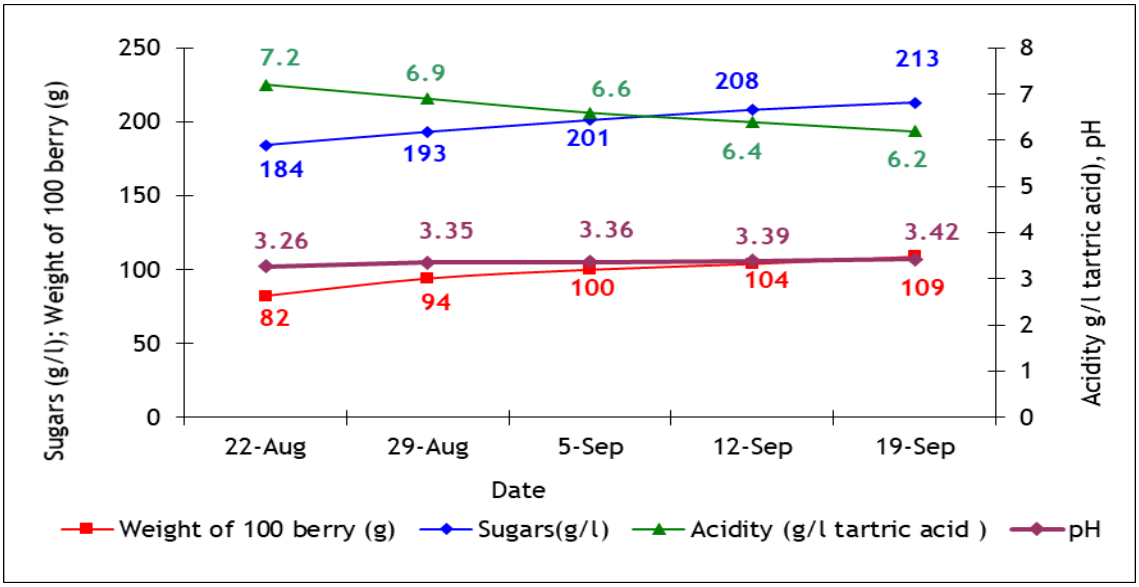

Figure 2 **Grape ripening dynamics at Cabernet Sauvignon variety**

The richness in phenolic compounds of grapes is typical of the variety and year of harvest. The 2019 harvest was characterized by a very good accumulation of phenolic compounds and anthocyanins (*figure 3*). After the full maturity of the grapes, so in conditions of over ripeness, there was a slow increase of total polyphenols and anthocyanin potential and a significant increase of anthocyanins, due to the increase of their extractability. After 10 days of full maturity, the amount of anthocyanin's reaches a maximum.

During grape over ripeness, the extractable anthocyanin content of Cabernet Sauvignon grapes increased from 650 to 736 mg /L. The comparative analysis of the other phenolic maturity indices revealed significant differences for anthocyanin extractability and seed maturity (*figure 4*), which positively influenced the phenolic composition of the crop.

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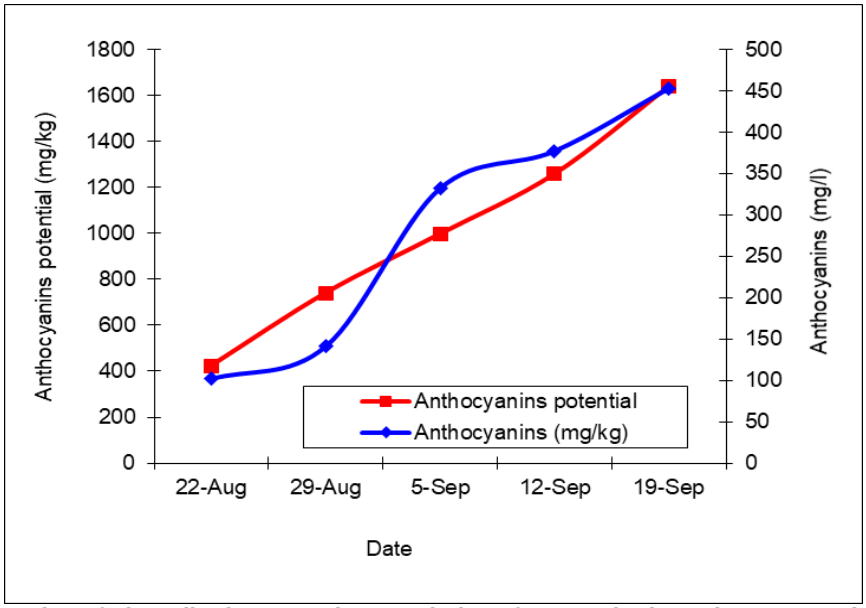

Figure 3 **Dynamics of phenolic ripeness characteristics of grapes in the Cabernet Sauvignon variety**

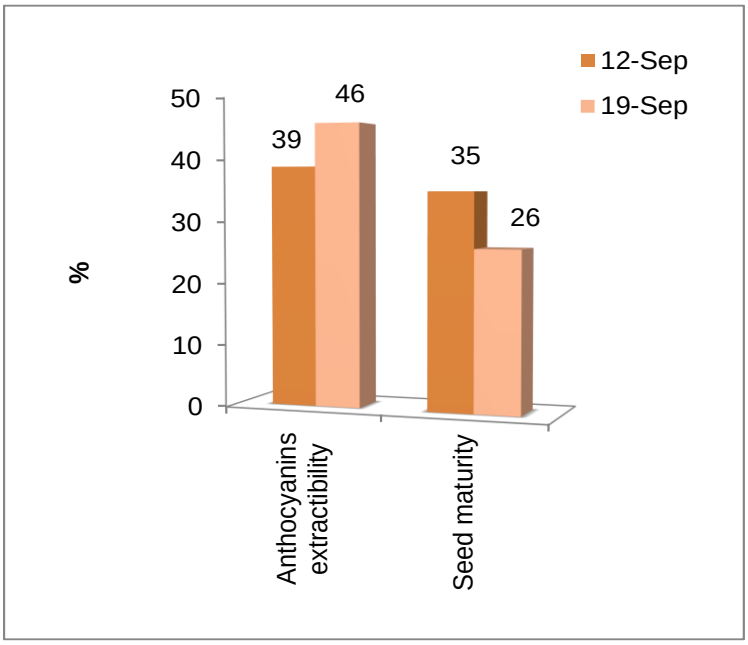

Figure 4 **Evolution of anthocyanin extractability and seed maturity in the Cabernet Sauvignon variety**

The average weight of a grape was variable, with oscillations between 134.49 g (Muscat Ottonel) and 123.38 g (Cabernet Sauvignon), (*table 2*).

Table 2

The quality of the grape harvest

Variety	Weight of grape g	Weight of 100 berry, g	Volume of 100 berry, cm^3	Sugars g/l	Total acidity g/l tartric acid
Muscat Ottonel	134.49	131	120	239	5.8
Cabernet Sauvignon	123.38	109	99	213	6.2

The accumulation potential of sugars in must, a characteristic of the variety, influenced by climatic factors during the ripening period of the grapes, was variable, with values between 239 g/l (Muscat Ottonel) and 213 g/l (Cabernet Sauvignon), and the total acidity of the must in the climatic conditions of 2019, in the case of the Muscat ottonel variety was 5.8 g/l tartaric acid, and in the case of the Cabernet Sauvignon variety it was 6.5 g/l.

CONCLUSIONS

The changes in the viticultural climate registered especially in the leech phenophases and the maturation of the grapes influenced the quality of the grape production, the potential of sugar accumulation in the must, was variable, with values between 239 g/l (Muscat Ottonel) and 213 g/l (Cabernet Sauvignon), and the total acidity of the must was 5.8 g/l tartaric acid in the case of the Muscat Ottonel variety and 6.5 g/l in the Cabernet Sauvignon variety.

The average weight of a grape was variable, with oscillations between 134.49 g (Muscat Ottonel) and 123.38 g (Cabernet Sauvignon).

The 2019 harvest was characterized by a very good accumulation of phenolic compounds and anthocyanins. After the full maturity of the grapes, there was a slow increase in total polyphenols and anthocyanin potential and a significant increase in anthocyanins, due to the increase in their extractability.

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THE MOST VALUABLE GRAPEVINE VARIETIES FOR WINE ESTABLISHED BY ANALYTICAL HIERARCHICAL PROCESS FOR A SUSTAINABLE VITICULTURE IN DANUBE TERRACES VITICULTURAL REGION

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Abstract

In order to promote a durable viticulture, an analytical hierarchical process (AHP) have been done to identify the most valuable grapevine varieties for wine in the Danube Terraces Viticultural Region. The grapevine varieties taken into the study are dedicated to white wine (Crâmpoșie, Riesling of Rhin, Fetească albă), red and rosé wine (Negru of Drăgășani, Pinot noir, Cabernet franc, Merlot, Sangioveze). The AHP exercise was based on pairwise comparisons of 11 subjective criteria (including knowledge for recognition, market potential, "celebrity" of the product on the market, biotic and abiotic threats), and expert's opinion. According to the results, the grapevine varieties with the highest potential for this region were selected as being Fetească albă, Merlot and Pinot Noir, also zoned for this wine region. Although the wine production of the area consists mostly of table wines, among which the dominant ones are those for white wines, two varieties for red wines and one for white wine were selected. The analyses were obtained by using the Expert Choice Desktop software (v. 11.5.1683). Taken into consideration the pedoclimatic characteristics of the region and the climatic changes situation, the behaviour of the three ranked grapevine varieties to different stress factors have been discussed. In the Danube Terraces conditions, the drought sensitivity of some grapevine varieties requires the reduction of water stress by irrigation. In areas with heavily eroded land on the slopes or fronts of terraces, it is recommended to use some rootstocks (Kobber 5BB, 41-B, SO4-4) to avoid the appearance of ferro-calcium chlorosis produced by the excessive presence of carbonates.

Key words: AHP, pairwise comparisons, durable viticulture, cultivars, Region VII

The Danube Terraces Viticultural Region is located mostly on the Danube terraces in the south-east of the Romanian Plain and stretches along the lower sides of the Danube, along the border with Bulgaria, from Zimnicea (Teleorman county), to Însurăței (Brăila county) (*figure 1*). According to Order no. 1205/2018 for the approval of the Nomination of the viticultural areas and the classification of the localities by viticultural regions, vineyards and viticultural centers, this region (Region VII) includes in its area the Ostrov and Greaca vineyards (with the viticultural centers Ostov, Băneasa, Oltina, Aliman, all in Constanța county and the viticultural center Greaca (Giurgiu county) respectively, to which are added 4 independent viticultural centers: Feteşti (Ialomița county), Giurgiu (Giurgiu county), Zimnicea and Însurăței. The viticultural centers are spaced between them, but the presence of scattered vineyards, occured in similar ecological conditions, certifies the shaping of a distinct wine – viticultural region called the Danube Terraces.

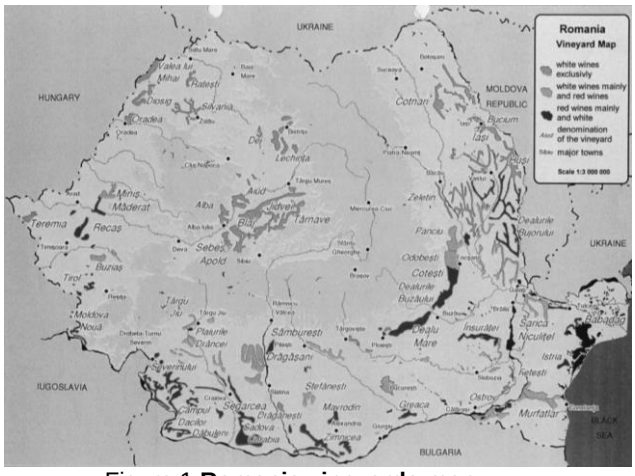

Figure 1 **Romania vineyards map**
Source: https://www.winebehindthelabel.org/team-blogs/kathleens-blog/romania-and-its-wines

Due to its geographical position, this viticultural region has the largest heliothermal resources. On the Romanian territory, the

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values of the Huglin heliothermal index vary between 2341.48 in the viticultural Region of the Danube Terraces and less than 1500 in the Viticultural Region of the Transylvanian Plateau (Irimia L.M. *et al*, 2013).

The conditions during flowering, in the growing and ripening grapes phenophases are very favorable for grapevine growing, both in terms of temperature and humidity. The combined effect of vegetation, water, climate-soil complex created favorable conditions for the grapevine cultivation in many areas of the country, thus explaining the expansion of vineyards on the Black Sea coast and along the Danube.

The climate is temperate continental, stepic and silvostepic, with insufficient precipitation and extreme temperatures, which endanger the normal development of the phenological spectrum if no protective measures are taken (protected crop, irrigation) especially against winter frosts and water deficit during the summer-autumn period. The annual precipitations register an average of 500 mm annually, and during the vegetation period they rich to 300 mm on average, a higher average in the Greaca and lower in the Feteşti viticultural center. As compared to the potential evapotranspiration that varies between 700-750 mm, there is an accentuated water deficit that must be completed by irrigations (Stroe M., 2012).

The low average altitude of the vineyards, of 72 m in the conditions in which the viticulture uses the lands with microslope and microrelief is an important inconvenience, because, although it is located in the most southern part of the country, the Danube Terraces viticultural region reaches an average of minimum extreme temperatures of - 27.0°C, the lowest value being - 30.2°C recorded in Zimnicea and Greaca (Oșlobeanu *et al*, 1991).

The main types of soil from Danube Hills Viticultural Area, defined according to SRTS - 2012 (Florea N., Muntean L., 2012) are the following: calcium chernozem, typical chernozem, eroded cambic chernozem, batigleic aluvisol, aluvisol, eutric regosol, typical kastanoiziom (Toti M. *et al*, 2017).

The Danube Terraces viticultural region is recognized primarily for the production of table grapes from the entire varietal conveyor from early to late maturing varieties, because the vegetation period is the longest here, meaning 202 days.

The wine production consists mostly of table wines, among which the dominant ones are those for white wines. In some wine centers, in certain particularly favorable years, some red wines can also reach the quality required of a quality wine. Among the varieties for white wines, are appreciated: Fetească albă, Feteasca regală, Riesling italian, Sauvignon blanc, Crâmpoşie selecţionată, Pinot gris, Cardonnay, Columna Donaris, and among red varieties are preferred Cabernet sauvignon, Merlot, Pinot noir, Burgund mare (Stroe M., 2012; Antoce A.O. *et al*, 2013).

In Romania the distribution of vineyards by regions is: Moldova – 38%, Muntenia and Oltenia – 29%; Danube Terraces – 13%; Dobrogea – 9%; Crișana-Maramureș – 5%; Transylvania – 4%; Banat – 2% (Ştefan P. *et al*, 2017).

At the 2016-year level, the area cultivated with grapevines in the Danube Terraces was smaller than in 2007 (11250.6 ha as compared with 11822.0 ha) (according with the Romanian viticultural regions, from ONVPV Communication 2007 and Vine Plantations Registry, ONVPV, 2015–2016) (Antoce A.O., Călugăru L.L., 2017).

The aim of this work is the application of a hierarchical methodology (AHP) to give a scientific contribution to a durable viticulture, by assessing and ranking some grapevine varieties of white, red and rosé wine that exploit well the potential of the Danube Terraces Viticultural Region.

MATERIAL AND METHOD

One of the most used multicriteria decision making tool, the AHP method relies on the judgments of experts to derive priority scales (Saaty L., 2008).

The grapevine varieties (*Vitis vinifera* L.) studied by AHP in this paper are dedicated to white wine (Crâmpoșie, Riesling of Rhin, Fetească albă) and, red and rosé wine (Negru of Drăgășani, Pinot noir, Cabernet franc, Merlot, Sangioveze).

In order to determine the most important grapevine varieties for Danube Terraces Viticultural Region, 11 criteria with a scale of 8 levels each were used in the AHP exercise, as follows: criterion 1 - harvesting period (from 1: the shortest harvesting period to 8: the longest

harvesting period); criterion 2 - portfolio of derived products (from 1: the smallest number of derived products to 8: the highest number of derived products); criterion 3 - harvested quantity by one worker in 8 hours (from 1: the lowest quantity to 8: the highest quantity); criterion 4 - harvesting cost (from 1: the lowest cost to 8: the highest cost); criterion 5 - knowledge for recognition (from 1: most recognizable product to 8: hardest recognizable product); criterion 6 - knowledge for harvesting (from 1: the less knowledge necessary to 8: most knowledge necessary); criterion 7 - market potential (from 1: low to 8: high); criterion 8 - perishability (from 1: lowest to 8: highest); criterion 9 - "celebrity" of the product on the market (from 1: the least known to 8: the most popular); criterion 10 - biotic threats (from 1: the fewest threats to 8: the most threats); criterion 11 - abiotic threats (from 1: the fewest threats to 8: the most threats).

The analyses were obtained by using the Expert Choice Desktop software (v. 11.5.1683).

Having a high degree of generality, these criteria have been also used in other fields of research: in the case of forest fruits (Vechiu E., Dincă L., 2019; Enescu R., Dincă L, 2020), for all the non-wood forest products (Blaga T. *et al*, 2019; Tudor C., Dincă L., 2019; Plesca I.M. *et al*, 2019) and even for wild animals (Ciontu C.I *et al*, 2018). An important influence for this analyse are the climatic changes influences reported in the viticulture area (Dincă L. *et al*, 2018b; Vizitiu D.E. *et al*, 2018; Buciumeanu E.C. *et al*, 2019) and the need to formulate solutions (Vizitiu D.E. *et al*, 2019) and recommendations (Dincă L. *et a*l, 2018a).

RESULTS AND DISCUSSIONS

The studied grapevine varieties make good use of the area potential and can be used to obtain wines with a geographical indication "Danube Terraces". Of these, in Order no. 225/2006 regarding the approval of the Zoning of the noble fruitful grapevine varieties admitted in culture in the viticultural areas of Romania are mentioned Fetească albă, Pinot noir and Merlot as being zoned for the Danube Terraces viticultural region.

The AHP alternative ranking, based on expert's opinion, is presented in *table 1*.

Table 1

AHP alternative ranking

Criterion	Grapevine varieties							
	Crâmpoșie	Negru of Drăgășani	Riesling of Rhin	Pinot Noir	Fetească albă	Cabernet franc	Merlot	Sangiovese
1	3	4	6	1	8	5	7	2
2	5	3	4	7	8	1	6	2
3	3	7	6	1	2	4	5	8
4	6	3	4	8	7	5	2	1
5	5	3	4	8	6	2	7	1
6	7	4	3	5	8	2	6	1
7	1	2	5	6	7	3	8	4
8	4	5	3	7	6	1	8	2
9	5	4	3	7	8	2	6	1
10	1	2	8	3	7	5	4	6
11	3	4	8	1	2	5	6	7

According to the AHP results, the grapevine varieties of red and rosé wine with the highest potential for the Danube Terraces, in descending order, were: Fetească albă, Merlot and Pinot Noir (*figure 2*).

It is not at all surprising that the varieties ranked on the first three places are the same as those zoned for this wine region. The other varieties studied also placed in descending order were: Riesling of Rhin, Sangioveze, Crâmpoșie, Negru of Drăgășani, Cabernet franc.

In sustainable viticultural systems, the soil must be protected and improved to ensure its long-term productivity and stability by weeding or mulching, the use of compost or manure, the reduction of soil work and the avoidance traffic of the wet ones. Regular application of organic matter can help to improve soil characteristics such as water infiltration in the arable layer and fertility.

Choosing the grapevine rootstocks is an important criterion for the affinity between scion and rootstock, necessary for a sustainable and harmonious coexistence of the two partners, the scion and the rootstock, within the viticultural ecosystem (Bucur G.M., 2011).

Pinot noir behaves well in combination with Chasselas x Berlandieri 41 B, Riparia gloire, SO4, 3309 C, Teleki 8 B rootstocks. It adapts very well to the temperate continental climate and the best wines are obtained on calcareous soils. Grafting on the Riparia gloire rootstock is recommended on fertile and moist soils with a low limestone content and on Chasselas x Berlandieri 41 B rootstock on dry soils with a high limestone content (Stroe M., 2012). For grafting the Fetească albă variety, SO4-4, Riparia gloire, SC-25 rootstocks are recommended, which manage to temper its growth vigor (Stroe M., 2012). Merlot

has a good compatibility with Riparia gloire, Chasselas x Berlandieri 41B, Riparia x Rupestris 101-14, 26 C, Ruvis, Berlandieri x Riparia Kober 5 BB rootstocks (Constantinescu G. *et al*, 1960; Bucur G.M., 2011; Stroe M., 2012).

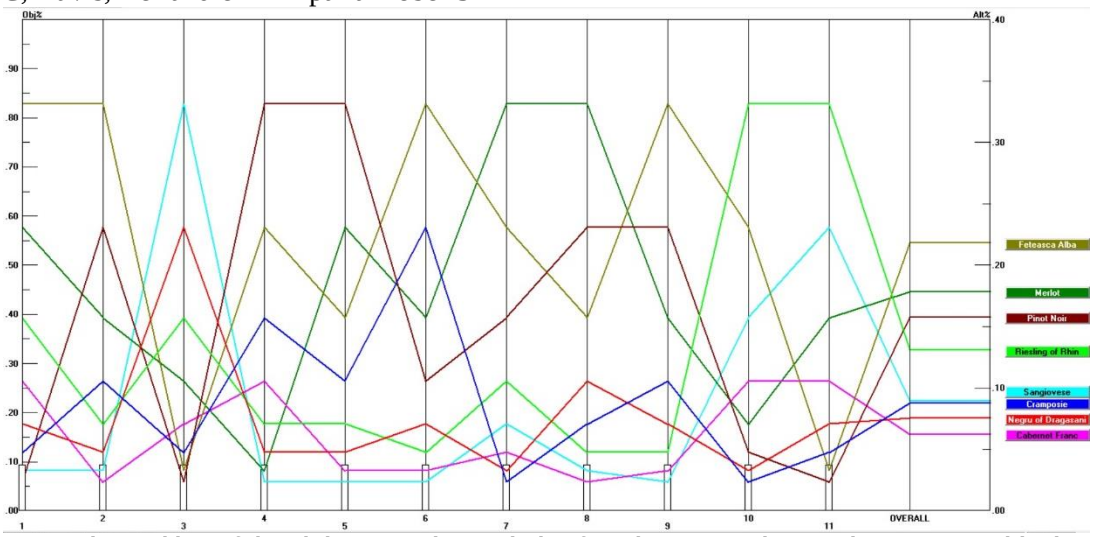

Figure 2 **The ranking of the eight grapevine varieties for wine, grown in Danube Terraces viticultural region**

In the few areas with heavily eroded terrain on the slopes or terrace fronts, it is recommended to use Kobber 5BB, 41-B and SO4-4 rootstocks to avoid the appearance of ferro-calcium chlorosis (due to the excessive presence of carbonates).

Fetească albă, Merlot and Pinot noir varieties show different resistance levels to biotic and abiotic stress factors. However, it was noted that all are sensitive to downy mildew and moths attack (*table 2*).

In the Danube Terraces conditions, the drought sensitivity of some grapevine varieties requires the water defficit reduction through irrigation.

The three grapevine varieties are characterized by a short vegetation period (150-160 days, for Fetească albă and Pinot Noir) that allows the maturation of the wood, or medium-long (180-200 days, for Merlot), which induces a low frost resistance.

Downy mildew, powdery mildew and grey mould are considered the most damaging cryptogamic diseases of grapevines. It was noted that the three varieties are sensitive to downy mildew and moths attack. The climate of the area, with low rainfall, does not favor the development of downy mildew (produced by the *Plasmopara viticola* fungus). Of the three varieties, only Merlot shows good tolerance to grey mould (*Botrytis cinerea*), sensitive varieties can be severely damaged in rainy autumns. The attack of powdery mildew (produced by the *Uncinula necator* fungus) takes place especially in dry summers; Pinot noir variety is very sensitive to powdery mildew.

A high density of mites *Eotetranychus carpini* favored by drought and heat can cause considerable damage. The red mite of the grapevine (*Panonychus ulmi*) it can develop up to seven generations per year, depending on weather conditions. The determining factor of the appearance of the common spider (*Tetranychus urticae*) is drought.

Regrading the grapevine moth (*Lobesia botrana*), which attacks flowers and berries at various stages of development, the pest's eggs are largely destroyed by the sun's rays that penetrate the grapes as a result of working in the green (lateral shoot removal, binding).

Table 2

Behavior of the Fetească alba, Merlot, Pinot Noir varieties to different stress factors (adapted after Constantinescu G. et al., 1960; Stroe M., 2012; https://www.agrodenmar.ro/vita-de-vie-merlot, https://www.horticultorul.ro/vita-de-vie/soliul-de-vita-de-vie-pinot-noir/)

Grapevine varieties	Drought	Frost	Downy mildew	Powdery mildw	Gray mould	Mites	Moths
Fetească albă	Sensitive	Medium tolerance	Sensitive	Medium resistance	Sensitive	High sensitivity	Sensitive
Merlot	Low tolerance	Low resistance	Sensitive	Good tolerance	Good tolertance	Good tolerance	Sensitive
Pinot Noir	High resistance	High resistance	Very sensitive	Sensitive	Very sensitive	Good tolerance	Sensitive

In order to increase the quality of the environment, the inputs from outside the farm, such as chemical fertilizers, must be minimized. Thus, the vegetal cover (between the grapevine rows) can be used to increase the soil content in dry matter (in the first 20 cm), which also opposes

to the calcium, magnesium and nitrates leaching. Fertilization with composted organic fertilizers is also an excellent source of nutrients (vegetable remains, canes, shoots, marc).

In Romania it is registered an active thermal balance between 2700 and 3600°C (Dejeu L.C., 2010) and in the viticultural area of the Danube Terraces the multiannual average in the 1990-2013 period was 3466°C which shows a heating with 197°C as compared to the 1961-1990 period (Irimia L.M. *et al*, 2017), which favors the sugars accumulation and the obtaining of qualitative grape productions.

CONCLUSIONS

According to AHP results, based on pairwise comparisons of subjective criteria with high degree of generality, Fetească albă, Merlot and Pinot noir grapevine varieties for wine were selected as the most important for Danube Terraces viticultural region. Of the group of eight grapevine varieties for wine taken into the study (Crâmpoșie, Riesling of Rhin, Fetească albă, Negru of Drăgășani, Pinot noir, Cabernet franc, Merlot, Sangioveze), only these varieties that ranked on the first three places are zoned for this viticultural region.

In the durable viticultural systems, the soil must be protected and improved to ensure its long-term productivity and stability. It is also necessary to manage all biotic (diseases, pests) and abiotic (drought, frost) stress factors, so that the grapevine plants benefit of an adequate protection, which takes into account the new climatic conditions.

Danube Terraces viticultural region benefits of favorable eco-climatic conditions for grapevine cultivation of and the application of the results can contribute to the development of a sustainable viticulture.

ACKNOWLEGMENTS

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PHOTOSYNTHETIC CAPACITY IN *AMORPHA FRUTICOSA, ACER NEGUNDO, AILANTHUS ALTISSIMA* AND *ELEAGNUS ANGUSTIFOLIA,* THE INVASIVE PLANTS VS. NATIVE PLANT IN DANUBE DELTA BIOSPHERE RESERVE AREAS

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Abstract

The purpose of this study is to analyse gas- exchange parameters and chlorophylls synthesis in order to establish the photosynthetic capacity of some ligneous plants with invasive behaviour in comparison with native trees in areas of Danube Delta. The investigation was carried nearly of Razelm Lake (Beștepe hill), a xerophilous coastal meadow with clumps of trees (fallow vine plantation) and in three other plots (Plaur I, Plaur II and Pătlăgeanca) situated along Chilia branch. Photosynthesis rate registered lower values in *Amorpha fruticosa* (3.53 µmol m^{-2}-s^{-1}) in comparison with *Populus alba*, young plantation (33 µmol m^{-2}-s^{-1}), lower value in *Ailanthus altissima* (13.5 µmol m^{-2}-s^{-1}) in comparison with *Fraxinus ornus* (14.54 µmol m^{-2}-s^{-1}), comparable values in *Acer negundo* with *Amorpha fruticosa* (close to 3.5 µmol m^{-2}-s^{-1}). Generally, the investigated invasive plant registered a lower respiration rate than non-invasive/native species. Transpiration was direct proportional with photosynthesis rate and with stomatal conductance. Photo-assimilatory pigments represented by chlorophyll a, chlorophyll b and carotenoids as total registered in *Ailanthus altissima* being by approximative 1.4 times higher in comparison with *Crataegus monogyna* and *Fraxinus ornus* (Beștepe station), by 1.5 times higher in *Amorpha fruticosa* than *Acer negundo* in ruderal area (Plaur I) and having close values at *Amorpha fruticosa* and *Populus alba* in riparian plantation (Plaur II). Analysis of photosynthetic capacity revealed the competition strategy between invasive plant and native or even among invasive, especially co-dominant species such as *Amorpha fruticosa* vs. *Populus alba*, *Amorpha fruticosa* vs. *Acer negundo*, *Ailanthus altissima* vs. *Fraxinus ornus and Eleagnus angustifolia* against *Salix alba* in studied areas.

Key words: *Amorpha fruticosa, Acer negundo, Ailanthus altissima, Eleagnus angustifolia,* invasive, gas-exchange parameters

Invasive plants species appear mostly in different disturbed environments, ecosystems characterized by higher availability of resources, sometimes affected by climatic extremes. Species adapted to low-resource system show traits associated with its resource conservation, such as slow growth, high tissue longevity, and resource efficiency (Funk J.L., 2013). Last decades dryness and drought have the greatest intensity and frequency in Romania. Danube Delta annual average of precipitation decrease to the sea shoreline and the average temperature increases, natural habitats of Natura 2000 being exposed to the spreading potential of invasive species.

Amorpha fruticosa (false indigo bush) is one of the most important invasive terrestrial plant species in Romania with other species such as *Ailanthus altissima*, *Acer negundo*, and *Fraxinus pennsylvanica*. In the last 20 years, in Romania within framework of Kyoto Protocol, Afforestation of Degraded Agricultural Land Project, 6500 ha in Romania was destined to mitigate climate change to reduce CO_2 emissions by planting different ligneous species. Within the located plots, *Amorpha fruticosa* was introduced in the riparian areas of the Danube, including Danube Delta, thus this species invaded the gaps between the trees and even the young white poplar plantations (Ciuvăț A. L., 2016; Doroftei M., Covaliov S., 2009). It has a negative impact on native wetland ecosystems and control measures have been applied exclusively in protected areas. *Eleagnus angustifolia* was introduced in forest cultures from the coastline cordon area and on sand banks in order to fix sand, being present on a large surface. Generally, it appears in the fluvio-maritime delta, in all the localities along the Danube Delta as well as in the fluvial Delta. Nowadays, it is considered subspontaneous species and due to spreading potential, it competes and eliminates *Hippophaë* sp. *Ailanthus altissima*, cultivated as ornamental, also could be considered a subspontaneous species, being present around

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localities and in forest plantations. In last years, these species are catalogued as invasive (Doroftei M., Anastasiu P., 2014; Doroftei M., Covaliov S., 2009).

The purpose of this study is to analyse foliar gas- exchange parameters, chlorophyll synthesis and parameters of water status in order to establish the photosynthetic capacity of some ligneous plants with invasive behaviour in comparison with native or non-invasive species in areas of Danube Delta Biosphere Reserve.

MATERIAL AND METHOD

Study sites

Four natural and anthropic site from Danube Delta Biosphere Reserve were selected from the geographical area:

1. Pătlăgeanca (45°13′45″N 28°44′45″E) a riparian area with *Salix alba* and *Eleagnus angustifolia* along of Chilia brunch on aluvisols.
2. Plaur I (45°19′26″N 28°49′48″E), a ruderal area near dyke with *Amorpha fruticosa* and *Acer negundo* as co-dominant species. Aluviosol is the soil type.
3. Plaur II (45°16′31.4″N 29°39′21.8″E) is the riparian coppice with young plantation of *Populus alba* (5 - 10 years-old). In the vicinity to the old plantation (*Populus x canadensis*) there are dense bushes of *Amorpha fruticosa*. Type soil is aluviosol gleic eutric (with relatively high fertility).
4. Beștepe hill (45°05′32″N 29°00′53″E), a fallow vine plantation with *Ailanthus altissima, Crataegus monogyna* and *Fraxinus ornus* as resentative tree species beside a xerophilous grassland and shrubs on a slope dominated by limestone-rocks, with calcareous soil or different type of chernozem.

Gas-exchange parameters, *in situ* determination of photosynthesis rate (A), respiration rate (R), transpiration (E), respiration (R) and also, instantaneous water-use efficiency (WUE=A/E ratio) were analysed with Lci photosynthesis portable system (ADC BioScientific, UK).

The spectrophotometric determination of photo-assimilating pigments was by fresh leaves solvation in 85% acetone (Meyer-Berthrand modified by Ştirban, 1985). The results were expressed in mg/g fr.w. as fresh weight.

Dry matter of plant leaves was analyzed by heating at 105℃ for 2 hours until constant weight through gravimetric moisture method.

RESULTS AND DISCUSSIONS

Analysis of gas-exchange parameters *in situ* showed that photosynthesis rate registered a higher value of 19.94 µmol m^{-2} s^{-1} in *Eleagnus angustifolia* in comparison with 18.41 µmol m^{-2} s^{-1} registered in *Salix alba*, a native tree from Pătlăgeanca plot (*table 1*). An interesting aspect is observed in Plaur I where photosynthesis rate, transpiration and stomatal conductance have close value in the two invasive species, *Amorpha fruticosa* and *Acer negundo*. Thus, photosynthesis rate was almost 3.4 µmol m^{-2} s^{-1} in both species, transpiration was 1.18 in *Amorpha fruticosa* and higher by 1.52 mmol m^{-2} s^{-1} in *Acer negundo*, leading to a water use efficiency (A/E) with a higher value in *Amorpha fruticosa* of 3.033 in comparison with 2.24 in *Acer negundo*. In that case, in Plaur I plot, *Amorpha fruticosa* registered a respiration rate of 0.41 µmol m^{-2} s^{-1} being by 4.4 times lower than that 1.815 µmol m^{-2} s^{-1} registered in *Acer negundo*. In Plaur II, a riparian coppice, young *Populus alba* tree registered highest photosynthesis rate of 33.74 µmol m^{-2} s^{-1}, highest transpiration rate of 10.22 mmol m^{-2} s^{-1} and also highest stomatal conductivity of 2.19 mmol m^{-2} s^{-1} than *Amorpha fruticosa* from the same plot and also of all investigated species (*table 1*). Water use efficiency was slightly higher in *Populus alba* with the value of 3.46 in comparison with 3.20 obtained in *Amorpha fruticosa.* Although *Populus alba* is a water-consuming tree and in this case a young one (5-10 years-old), recorded respiration was 6.75 times higher in *Amorpha fruticosa* (4.05 µmol m^{-2} s^{-1}) than in *Populus alba* (0.6 µmol m^{-2} s^{-1}). In Beștepe hill, *Fraxinus ornus* registered higher value of photosynthesis rate of 14.54 µmol m^{-2} s^{-1}, even of transpiration by 5.74 mmol m^{-2} s^{-1} and stomatal conductance by 0.26 mmol m^{-2} s^{-1} than obtained in *Ailanthus altissima*. *Ailanthus altissima* registered increased water use efficiency with a value of 3.93 in comparison with 2.69 obtained at *Fraxinus ornus.* Respiration in *Fraxinus ornus* registered an increased value by 7.96 µmol m^{-2} s^{-1} being 2.6 times higher than that showed by *Ailanthus altissima (table 1)*. Internal concentration of CO_2 and stomatal conductance *gs* registered lower values in invasive plant in comparison with its ligneous cohabitant. Another characteristic for invasive plant is a lower respiration rate in comparison with other cohabitants. Thus, *Acer negundo* registered a respiration with almost 2 times higher (1.815 µmol m^{-2} s^{-1}) than *Amorpha fruticosa* (0.41 µmol m^{-2} s^{-1}) in ruderal area at Plaur I. Although, an exception occurred such as in case of *Eleagnus angustifolia*, an invasive, subspontanous species which registered a respiration by 2.6 times higher (3.63 µmol m^{-2} s^{-1}) than *Salix alba* (1.38 µmol m^{-2} s^{-1}), a native species. Subsequently, water use efficiency in *Salix alba* obtained a higher value of 7.70 than that showed by *Eleagnus angustifolia* of 6.83 (*table 1*).

Table 1

Photosynthetic gas-exchange parameters in representative invasive and native plants at studied sites

Station	Species	Ci (µmol mol^{-1})	A (µmol m^{-2} s^{-1})	E (mmol m^{-2} s^{-1})	gs (mmol m^{-2} s^{-1})	R (µmol m^{-2} s^{-1})	Wue (µml/mmol)
Pătlăgeanca	*Eleagnus angustifolia*	319 ± 23	19.94 ± 3.38	3.09 ±0.16	1.97± 0.27	3.63 ±0.87	6.83 ± 1.53
	Salix alba	222 ± 19.45	18.41 ±1.04	2.65 ± 0.27	0.24 ± 0.04	1.38 ± 0.5	7.70 ± 0.74
Plaur I	*Amorpha fruticosa*	275 ± 15.31	3.36 ± 0.30	1.18 ± 0.06	0.04 ± 0.004	0.41 ± 0.11	3.03 ±0.31
	Acer negundo	323± 11.15	3.47 ± 0.42	1.52± 0.03	0.05 ± 0.0	1.815 ± 0.34	2.24 ±0.25
Plaur II	*Amorpha fruticosa*	262 ± 15.78	3.97 ± 0.32	1.47± 0.18	0.042 ± 0.0	4.05 ± 0.73	3.20± 0.14
	Populus alba	287 ± 11.18	33.74 ± 1.98	10.22 ± 0.97	2.19 ± 0.81	0.6 ± 0.44	3.46 ± 0.29
Beștepe	*Ailanthus altissima*	262 ± 10.76	13.9 ± 1.27	3.53 ± 0.16	0.22 ± 0.01	2.52 ± 0.76	3.93 ± 0.35
	Fraxinus ornus	254± 16.8	14.54 ± 0.93	5.74 ± 0.38	0.26 ± 0.02	7.97 ± 0.63	2.69 ± 0.02

Legend: Ci - Substomatal cavity CO_2 concentration, A - photosynthesis rate, R - respiration rate, E - transpiration rate, gs - stomatal conductance, Wue - water use efficiency, Mean ± standard error

Analysis of photosynthetic pigments showed the invasive plant registered close value with native plant, or even with other representative spontaneous plant. In invasive plant are observed that chlorophyll a have a slightly higher value, such as in *Amorpha fruticosa* with 2.56 mg/g fr. w. in comparison with *Acer negundo* with a value of 1.86 mg/g fr. w. at Plaur I, also, *Ailathus altissima*, invasive species registered 1.23 mg/g fr. w. in comparison with 0.796 mg/g fr. w. in *Fraxinus ornus* and respectively, by 0.93 mg/g fr. w. in *Crataegus monogyna*, non-invasive in Beștepe hill plot (*figure 1*).

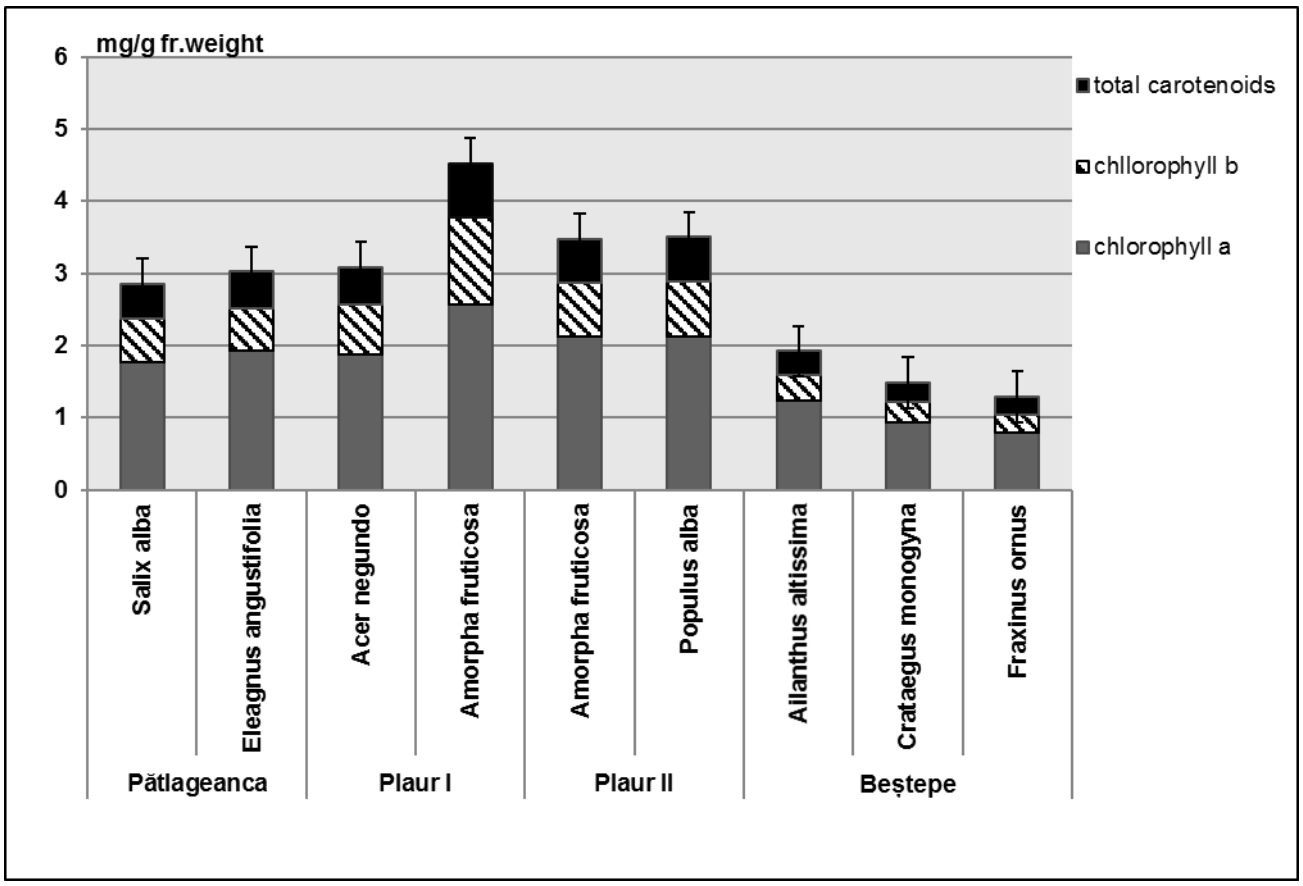

Figure 1 **Graphic representation of chlorophyll a, chlorophyll b and total carotenoids in invasive and native ligneous plant in investigated sites**

Eleagnus angustifolia with 1.93 mg/g fr. w., showed a higher value than 1.77 mg/g fr. w. registered in *Salix alba*, native species at Pătlăgeanca plot. In Plaur II, *Amorpha fruticosa* and *Populus alba* registered very close values of chlorophyll a, approximatively of 2.12 mg/g fr. w., also chlorophyll b being of 0.7 mg/g fr. weight and total carotenoids with 0.61 mg/g fr. Total carotenoids obtained higher values by 0.60 mg/g fr. w in *Salix alba*, a native species than 0.57 mg/g fr. w obtained in *Eleagnus angustifolia*, invasive species at riverside cordon area from Pătlăgeanca. *Amorpha fruticosa* showed a value of 0.74 mg/g fr. higher than *Acer negundo* which obtained 0.61 mg/g fr. in Plaur I plot and also higher value in *Ailathus altissima* 0.34 mg/g fr. than those registered in *Crataegus monogyna* by 0.26 mg/g fr. and *Fraxinus ornus* by 0.25 mg/g fr. (*figure 1*). Generally, photo-assimilatory pigments represented by chlorophyll a, chlorophyll b and carotenoids as total registered higher values in *Ailanthus altissima* (1.92 mg/g fr.w) than in *Crataegus monogyna* (1.28 mg/g fr.w) and also than *Fraxinus ornus* (1.48 mg/g fr.w) in Bestepe station, being higher in *Amorpha fruticosa* (4.52 mg/g fr.w) than *Acer negundo* (3.08 mg/g fr.w) in ruderal area (Plaur I) and close value in *Amorpha fruticosa* and *Populus alba* (close 3.5 mg/g fr.w) in riparian plantation (Plaur II) (*figure 1*).

Some invasive species such as *Alnus formosana* had a higher plasticity in photosynthetic pigments than the native species at different irradiance, which contribute to successfully invasion in high-irradiance locations through better photoprotection (Liu S. et al, 2016). In present study, the chlorophyll a and total carotenoids registered values from one to around 1.5 three times higher than in non-invasive or native plant. *Amorpha fruticosa* developed a competitive strategy perfectly adjusted to the other ligneous plant in investigated plots, such as against *Acer negundo* (representative, other invasive plant) and against *Populus alba* (native young tree) (*figure 1*).

Table 2

Chlorophylls ratio (a/b) and chlorophylls/total carotenoids (a+b/c) ratio in invasive and native/non-invasive species in studied sites

Station	Species	Total pigments (a+b+c)	a/b	(a+b)/c
Pătlageanca	*Salix alba*	2.863± 0.05	2.931 ± 0.14	4.938 ± 0.093
	Eleagnus angustifolia	3.025 ± 0.042	3.336 ± 0.132	4.916 ± 0.1
Plaur I	*Acer negundo*	3.086 ± 0.035	2.71 ± 0.14	4.93 ± 0.1
	Amorpha fruticosa	4.523 ± 0.05	2.106 ± .139	5.064 ± 0.18
Plaur II	*Amorpha fruticosa*	3.478 ± 0.052	2.859 ± 0.16	4.681 ± 0.2
	Populus alba	3.51 ± 0.03	2.745 ± 0. 16	4.714 ± 0.21
Beștepe	*Ailanthus altissima*	1.923 ± 0.046	3.465 ± 0.147	4.733 ± 0.15
	Crataegus monogyna	1.487 ±0.05	3.2230 ± 0.12	4.588 ± 0.16
	Fraxinus ornus	1.29 ± 0.048	3.309 ± 0.15	4.116 ± 0.14

Photooxidative protection of invasive plant is increased, chlorophylls a+b / total carotenoids ratio are higher having values from 1 to 1.15 times higher in *Amorpha fruticosa* vs. *Acer negundo* and respectivelly, in *Ailanthus altissima* vs. *Fraxinus ornus*. In riparian plantated corridors, *Salix alba* vs. *Eleagnus angustifolia* and respectively *Populus alba* vs. *Amorpha fruticosa* realized close values at chlorophylls ratio as well as in chlorophylls (a+b)/total carotenoids (*table 2).* The exotic tree species *Ailanthus altissima* is shade intolerant but succeeds in low-light area because it requires only a small place to rapidly growth and this species are able to take advantage of high-light conditions and grow rapidly in response to natural or human-produced canopy gaps (Funk J., 2013).

Water content analysis showed that leaves of invasive plant registered a higher value than non-invasive species but smaller than native species (*figure 2*).

Thus, *Salix alba* showed a higher value of 39.83 % in comparison *Eleagnus angustifolia* with 32.82 % in Pătlăgeanca. In Plaur I, *Amorpha fruticosa* with 35.84 % retained a more water in leaves having almost by 1.3 times more humidity than *Acer negundo* which registered 27.74 %.

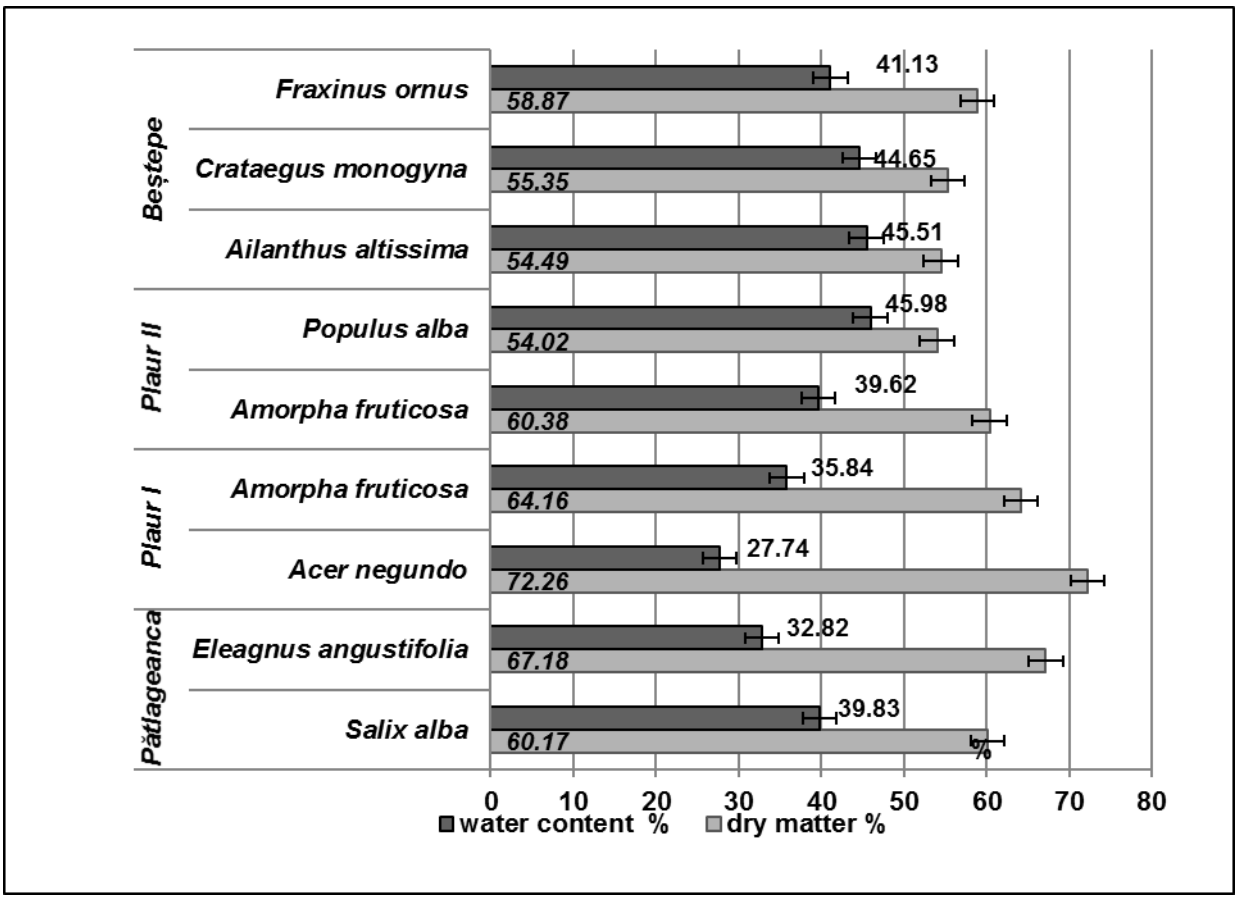

Figure 2 **Graphic representations of humidity and dry matter in invasive and native/non-invasive leaves of ligneous plant in investigated sites**

In riparian young plantation, *Populus alba*, native, young tree, accumulated a water value of almost 50 % being that 1.2 times higher than *Amorpha fruticosa* with a value of 39.62 % (Plaur II).

In Beștepe hill, at fallow land, *Ailanthus altissima* registered close value of water content, with *Crataegus monogyna*, which was approximately 45 %, but higher than *Fraxinus ornus* which accumulated 41 % water in their leaves.

Generally, water status is linked with a strategy to adjust and modulated the plant resistance over temperature variation. Invasive plant it was observed to have mechanism at leaf level to reduce the water loss and thus humidity maintain during vegetation stage (Acatrinei L., 2016; Cavaleri M. A., Sack L., 2010).

CONCLUSIONS

Gas-exchange parameters at invasive ligneous species analysed from different plots of Danube Delta Biosphere Reserve showed an increased photosynthesis rate combined with a lower internal CO_2 and a lower stomatal conductance. These ligneous invasive realized a higher water use efficiency among investigated plant with the exceptions of *Populus alba* and *Salix alba*, both native species. Also, there are observed a lower respiration rate in invasive than non-invasive/native, with the exception of *Populus alba* young tree, (young plantations) which registered a lower value in comparison with *Amorpha fruticosa* .and respectively, *Salix alba* in comparison with *Eleagnus angustifolia* in the riparian corridors. Generally, the concurrence strategy was observed between invasive vs. invasive, such as *Amorpha fruticosa* against to *Acer negundo* or invasive vs. native, between *Eleagnus angustifolia* and *Salix alba* and respectively, *Amorpha fruticosa* against *Populus alba.* This photosynthetic strategy was revealed by close value or even higher value of photosynthesis rate, contents of photo-assimilatory pigments (especially, chlorophyll a and carotenoids pigments) or chlorophylls/carotenoids ratio observed in invasive ligneous species.

ACKNOWLEGMENTS

This work was partially supported by the Romanian Ministry of Education and Research through the NUCLEU program (Contract no. 25N/2019/Project code 19-270301) and also, by a grant of the Ministry of Research and Innovation through Program 1 - Development of the National R & D System, Subprogram 1.2 - Institutional Performance - Projects for Excellence Financing in RDI, Contract no. 22PFE / 2018.

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THE CHARACTERISATION OF GRAPEVINE VARIETIES FOR WINES IN THE CONTEXT OF CLIMATE CHANGE IN THE VALEA CALUGAREASCA VITICULTURAL AREA

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Abstract

Climate change is a reality today and a challenge because the effects need to be evaluated and identified over time. Although it was acclimatized over times in different viticultural climates, grapevine is a plant which has its optimal limits in physiological meaning. The researches were carried out in the Valea Călugărească viticultural center within seven viticultural plantations with the varieties Olivia, Negru aromat, Mamaia, Feteasca neagra 4 Vl, Columna, Grasa de Cotnari 4 Pt. In the last 30 years, the climate has changed in the sense that the thermal regime has increased on the background of an unevenly distributed and deficient pluviometric regime, during the vegetation period of the vine. The vegetation period (April) begins with higher average temperatures than the multiannual average (12.6ºC compared to 11.2ºC) and a high-water regime (74.8 l/square meter compared to 52.0 l/square meter), compared to the multiannual averages. There were registered, also, years with hot summers which significantly influenced the grapevine. During hot summers, vine phenology has changed in that way in which the period between two phenophases was shortened greatly. Also, grapevine evolved under conditions of heat and hydric stress.

Key words: grapevine, climatic change, phenology, phenophases

The reality of climate change is admitted by the vast majority of the scientific community (IPCC, 2014). The viticulture is highly dependent upon climatic conditions during the growing season. The climatic conditions vary from one year to the other. These variations induce the "vintage effect," year-to-year variations in yield, quality, and typicity (Van Leeuwen T, Darnet L, 2016)**.** Sugar accumulation increases with temperature (Coombe B.G., 1987), but certain secondary metabolites, like anthocyanins, are negatively affected by high temperature (Kliewer M., Torres R., 1972). Grape acidity, in particular the malic acid content, decreases in high temperature (Coombe B.G., 1987). The main measurable effect of climate change is a steady increase in temperature.

Grapevine phenology was modified, all phenological stages are shorter, except bud burst which appeared late. The shorter period of ripening grape berries has changed the composition of grapes sugar, the concentration has significantly increased and the acidity decreased.

MATERIAL AND METHOD

The study was realized in 2019 year, in DOC Dealu Mare-Valea Calugareasca viticultural area specialized in the cultivation of black grapes. The analysis was performed on Olivia, Negru aromat, Mamaia, Feteasca neagra 4 Vl, Columna, Grasa de Cotnari 4 Pt varieties. The soil in the experimental polygon is eumezobazic brown, with a sandy loam texture, pH weak acid (6.1), well supplied with humus (2.9%) and useful mineral elements (N, P, K).

The viticultural climate parameters analyzed were: air temperature, precipitation and insolation. The evaluation was made by comparative analysis of annual and multiannual values. The grapes were harvested at technological and phenological maturity and analyzed in terms of soluble sugar content and total acidity.

RESULTS AND DISCUSSIONS

From an ecoclimatic point of view 2019 was characterized by a moderate heliothermic regime, against the background of rich water resources, especially in April and May, when the multiannual averages were exceeded The growing period (April) started with average temperatures higher than the multiannual average (12.6°C vs. 11.2°C) and a high water regime (74.8 l/square meter vs. 52.0 l/square meter), compared to multiannual averages (*table 1*).

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Table 1

The thermal regime in 2019

Month	The air temperature ˚C			
	Average		Absolute maxima	Absolute minima
	1999-2018	2019		
I	0.3	-0.4	11.4	-0.8
II	1.9	3.7	19.0	-7.4
III	6.8	8.8	24.5	-3.2
IV	12.6	11.2	26.8	0.5
V	18.1	17.0	28.4	6.0
VI	22.0	23.6	33.7	14.2
VII	24.2	22.7	36.2	11.0
VIII	24.0	24.2	35.5	12.8
IX	18.7	19.1	33.4	6.0
Annual	14.3	14.4	36.2	-7.4

Compared to normal (1999-2018) the average monthly air temperature showed variations between +1.4° (April), +1.1° (May), +1.5° (July) and -1.6°C (June), -0.2°C (August), -0.4°C (September). The year 2019 benefited from a very high thermal resource with multiple influences in the evolution of vegetative phenophases. The amount of monthly precipitation in 2019 registered compared to the multiannual average (1999-2018) positive differences of 30 mm (April), 123.3 mm (May), +4.1 mm (June), as well as negative differences of -7.4 mm (July), -25.7 mm (August) and -50.6 mm (September) (*table 2*).

Table 2

Rainfall regime and air hygroscopicity in 2019 year

Month	Rainfall(mm)		Number of rainy days			Higroscopicity%	
	1999-2018	2019	>0.1 mm	>5 mm	>10 mm	1999-2018	2019
I	33.5	55.2	11	2	2	68.2	86.6
II	28.0	7.8	2	1	-	68.0	74.7
III	35.3	31.4	2		2	69.5	58.3
IV	44.8	74.8	8	1	2	67.7	74.8
V	67.3	190.6	10	5	2	68.4	77.6
VI	81.5	85.6	5	1	4	70.1	70.9
VII	75.8	68.4	3	4	1	67.5	44.6
VIII	62.7	37.0	3		2	66.5	60.9
IX	54.4	3.8	2			70.7	57.9
Annual	483.3	554.6	46	14	15	68.5	67.4

Air hygroscopicity showed positive varying between in April (7.1%), May (9.2%) and June (0.8%) and negative in July (-22.9%), August (-5.6%) and September (-12.8%).

The frequency of air temperatures exceeding the critical threshold of normal development of physiological processes (30°C), in the summer months shows varying between 71% (August), 41-50% (June-July) and only 13% in September.

Regarding the grape production, the highest values were recorded in the case of varieties: Feteasca neagra 4 Vl (3.500 kg/vine), Olivia (3.480 kg/vine), Columna (3.410 kg/vine) and (*table 3*).

Table 3

Harvest quatity and quality obtained in the wine year 2019

Variety	Grape production kg/vine		Sugar content g/l		Total acidity g/l sulphuric acid	
	Average 1999-2018	2019	Average 1999-2018	2019	Average 1999-2018	2019
Olivia	3.640	3.480	222.4	228.6	4.6	4.4
Negru aromat	3.420	3.100	216.6	219.8	4.2	4.0
Feteasca neagra 4 Vl	3.850	3.500	227.4	238.6	4.4	4.2
Mamaia	4.220	3.450	216.8	224.2	4.6	4.4
Columna	3.530	3.410	186.9	198.6	4.8	4.7
Grasa Cotnari 4 Pt	3.715	3.320	224.8	234.6	4.3	4.2

Compared to the multiannual average, grape production decreased with 3.4% (Columna), 4.4% (Olivia), 9.36% (Negru aromat), 10% (Grasa Cotnari 4 Pt) and 18.3% (Mamaia).

Regarding the quality of grape production, expressed by the sugar content and the acidity of the must, Feteasca neagra 4 Vl variety regorded the highest concentrations of sugars in grapes. Potential accumulation of sugars, a characteristic of the variety, influenced by climatic factors during the period of ripening of the grapes, was variable, with values between 238.6 grams/litre (Feteasca neagra 4 Vl) and 234.6 grams/litre (Grasa Cotnari 4 Pt).

The sugar content increased with 1.46% (Negru aromat), 4.69% (Feteasca neagra 4 Vl) and 5.89% (Columna).

The total acidity in the climatic conditions of 2019 for the Feteasca neagra 4 Vl. variety was 4.2 g/l sulphuric acid and 4.8 g/l sulphuric acid (Columna).

The average weight of a grape was variable, with varying between 90.56 grams (Olivia), 87.63 grams (Grasa Cotnari 4 Pt) and 98.44 grams (Feteasca neagra 4 Vl) (*table 4*).

Table 4

Harvest quatity and quality obtained in the wine year 2019

Variety	The average weight of grape g		Weight of 100 berry, g	
	Average 1999-2018	2019	Average 1999-2018	2019
Olivia	95.28	90.56	132.6	118.4
Negru aromat	92.64	86.24	124.6	112.8
Feteasca neagra 4 Vl	104.56	98.44	114.8	102.2
Mamaia	98.82	90.48	106.6	96.4
Columna	88.56	79.26	98.2	89.4
Grasa Cotnari 4 Pt	94.64	87.63	128.6	116.8

Compared to the multiannual average, the average weight of a grape has diminished with 4.95% in case of Olivia variety, 7.41% (Grasa Cotnari 4 Pt) and 10.5% (Columna).

The average weight of 100 berry was variable, with varying between ranging from 118.4 grams (Olivia variety), 116.8 grams (Grasa Cotnari 4 Pt variety) and 102.2 grams (Feteasca neagra 4 Vl). The average weight of 100 grains compared to the multiannual average decreased by 95 in case of Columna variety, 9.5% at Negru aromat variety, 10.7% (Olivia variety) and 11% (Feteasca neagra 4 Vl).

The leaf area required for the production of one gram of grapes in the conditions of maximum accumulations of sugars when harvesting Olivia grapes was 11.72 square centimeter/vine (*table 5*).

Table 5

The relationship between leaf area / production

Variety	Leaf area square meter		Grape production kg/vine		Area required for ripening one gram of fruit (square centimeters / g)	
	Average 1999-2018	2019	Average 1999-2018	2019	Average 1999-2018	2019
Olivia	4.36	4.08	3.640	3.480	11.98	11.72
Negru aromat	3.24	2.86	3.420	3.100	9.47	9.23
Feteasca neagra 4 Vl	4.12	3.46	3.850	3.500	10.70	9.89
Mamaia	3.23	3.76	4.220	3.450	9.43	9.36
Columna	3.54	3.26	3.530	3.410	10.03	9.56
Grasa Cotnari 4 Pt	4.06	3.48	3.715	3.320	10.93	10.48

For the Fetească neagră 4 Vl. variety, the leaf area of 3.46 square meter/vine can ensure the maturation of a production of 3.500 kg of grapes, the leaf area necessary to achieve a gram of ripe fruit having value of 9.89 square centimeters/g, at a sugar content of 238.6 g/l of must. The leaf area of varieties has been reduced with 6.42% (Olivia), 11.73% (Negru aromat), 16.02% (Feteasca neagra) and 18.84% (Mamaia).

CONCLUSIONS

High temperatures and precipitation in lower quantities have affected grape production and vegetative growth is lower.

The grape production and must content are influenced by climate change. The highest production was obtained in the case of Feteasca neagra 4 Vl variety (3.500 kg/vine) followed by Grasa Cotnari 4 Pt variety (3.320 kg/vine).

In order to achieve the production of 3.500 kg/vinethe Feteasca neagra 4 Vl varirty requires a leaf area of 3.46 square meter/vine.

Potential accumulation of sugars, a characteristic of the variety, was variable, with values between 238.6 grams/litre (Feteasca neagra 4 Vl) and 234.6 grams/litre (Grasa Cotnari 4 Pt). The sugar content increased with 1.46% (Negru aromat), 4.69% (Feteasca neagra 4 Vl) and 5.89% (Columna).

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ANALYSIS OF DEOXYNIVALENOL IN CEREALS AND FOODS DERIVED FROM THEM, AT THE LEVEL OF IASI COUNTY

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Abstract

The paper presents information on deoxynivalenol contamination of cereals and food products derived from them, in Iasi County, in the 2015-2019 study interval. Data are presented on the incidence of deoxynivalenol, which has a negative influence on food safety, with a negative impact on the consumer's health. The study was conducted to assess the level of contamination of cereals and food products derived from them in Iasi County and to adopt European Commission regulations on maximum levels of mycotoxins in various raw materials and products for human consumption.The method used for the study is a direct competitive enzyme-linked immunosorbent assay (ELISA), which allows to obtain exact concentrations for the studied mycotoxin, expressed in µg / kg. The obtained results were within the maximum limits allowed by the current specific legislation.

Key words: mycotoxins, deoxynivalenol, cereals, cereal products, ELISA

Contamination with fungi and mycotoxins of food and feed is a major risk to consumer safety. The appearance of mycotoxins in food and feed can lead to acute intoxications, to high levels of contamination; it is necessary to mention that mycotoxins are toxic even in extremely low concentrations and have cumulative, immunosuppressive and immunotoxic effects in the human body.

Molds that can appear on cereals and products derived from them are mostly toxigenic, so they require special attention. Apart from the fact that their toxins act strongly, even in small quantities, there is the problem of the synergism of these toxins once they reach the higher organisms. It will not matter much how many µg / kg of a toxin have been found in an environment, but how many types of toxins that potentiate their effects (even in smaller quantities) are in it. Mycotoxin-induced conditions are called mycotoxicosis. (Suteanu E. *et al*, 1995)

Trichothecenes are a group of mycotoxins having the same basic structure. All these substances contain an epoxy group placed at C12-C13, which is responsible for their toxic activity, being classified into two major groups: macrocyclic and non-macrocyclic.

Macrocyclic trichothechenes are subdivided into types C and D. Type C (crotocin, baccharin) has an additional epoxy group at positions C7-C8 or C9-C10. Type D (satratoxin, roridine) contains a macrocyclic ring between C4-C15.

Non-macrocyclic trichothecenes are subdivided into types A and B, where type A appears to be more toxic than type B. The toxicity is due to the various radicals on the hydro- and lipophilic chains.

Type A includes: T-2 toxin, HT-2 toxin, diacetoxycirpenol (DAS), etc.

Type B includes: deoxynivalenol (DON), 3-acetyldeoxynivalenol, 15-acetyldeoxynivalenol, nivalenol (NIV), fusarenone-X (FUX identical to 4-acetylnivalenol) etc.

Trichothecenes - type B are mainly synthesized by *Fusarium culmorum* and *Fusarium graminearum*. Although *Fusarium* species (*F. roseum, F. graminearum, F. solani, F. oxysporium*) are not of major biotechnological importance, we must remember that they appear on cereals, fruits, vegetables, and their mycotoxins are particularly dangerous. The toxicity of trichothecans is due to their ability to inhibit protein synthesis (Sesan Tatiana Eugenia *et al*, 2009).

Deoxynivalenol (DON, vomitoxin) is a mycotoxin produced by many species of the genus *Fusarium (F. culmorum, F. graminearum, F. roseum, F. sporotrichioides and F. sambucinum*). The incidence of deoxynivalenol is associated with *Fusarium graminearum* (teleomorph *Gibberella zeae*) and *Fusarium culmorum* (teleomorph

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unknown), both fungi being important plant pathogens, found in cereals and other crops. It is synthesized and found on plant material and its presence depends a lot on temperature (6-24°C) and other climatic conditions favorable to its development (extremely humid environment). (Toth B. *et al*, 2006).

Deoxynivalenol causes general weakening of organisms, necrosis (gangrene) in various tissues (gastrointestinal wall, bone marrow, lymphatic tissue), changes blood parameters and attacks the immune system. In fact, the Scientific Committee on Food of the European Commission (EFSA) suggests that the toxicity of deoxynivalenol is due to the general effect on organisms and in particular the harmful effect on the immune system. Another problem lies in the synergistic effect of deoxynivalenol with other trichothechenes, from which it can practically not be separated, because they are synthesized simultaneously.

Fungal infection and deoxynivalenol production, simultaneously in the field, depend on weather conditions, being favored by low temperatures and high humidity. Contamination is most severe in fields where crop rotation is not applied (corn follows corn or corn follows wheat), especially if the previous crop has been infected. These fungi have two distinct growth cycles, with mold growing during the day when the temperature is high (21-25ºC), while toxins are produced during the night when temperatures drop. Although deoxynivalenol is among the least toxic trichothechenes, it is the most commonly detected worldwide, and its occurrence is considered to be an indicator of the possible presence of other and more toxic trichothechenes (Alexander N.J. *et al*, 2006).

In humans, DON can cause bleeding, septic arthritis, endophthalmitis, osteomyelitis, cystitis and brain abscesses, with an invasive or disseminated outbreak.

Cereals and cereal by-products are a major part of the human and animal diet. It has been estimated that up to 25% of the world's crops can be contaminated with mycotoxins. The relevance of mycotoxins to human / animal health has led the European Community to introduce maximum permitted limits in food and feed. In Romania, deoxynivalenol is present in wheat and triticale, in particular. Romanian wheat contains on average between 100-500 µg/kg mycotoxins (1.0-5.0 ppm), ie 10-50 times above the maximum limit allowed by the NOEL norms (NO EFFECT LEVEL - the limit up to which DON can be supported without negative effects) (Berca M., 2011). The tolerable daily dose (DZT) of deoxynivalenol is 1 µg/kg body weight.

The fungal and mycotoxin surveillance program for food and feed should be applied equally to farms producing plant substrates, grain reception bases, compound feed processing plants, livestock farms, and food manufacturing units. The placing on the market of food containing a contaminant in an amount considered unacceptable from the point of view of human health is prohibited. In addition, the level of the contaminant must be kept as low as possible by the use of good practices at all levels of production, processing, preparation, treatment, packaging, storage, transport or marketing of foodstuffs.

MATERIAL AND METHOD

The determinations were performed in the period 2015-2019, from samples of cereals and products derived from cereals, which were taken randomly, according to an objective sampling strategy, both from grain storage units and from retail units. of food products (supermarkets), from Iasi county.

Sampling was performed based on a pre-established working procedure, in accordance with Annex no. 1 of the EC Regulation no. 401/2006 which establishes the sampling modalities and the analysis methods for the official control of the mycotoxin content in food (*figure 1*).

Mycotoxins are unevenly distributed in a batch; therefore, all necessary measures are taken to ensure that the sample taken is representative of the batch. Therefore, it is necessary to take a large number of elementary samples from various places in the lot, according to the legislation (random sampling = several elementary samples by joining which the aggregate sample is formed). The incremental samples shall be taken from different places in the lot so that the aggregate sample is representative of the lot. The area intended for sampling or storage of those products must not expose the product to any risk of contamination or degradation. In the case of mycotoxins, it is essential that the sampling action be carried out correctly because it is impossible to establish a subsequent measure based on the analysis of a non-representative sample.

The global sample must be thoroughly mixed but must not be ground before splitting the sample into laboratory samples. The aggregate sample shall be clearly labeled and sealed at the place of sampling. It must reach the laboratory as soon as possible, sealed and stored in an opaque bag / container (because mycoxins are destroyed under the influence of ultraviolet rays or natural light).

In the case of samples taken during the storage-marketing stage, these being pre-packaged in packages ready for sale, the product

is not removed from the original packaging until it is to be analyzed in the laboratory.

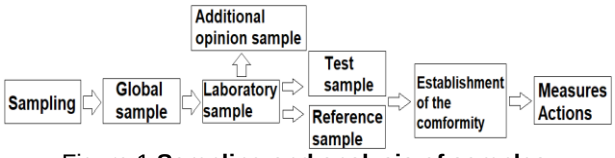

Figure 1 **Sampling and analysis of samples**

The samples that arrive at the laboratory for analysis are each divided into three distinct samples: the test sample, the additional opinion sample and the reference sample. All these are obtained only in the laboratory, being separated from the previously homogenized laboratory samples.

The sample for additional opinion may be kept by the laboratory or operator. If the sample for additional opinion is kept in the laboratory, the storage time is:

-until the issuance of the analysis bulletin, in case of compliant products;

-1 year when the evidence is non-compliant.

The reference sample is kept in the laboratory for the following period:

-until the release of BA in the case of compliant products:

-1 year when the evidence is non-compliant.

The establishment of the conformity of the samples is made on the basis of the results obtained following the laboratory analysis, to which the correction for recovery and the degree of uncertainty of the measurement are applied, in accordance with the provisions of Reg. CE 401/2006.

Acceptance of lots:

-The test is compliant if the value obtained after performing the laboratory analysis is less than or equal to that provided in EC Regulation no. 1881/2006 with the subsequent completions and modifications.

-The test is non-compliant if the value obtained after performing the laboratory analysis is higher than the one provided in the EC Regulation no. 1881/2006 establishing maximum levels for certain contaminants in foodstuffs.

-The lot is declared accepted if the analyzed sample is compliant.

During the study period (2015-2019) a total number of 118 samples were taken and analyzed consisting of cereals (wheat, corn) and products derived from cereals (wheat flour, corn, bread, pasta, biscuits). The product samples taken for the quantitative determination of the deoxynivalenol content were analyzed based on the specific RIDASCREEN DON determination kit, and the ELISA photometer was used to interpret the results.

Sample preparation: cereals, cereal products - extraction, filtration.

Detection limit: cereals, bakery products - 18.5 ppm.

Reproducibility: 85-100%.

Principle of the test: the test is based on the antigen-antibody reaction. The plate wells are labeled with anti-DON antibodies. Add standards or samples, enzyme conjugate and anti-DON antibodies. Free deoxynivalenol and the enzyme conjugate compete for antibody binding sites (competitive enzyme-linked immunosorbent assay). At the same time, deoxynivalenol antibodies are bound to immobilized antibodies. The unbound enzyme conjugate is removed by the washing step. Add the substrate-chromogen mixture to the wells and leave to incubate; the bound enzyme conjugate will convert the colorless chromogen into a blue substance. Adding the stop reagent will cause the color to change from blue to yellow. The measurement is made spectrophotometrically at 450 nm (optional wavelength> 600 nm). The absorbance is inversely proportional to the concentration of deoxynivalenol in the sample.

Equipment used: microELISA photometer (450nm), mill, shaker, graduated cylinder: 100ml, 1l, funnel and filter paper Whatman nr. 1, graduated pipettes, micropipettes: 50μl, 100μl, 1000μl.

Reagents: distilled water.

Samples preparation:

Samples should be kept in a cool place, protected from light. The representative sample must be ground and thoroughly homogenized before starting the extraction procedure.

Working procedure:

-weigh 5g of ground sample and transfer to a container with a lid over which 25ml of distilled water is added. The sample size can be increased if necessary, but the volume of distilled water must be adapted accordingly (for example: 25 g of sample in 125 ml of distilled water or 50 g of sample in 250 ml of distilled water);

- shake vigorously for 3 minutes (manually or with a stirrer);

-filter the extract using Whatman filter paper no.1;

-50μl of extract per well is used, in the test.

Protocol:

- Before starting work, bring all reagents to room temperature.

-Insert a required number of wells for standards and test samples into the holder.

-Add 50l of standard sample.

-Add 50 μl of enzyme conjugate to each well.

-Add 50μl of antibody solution to each well.

-Mix manually by rotating the plate and incubate for 30 minutes at room temperature (20-25°C).

-Pour the liquid and beat it vigorously face down on an absorbent paper to remove traces of liquid.

-Add 250μl wash buffer and remove the liquid again. Repeat the washing step 2 times.

-Add 100μl (2 drops) of substrate / chromogen in each well. Mix by hand, rotating the plate and incubate for 15 minutes. at room temperature (20-25°C).

The average value of the absorbents obtained for standards and samples are divided by the absorbance value of the first standard and multiplied by 100. The zero standard is equal to 100% and the absorbent values are expressed as a percentage:

$$\frac{abs.\ standard}{absorbanta} \times 100 = \%\ abs.\ zero\ standard.$$

The values calculated for the standards are entered in a coordinate system on semi-logarithmic millimeter paper with respect to the deoxynivalenol concentration expressed in µg/kg. The deoxynivalenol concentration corresponding to the absorbance of each sample can be read using the calibration curve.

To obtain the mycotoxin concentration in the sample in µg/kg, the concentration read from the calibration curve must be multiplied by the corresponding dilution factor (for cereals and cereal products its value is 5).

RESULTS AND DISCUSSIONS

Deoxynivalenol is one of the most common fusariotoxins that contaminates feed and food, resulting in food poisoning in animals and humans.

EC Regulation no. 1881/2006 establishes the maximum allowed levels for some contaminants in food products. According to this Regulation, the maximum permitted level of deoxynivalenol in foodstuffs is:

-500 µg / kg for bread and bakery products;

-750 µg / kg for wheat flour, pasta, cereal flakes and breakfast cereals;

-1250 µg / kg for wheat grain;

-1750 µg / kg for grain corn.

In *table 1* are presented the analytical results of the analyzed samples which registered positive values, obtained in the study interval 2015-2019, for the characterization of deoxynivalenol from cereals and food products derived from them.

Table 1

Analytical results of the analyzed samples

Nr. crt.	The sample analyzed	Total number of samples analyzed	No. of negatives samples	No. of positives samples	The value of the positive sample analysis (µg/kg)	LMA (µg/kg) according to Reg. CE 1881/2006
1.	biscuits	2	1	sample no. 1	43.8	**500**
	breakfast cereals	5	1	sample no. 1	25.0	**750**
				sample no. 2	26.3	
				sample no. 3	27.0	
				sample no. 4	57.0	
2.	pretzel	3	0	sample no. 1	31.15	**500**
				sample no. 2	128.0	
				sample no. 3	230.71	
3.	wheat flour	12	3	sample no. 1	21.0	**750**
				sample no. 2	22.0	
				sample no. 3	23.0	
				sample no. 4	82.0	
				sample no. 5	82.0	
				sample no. 6	136.0	
				sample no. 7	242.32	
				sample no. 8	347.35	
				sample no. 9	491.0	
4	cereal flakes	6	2	sample no. 1	39.0	**750**
				sample no. 2	60.0	
				sample no. 3	70.0	
				sample no. 4	70.0	
5.	wheat grains	17	16	sample no. 1	636.0	**1250**
6.	white bread	26	13	sample no. 1	25.0	**500**
				sample no. 2	25.0	
				sample no. 3	26.2	
				sample no. 4	38.0	
				sample no. 5	43.83	
				sample no. 6	51.0	
				sample no. 7	54.1	
				sample no. 8	99.0	
				sample no. 9	124.0	
				sample no. 10	140.0	

				sample no. 11	161.24	
				sample no. 12	226.36	
				sample no. 13	295.0	
7.	pasta	21	1	sample no. 1	26.0	**750**
				sample no. 2	26.0	
				sample no. 3	30.0	
				sample no. 4	31.2	
				sample no. 5	37.77	
				sample no. 6	38.72	
				sample no. 7	40.0	
				sample no. 8	47.0	
				sample no. 9	57.9	
				sample no. 10	68.0	
				sample no. 11	68.0	
				sample no. 12	68.0	
				sample no. 13	74.0	
				sample no. 14	94.0	
				sample no. 15	152.0	
				sample no. 16	206.69	
				sample no. 17	213.0	
				sample no. 18	294.94	
				sample no. 19	318.0	
				sample no. 20	424.0	
8.	corn grains	26	15	sample no. 1	41.0	**1750**
				sample no. 2	69.0	
				sample no. 3	114.0	
				sample no. 4	157.92	
				sample no. 5	170.49	
				sample no. 6	252.27	
				sample no. 7	324.2	
				sample no. 8	324.2	
				sample no. 9	324.2	
				sample no. 10	324.2	
				sample no. 11	446.96	
Total samples		**118**	**52**	**66**		

CONCLUSIONS

Mycotoxin contamination is favored by the humid continental temperate climate specific to our country and implicitly to Iasi County, this aspect having negative effects on the productivity and quality of crops.

In the studied period (2015-2019) a total number of 118 samples were analyzed, of which 52 samples representing a percentage of 44% did not register values for the deoxynivalenol parameter. A number of 66 samples, representing approx. 56% of all those studied presented positive values for this mycotoxin, which is a considerable percentage. None of the samples analyzed for the determination of deoxynivalenol did not exceed the maximum permitted limit provided by the legislation in force (EC Reg. 1881/2006).

The general conclusion is that, based on the results of the analyses performed for the selected products taken from the entire food chain, there is a potential contamination with deoxynivalenol. Apart from the particular regional circumstances, the general situation is characterized by widespread contamination at low levels, leading to risks to human health related to chronic exposure. At the same time, the synergistic toxicity of mycotoxins encountered simultaneously, especially in cereals, should not be ignored.

The maximum levels for mycotoxins, permitted by the legislation in force, shall be set at a level which takes into account human exposure in relation to the tolerable dose of the toxin in question and which can reasonably be achieved by observing good production practices and hygiene in all the stages of production, storage, processing and distribution of agricultural products and food derived from them. This approach ensures that food business operators apply all possible measures to prevent / limit as far as possible mycotoxin contamination in order to protect public health.

Deoxynivalenol is the most common contaminant of cereals and cereal products, its presence being a potential indicator of contamination with other mycotoxins. Increased attention should be paid to all sources of deoxynivalenol contamination in order to minimize its presence in food, in order to remove the subsequent negative impact on human health.

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ASSESSMENT OF BACTERIA AND FUNGI ASSOCIATED WITH THE INSTANT NOODLES AND ACCOMPANYING SEASONING PACKETS

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Abstract

Instant noodles and the accompanying seasonings have gained popularity because of its convenience and affordability among young population in most country of the World. In this study the microbial quality (bacteria and fungi) of three different brands of noodles (designated as A, B and C) with their accompanying seasonings commonly marketed and consumed in Romania were investigated. The samples were serially diluted and poured in Petri plates. One gram of each brand of noodles and seasonings was aseptically transferred into 9 ml of sterile distilled water. Potato dextrose agar (PDA) in different compositions (classic, with streptomycin and rose-bengal stain) were the media used in this research. The least microbial load was obtained by heating samples at 100°C for 10 min. Sample B had the highest bacterial count of 16×10^3 cfu/g for cold noodles, and also the highest count of 6.6×10^3 cfu/g for hot noodles. For the seasonings, the total bacterial count varied from 6.6×10^3 cfu/g (sample A) to 33×10^3 cfu/g (sample B). The total fungal count of all samples was slightly higher than that of the bacterial counts. Microbial analysis showed the presence of Gram negative bacteria as predominant bacteria type (e.g. *Pseudomonas* spp), while *Aspergillus*, *Rhizopus*, *Penicillum* were the three isolated genera of fungi. *Penicillum* was the most frequently isolated genera of fungi in case of all brands of noodles.

Key words: bacteria, fungi, instant noodles, seasoning packets

Instant noodles have become a controversial global food product in the last decade, as their nutritional qualities are questioned, but despite this fact, approximately 106 billion servings were consumed globally in 2019, (instantnoodles.org), with increasing tendency for 2020. Such high demand requires rigorous control over the microbial quality. The growth of microorganisms in foods is facilitated, prevented or restricted by many factors; water activity, pH and temperature are the most important (Akhigbemidu W. *et al*, 2015).

The physical, chemical and microbiological spoilage of cereal products influences the flavor, aroma, leavening, presentation and overall consistency of the final consumer product (Cook F.K., Johnson B.L., 2009).

Instant noodles (dried or precooked) are commercially available either in cups with the seasoning sprinkled over the noodles or in pouches with packets of flavoring including seasoning oil (Hou G., 2001).

Instant noodles are especially popular among young people and have become a convenient alternative for lunch or dinner for its "quick to cook" properties and affordable price.

After being boiled or immersed in boiling water for 2-5 minutes, dry noodles are normally consumed, while precooked noodles may be reheated or eaten straight from the box. A single instant noodle portion is high in fat and carbohydrates, but low in fiber, vitamins and minerals (Lee E.T., 2009).

Thanks to their preservation, fine dried noodles (moisture content less than 14%) have accounted for the majority of noodle production for a long time. However, the taste, texture and nutritional properties of noodle products may be destroyed by these deep drying processes (Li M. *et al*, 2012).

Despite the new technologies, there is still a risk of contaminants coming from the compounds used in the manufacturing process, as well as those accidentally introduced from other sources. Pathogenic microorganisms that manage to survive throughout the production chain and end up being consumed, occasionally have the ability to induce food poisoning.

The aims of this study are to assess the microbial quality of three brands of noodles with their accompanying seasonings, respectively and

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to isolate and identify the bacteria and fungi present in the noodles and the seasonings.

MATERIAL AND METHOD

Three brands of noodles with their packets of flavoring, commonly marketed and consumed in Romania, were purchased randomly from different retail outlets. To ensure that they were intact (no tear or damage) and not expired, the sachets were carefully examined and taken for microbiological analysis at University of Agricultural Sciences and Veterinary Medicine, Iasi. To accomplish the purpose of this study the brands were coded as A, B and C.

Cultivation and determination of bacteria and fungi in noodles and seasoning was done by serial dilution and plating into nutritive media. One gram of each brand of noodles and seasonings 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^{-4} dilution were prepared. From one dilution to another, mixture was thoroughly stirred for 5 min for the cold noodles and cold seasonings samples. The hot samples were obtained by boiling each of the three brands at 100°C for 10 min. Aliquots (1 mL) of 10^{-2} to 10^{-4} dilution were spread on nutritive media for assessing the total number of bacteria and fungi (Lipsa F.D., Ulea E., 2018).

Average numbers of colony forming units in 1 g of noodles and seasoning (cfu·g^{-1}) was determined using the plate counting method (Bressan *et al*, 2015), on potato dextrose agar medium (PDA) in different compositions: classic, with streptomycin and rose-bengal stain. Streptomycin antibiotic (35 mg·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 (incubation temperature 28°C). 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 and the results with $p<0.05$ were considered statistically significant.

RESULTS AND DISCUSSIONS

The generally result obtained for microbial quality evaluation is presented in figure 1. Based on the results, the ratio between the main groups of microorganisms for all three brands of noodles was dominated by filamentous fungi, present as spores, with a value of 54.9%, followed by Gram-negative (G-) and Gram-positive bacteria (G+), with 34.7 and 10.4%, respectively.

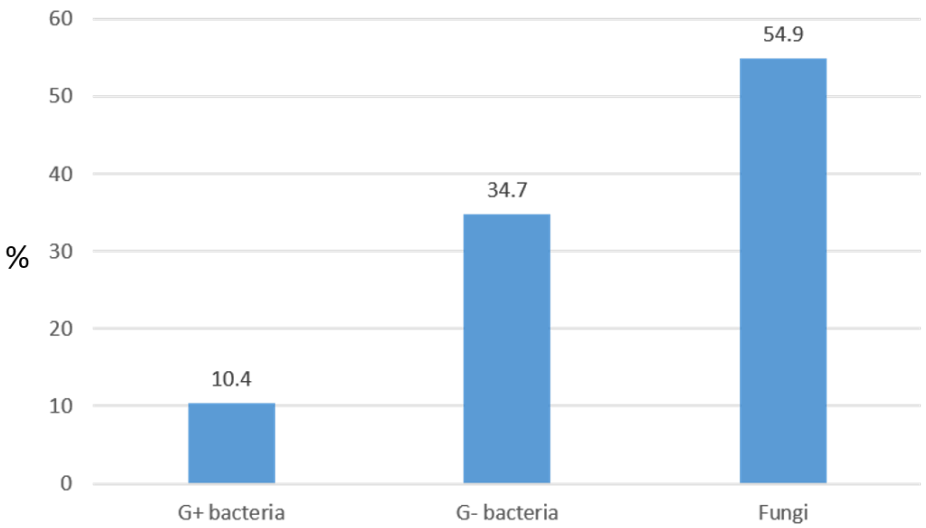

Figure 1 **Frequency of isolated microbiota from all 3 noodles samples (%)**

The categories of microorganisms in instant noodles primarily depend on wheat flour, condiments and the manufacturing and packaging methods, while microbial changes during storage depend on the composition of the substrate of the noodles and the conditions of storage. Under certain conditions, nearly all microorganisms can cause food spoilage, which is mainly based on nutrient composition and physicochemical parameters (Losio M.N. *et al*, 2017).

The microbial load varied with brands, and when considering both bacterial and fungal counts, the number of colony forming units per g of the product (cfu/g) was greater in cold samples than in hot samples (*tables 1 and 2*). In all the cases, the fungal counts were relatively smaller than the bacterial population.

Sample B had the highest bacterial counts of 16.0 and 6.6 x 10^3 cfu/g for both cold and hot noodles, respectively, while sample A recorded the lowest counts of 6.6 and 3.3 x 10^3 cfu/g, respectively. In case of accompanying seasoning packets, the most abundant bacterial community was recorded also in case of sample B (33.0 x 10^3 cfu/g), followed by tha samples C and A, both with 6.6 x 10^3 cfu/g (*table 1*).

These results show that the bacterial load is significantly reduced by heating the noodles. In the hot noodle samples, the least microbial load was found in all brands, while higher microbial load occurred in cold samples. The fact that all hot samples had a decrease in microbial load suggests that the use of hot water has an effect on the microbial quality compared to that of cold samples.

Table 1

Bacterial counts of three brands of noodles and accompanying seasonings (cfu/g)

Samples	Hot noodles	Cold noodles	Seasonings
A	3.3×10^3	6.6×10^3	6.6×10^3
B	6.6×10^3	16×10^3	33×10^3
C	3.3×10^3	16×10^3	6.6×10^3

Values as means of triplicate replication

The highest fungal load of 16.6 x 10^3 cfu/g were found in the accompanying seasoning packets of the samples B and C., while, in case of seasonings, the least occurred in sample A (*table 2*). In fact, the lowest count values of 3.3, 5.6 and 9.0 cfu/g were found in all hot noodles samples, respectively. Sample B had the highest fungal spore concentrations of 16.6 x 10^3 cfu/g for seasoning, 9.99 x 10^3 cfu/g for cold noodles and 9.0 x 10^3 cfu/g for hot noodles. Sample C recorded the lowest fungal load. Interesting was the fact, that in case of cold noodles from sample A, the concentration of filamentous fungi spores was higher (9.99 x 10^3 cfu/g) than the seasonings (6.6 x 10^3 cfu/g).

An explanation for this occurrence, could be that the peoples engaged in the production, packaging and retailing of these noodles do not take the required precautions or may indicate storage conditions, contamination from the seals of packets or from handlers before sampling.

Table 2

Fungal counts of three brands of noodles and accompanying seasonings (cfu/g)

Samples	Hot noodles	Cold noodles	Seasonings
A	5.6×10^3	9.99×10^3	6.6×10^3
B	9.0×10^3	9.99×10^3	16.6×10^3
C	3.3×10^3	6.6×10^3	16.6×10^3

Values as means of triplicate replication

The isolated species belonging to three micromycetes genera: *Penicillium*, *Aspergillus* and *Rhizopus*. Among the determined micromycetes in all the three different noodles samples, we pointed out *Penicillium* genus, which was isolated at a rate comprised between 68.9 (sample C) and 93.1% (sample A) of the total identified genera (*figure 2*). In smaller ratios were present *Aspergillus* and *Rhizopus* genera, with maximal values of 30.6 and 28.2% in case of hot noodles from sample C.

The presence of fungi from genera *Aspergillus* and *Penicillium* is of major health concern as they may produce mycotoxins (especially aflatoxins) in various foods (Barnett J.A. *et al*, 2000). Aflatoxins have been isolated from legumes, grains, fruits, meats, spices, cheeses, milk, rice or mais and have carcinogenic, hemorrhagic, hepatotoxic and neurotoxic properties (Akande O., Kuforiji O., 2013).

For some of the samples in this report, despite the high microbial counts obtained, it is important to note that these samples did not display any noticeable signs of spoilage. Therefore, external appearance may not be a good criterion for the microbial quality assessment of instant noodles.

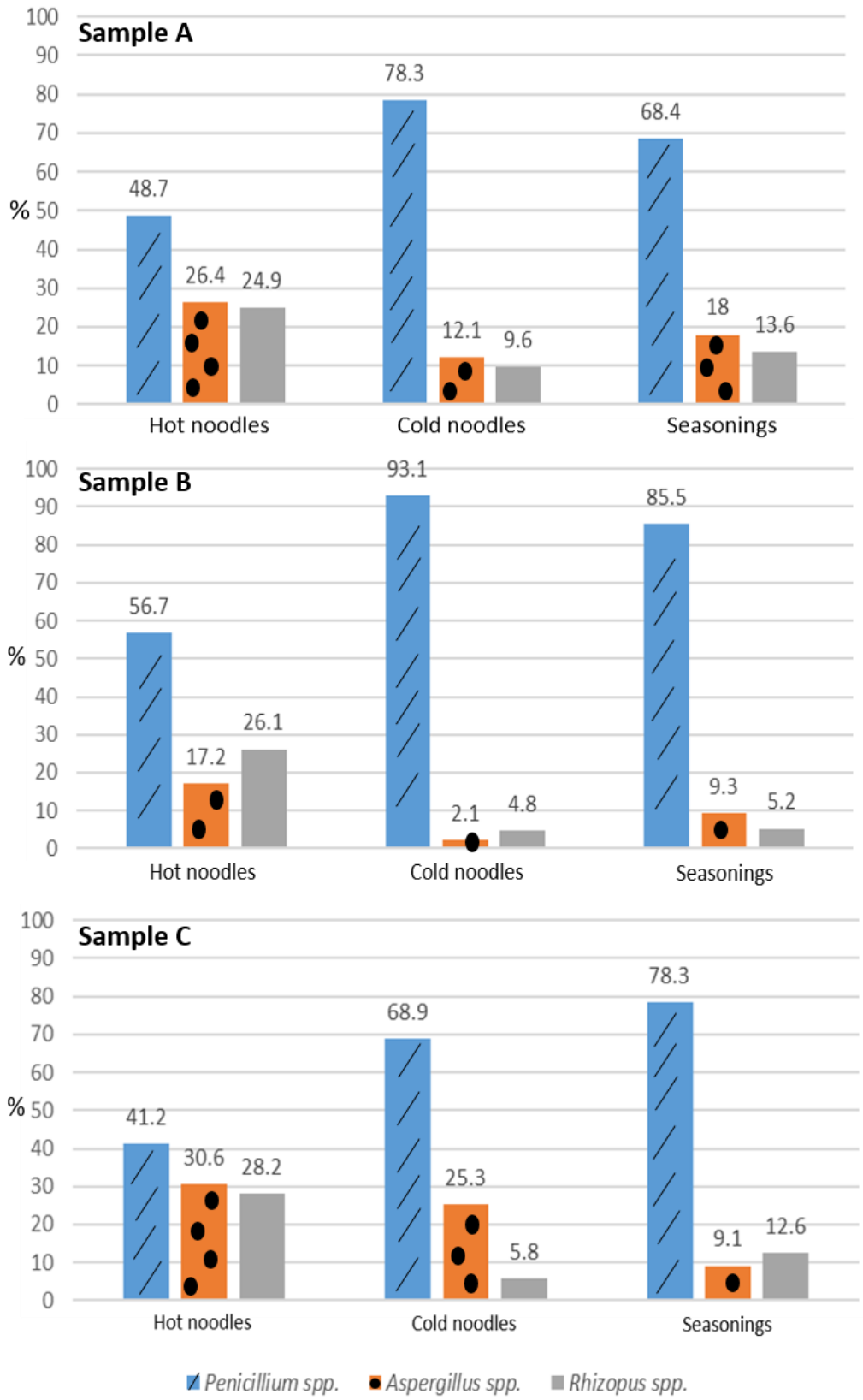

Figure 2 **Frequency of isolated filamentous fungi from samples A, B and C (%)**

The reduction in microbial load for the hot samples is in line with ICMSF (2011), which indicated that pH, water activity, and temperature control can be modified to control the production of fungal toxins. However, temperature does not protect against all toxigenic molds, since many can expand at cooling temperatures. Multiple toxigenic species have been found to be capable of growth and toxin production takes place at temperatures as low as 10°C (Akhigbemidu W. *et al*, 2015).

Because of the fact that some strains may be more toxigenic at low temperatures than at optimum growth temperatures, proper cooking of noodles and its seasonings is the best means of controlling growth of microorganisms in foods

The results underline the importance of performing microbiological control in order to ensure safe and uncontaminated food, but they may also indicate the existence or absence of a nutrient substrate necessary for the proliferation of microorganisms.

In all three instant noodles samples, a maximum concentration of about 15.6 cfu/g of bacterial and fungal spores in the hot samples was in agreement with the value recommended by ICMSF (ICMSF, 2011) for unfilled pasta. Similar results were reported by Akhigbemidu W. *et al* (2015) and Akineden *et al* (2015) in instant noodles and, respectively, in raw dried pasta.

The quality and safety of the finished goods depend directly on the quality and safety of the raw materials. Flour, water and various ingredients are raw materials for noodles and related items that are added to enrich the nutritional value of the final product (Bejarovic G., 2001).

CONCLUSIONS

The presence of microorganisms in noodles may be unavoidable due to the production, storage and handling, but they can drastically be reduced to a minimum level by good packaging and storing in a suitable environment to ensure good quality and safe noodles.

Highest microbial load is found in accompanying seasoning packets.

Rehydration with hot water reduce the concentration of microorganisms significantly.

Sample B had the highest bacterial count of 16×10^3 cfu/g for cold noodles, and also the highest count of 6.6×10^3 cfu/g for hot noodles.

For the accompanying seasoning, the total bacterial count varied from 6×10^3 cfu/g (sample A) to 33×10^3 cfu/g (sample B). The total fungal count of all samples was slightly higher than that of the bacterial counts.

Microbial analysis showed the presence of Gram negative bacteria as predominant bacteria type, while *Aspergillus*, *Rhizopus* and *Penicillum* were the three isolated genera of fungi. *Penicillum* was the most frequently isolated genera of fungi in case of all brands of noodles.

In all three instant noodles samples the maximum concentration of bacterial and fungal spores was in agreement with the recommended value.

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BROOMRAPE (*OROBANCHE CUMANA* WALLR.) CONTROL BY DEVELOPING GENETIC RESISTANT GENOTYPES IN SUNFLOWER

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Abstract

Sunflower broomrape (*Orobanche cumana* Wallr.) is a parasitic plant which has a significant negative impact on seed yield. The parasite is spread in large areas of Europe, Asia and it has identified recently, in North Africa. Breeding for resistance is regarded as the most effective, feasible and environmentally friendly solution to control sunflower broomrape. However, breeding for resistance is challenging as new races of the parasite have evolved. The use of resistant hybrids of monogenic resistance type, is followed by the appearance of new more virulent races that overcome the existing resistance genes. So, it is necessary to develop sunflower hybrids which can accumulate qualitative and quantitative resistance in a single one, in order to have a durable resistance. Among this, by developing Clearfield Production System in sunflower it could have an important control strategy and complemented the genetic resistance against the parasite.

Key words: sunflower broomrape, genetic control, qualitative resistance, quantitative resistance, herbicides resistance

The parasitic weed *Orobanche cumana* (sunflower broomrape) is an obligatory and non-photosynthetic root parasitic plant of the sunflower (*Helianthus annuus* L.) and is a substantial threat in Europe, especially in countries around the Black Sea and in Spain (Molinero-Ruiz L. *et al*, 2013, Louarn J. *et al*, 2016). Under favourable conditions, it infects the roots of sunflower plants and connects to the vascular tissue, thus depleting the nutrients and affecting host growth and yield (Heide-Jorgensen H., 2008; Molinero-Ruiz L. *et al*, 2015). Broomrape seeds are very small and individual plants can produce an impressive number of seeds that remain viable in the soil for up to 20 years. They are widely disseminated by water, wind, animals, humans, machinery, or though attachment to sunflower seeds (Parker C., 2013).

A major difficulty for the breeders is the fast development of new races of the parasite, which overcome the resistance of sunflower genotypes. To the present day, more than seven races of sunflower broomrape have been identified (Kaya Y., 2014). Vranceanu A.V. *et al* (1980) identified five races of *O. cumana*, designated as A, B, C, D and E. Later on, more virulent race F was identified in Spain (Alonso L.C. *et al*, 1996; Molinero-Ruiz L. *et al*, 2008, Martin-Sanz *et al* 2016), Romania (Păcureanu-Joita M. *et al*, 1998), Turkey (Kaya Y. *et al*, 2004) and some other counties. Presence of more virulent broomrape races, designated G and H, has been also reported (Shindrova P. and Penchev E., 2012, Antonova L. *et al*, 2014, Kaya Y., 2014).

Current racial situation of broomrape in the main infested areas is unclear, since there is a lack of information on whether races under the same name reported in different countries are the same or differ in terms of virulence (Fernández-Martínez J. *et al*, 2012; Molinero-Ruiz L. *et al*, 2015, Martin-Sanz A. *et al*, 2016).

Breeding for genetic resistance appears to be the most appropriate and reliable measure to control the parasite.

The changes in broomrape race composition have forced sunflower breeders to continuously search for resistance genes to new races and study their genetic control.

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The objective of this study was to identify sources of resistance to the parasite and to develop genetic resistant genotypes to broomrape.

MATERIAL AND METHOD

Six cultivated sunflower inbred lines and two sunflower wild species have been introduced in crossing for obtaining interspecific hybrids, in order to create sunflower populations which will be used for releasing inbred lines with high resistance to broomrape (*Orobanche cumana*).

These hybrids as well as the parental forms (cultivated and wild) have been studied for resistance to the parasite broomrape. There have been analyzed the number of sunflower heads and number of seeds/head, for each crossing.

The crossing between cultivated and wild sunflower was made by emasculation in cultivated inbred lines and making pollination with wild species pollen, as well as making emasculation in wild forms and pollination with pollen of cultivated ones.

The populations which were obtained from interspecific hybrids have been tested for resistance to broomrape. The resistance to broomrape parasite was made in natural and artificial infestation conditions. The testing in the artificial infestation was made in glass house, in pots of 5 liters capacity, having inside a mixture of soil and sand (3/1) as well as broomrape seeds (1 g/pot). It has been collected broomrape from areas very high infested with the parasite.

In natural infestation, the testing was made in two locations situated in areas Constanta and Tulcea, with different virulence of broomrape populations.

RESULTS AND DISCUSSIONS

The results regarding the crosses between wild and cultivated sunflower are presented in *table 1*. In case of using cultivated sunflower as pollen receptor, the number of seeds/head is high, comparing with case of using the wild sunflower as pollen receptor, when the number of seeds/head is very low. In this case the number of heads is high, taking into consideration that the wild sunflower is high branched, so, there are many small heads.

Table 1

Results regarding the crosses between wild and cultivated sunflower

Helianthus annuus	*H. tuberosus*	*H. agrestis*	LC 1001	LC 985	LC 1015	LC 1066	LC 1085	LC 1088
	Hybridization: number of heads and seed/heads							
LC 1001 B	3/640	3/250						
LC 985 B	3/520	3/120						
LC 1015 B	3/390	3/360						
LC 1066 C	3/150	3/150						
LC 1085 C	3/280	3/250						
LC 1088 C	3/130	2/110						
Helianthus tuberosus			25/15	25/7	25/5	25/14	25/23	25/12

In *figure 1* are presented the results regarding the resistance to broomrape for sunflower populations obtained from interspecific hybrids. Comparing the results obtained in two locations situated in Tulcea and Constanta areas, these are showing that some populations are full resistant in Tulcea area, having a low attack degree in Constanta area.

The sunflower differential line, for the race E which was used as check for sensitivity, has a high infestation degree, in both locations. This it means that in these locations the parasite has developed races more virulent.

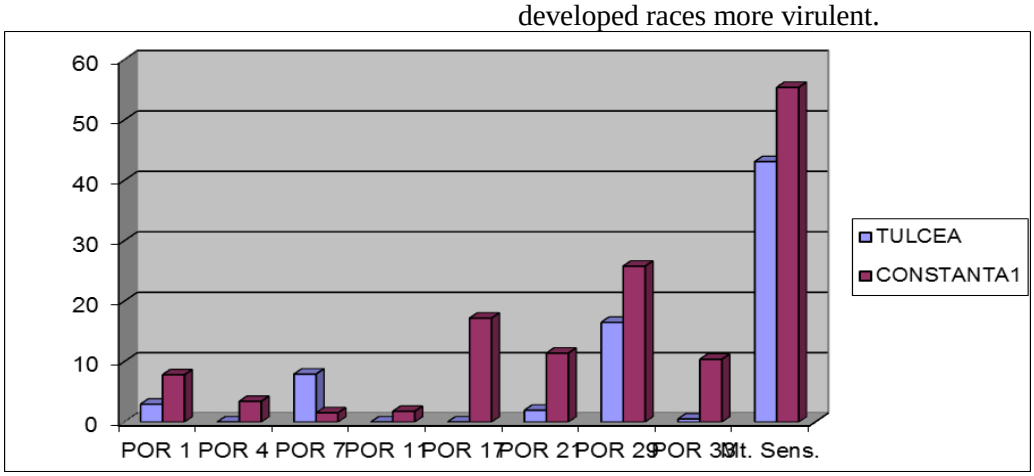

Figure 1 **Results regarding the resistance of some sunflower populations obtained from interspecific hybrids, to the broomrape parasite, in the natural infestation conditions, in two areas in Romania**

In *figure 2* is presented the scheme used for introducing the genes for resistance to the parasite broomrape, in the valuable sunflower inbred lines. In this process of the genes transferring it needs a number of 3-4 backcross generations, followed by 1-2 generation of self-pollination.

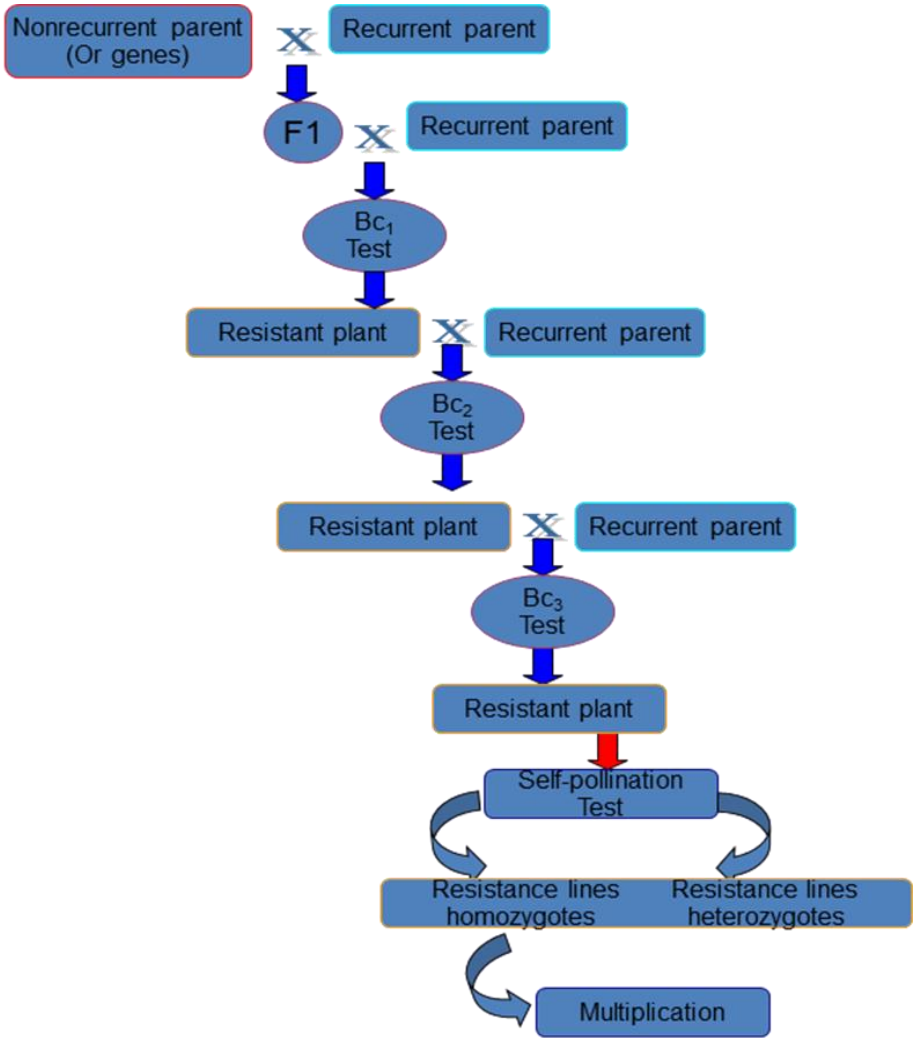

Figure 2 - **Scheme used for the genes for resistance transferring, in the valuable inbred lines**

In *figure 3* are presented the results regarding the behavior of some lines in different generations of the genes transfer, using many broomrape populations, from the most infested areas in southeastern Romania.

The testing was done in the artificial infestation conditions. It can be seen that for some lines, the resistance is increasing after each generation of selection, taking into consideration that it is made one generation per year.

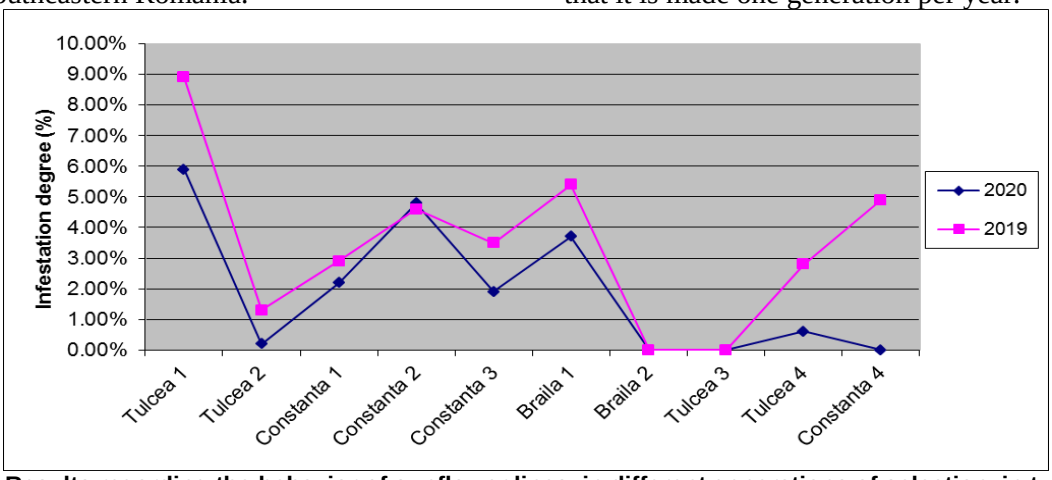

Figure 3 **Results regarding the behavior of sunflower lines, in different generations of selection, in two years**

CONCLUSIONS

The broomrape parasite has become very dangerous for sunflower crop in almost all areas cultivated with sunflower in Europe. It is of a great importance to identify sources of resistance to the new races of broomrape. For this, the sunflower wild species are very important, they being the best source of genes for resistance.

Some sunflower populations obtained by crossing sunflower wild species with cultivated genotypes have good resistance to the broomrape races which are spread in the most important areas cultivated with sunflower in Romania.

Using a scheme efficient for transferring the genes for resistance to broomrape parasite, in some valuable sunflower inbred lines, there has been obtained high resistant genotypes

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THE INFLUENCE OF AGROMETEOROLOGICAL CHARACTERISTICS OF THE AGRICULTURAL YEAR 2019-2020 ON WHEAT CROP IN THE NORTH-EAST PART OF MOLDOVA

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Abstract

The study based on the aforementioned theme puts to distinguish specifics agrometeorological characteristics of the agricultural year 2019-2020 in the North-East part of Moldova, and its influence on growth and yield in winter wheat crop. It's presented the average values of precipitations and air temperature for the last decade and the values of precipitations and air temperature recorded between September 2019 and July 2020 and its influence in winter wheat crop. The climatic conditions encountered during the agricultural year 2019-2020 and, especially in the first half of 2020 made this year a very special one, being characterized by the presence of a severe drought, with strong negative influences on growth of cultivated plants and especially of winter wheat.

Key words: agricultural year 2019-2020, wheat, yield, precipitation, temperature

Wheat is unquestionable the most important food crop in the world, and is counted among the 'big three' cereal crops, together with rice and corn (Shewry P.R., 2009; Morris C.F. *et al*, 1996). World wheat production currently stands at about 550 million metric tons, harvested from a surface of 220 million nectars, with a yield average around 2.4 t/ha^{-1}.

In Romania wheat and corn are the main crops, being cultivated on a surface around of 2.2 million hectares, each. Romanian national wheat production stands at about 6 million tons with an average yield around 4.5 t/ha^{-1}.

Stability of crop production is an important challenge for researchers. Although much has been done recently in this regard (yields stability), there are years in which crop production, including wheat yields, is decimated due to adverse weather conditions, of which drought is the phenomenon with the most serious implications (Săulescu N.N. *et al*, 2006; Pochișcanu S.F. *et al*, 2011).

Although, in Romania, wheat yields have increased gradually in recent years, reaching in 2017 the threshold of 4 t/ha^{-1}, there are years when the yield decreases by half, or even more, than that recorded in the previous years. Such years, when wheat yield was very low, were the agricultural years 1996, 2003, 2007, 2009, 2012 when during the vegetation period of wheat crop the atmospheric precipitations were completely absent (Gafencu A.M., 2019).

MATERIAL AND METHOD

The experience was placed in the experimental field of the Iasi Didactic Station, the "Ezăreni" farm of the "Ion Ionescu de la Brad" University of Agricultural Sciences and Veterinary Medicine of Iasi, in the agricultural year 2019-2020, on a cambic chernozem with loam-clay texture and medium-good fertility.

The experiment was bifactorial, AxB type, where A was represented by the winter wheat cultivars, and B was represented by the seed-treatment applied.

The design of the experiment was done according to the "randomized block method" in four replications.

First factor (A) was represented by the winter wheat cultivars, with five graduations. The winter wheat cultivars studied were represented by the Romanian winter wheat genotypes Glosa, Miranda and Izvor, but also by the foreign winter wheat genotypes Apache and Mulan. The Glosa genotype is the most cultivate cultivar in Romania, and Miranda and Izvor genotypes are on the following positions. Regarding the foreign genotypes, Apache cultivar is the most cultivated foreign winter wheat variety in Romania, and Mulan is a winter wheat cultivar that which is cultivated on higher and higher areas from one year to another, due to the properties it is endowed with.

Second factor (B) was represented by the plant protection products (PPPs) present on the Romania market and used for the treatment of

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winter wheat seed. The pesticides used to treat winter wheat seeds were: Systiva 333 FS (fluxapiroxad 333 g/l), Premis (triticonazole 25 g/l), Biosild Top (methyl thiophanate 350 g/l + tetraconazole 20 g/l), Difend Extra (difenoconazole 25 g/l + fludioxanil 25 g/l), Redigo Pro 170 FS (protioconazole 15 g/l + tebuconazole 20 g/l), Bariton Super 97.5 (protioconazole 15 g/l + tebuconazole 20 g/l + fludioxonil 37.5 g/l), Bariton Super 97.5 + Peridiam (protioconazole 15 g/l + tebuconazole 20 g/l + fludioxonil 37.5 g/l + Adjuvant), Celest Super (ciproconazole 6.3 g/l + fludioxonil 18.8 g/l), Sponsor 6 FS (tebuconazole 6%), Royal Flo 42S (thiouram 490 g/l), Admiral Proffy 6 FS (tebuconazole 60 g/l), Austral Plus + AG40R (tefluthrin 40 g/l + fludioxonil 10 g/l + Adjuvant), Difend Extra + Wuxal Terios Mn + (difenoconazole 25 g/l + fludioxanil 25 g/l + Adjuvant).

The control variant of the experience was represented by an untreated variant (*figure 1*).

Figure 1 **The experience designed in the field (original)**

Winter wheat crop technology was represented by classical technology. Wheat crop was sown after *Lupinus* sp. and was fertilized with moderate doses of fertilizer: 120 kg N/ha^{-1} and 45 kg P_2O_5/ha^{-1}.

It should be noted that no phytosanitary treatments were carried out during the growing season.

The sowing took place on October 22, 2019 and was done with the help of the Wintersteiger seed drill, and the harvesting took place on June 20, 2020 and was carried out with the Wintersteiger combine harvester.

Data on atmospheric conditions were obtained from the weather station located within the farm.

Statistical analysis was performed using the SPSS program (IBM SPSS Statistics 20).

RESULTS AND DISCUSSIONS

Agriculture in Romania, as well as in the world, is strongly influenced by climate change. Given that in our country the most extensive crops are corn and wheat, it is clear that the highest production losses, due to climatically conditions, will be reported in their case.

From year to year, the presence of unfavorable meteorological phenomena is observed, which can upset, in a very short time, a good agricultural year. The worst weather events are drought, hail, storms or floods.

The influence of extreme weather events was materialized by the negative effects on agricultural production. In 2020, the main crops that suffered as a result of the extreme drought were autumn crops, especially wheat.

Weather data during growth period of wheat in 2020 are presented in table 1 and table 2. Climate data recorded in 2020 are compared to some periods of reverence, e.g. last century, last decade, and last four years.

Rainfall quantity recorded between August 2019 and July 2020 was with 63.4 mm lower than multiannual average sum, and with 73.9 mm lower than last decade. Of the last five agricultural years studied, 2020 was the driest.

Although in autumn, at the time of sowing, the wheat crop had enough water available for emergence, in spring the lack of precipitation during the most important phenophases caused the plants to shorten their vegetation period and dry prematurely.

The lack of atmospheric precipitation, together with the air temperatures, which were higher this year than the periods taken as a reference, led to a dramatic reduction of winter wheat yields.

Table 1

Rainfall quantity and monthly distribution (mm) during wheat growing season at Ezareni Farm

Month		VIII	IX	X	XI	XII	I	II	III	IV	V	VI	VII	Quantity
Phenophases		Uncultivated land	Sowing - Emergency			Winter reserve				Increased growth-flowering		Ripening	Uncultivated land	
1990-2000		56.0	54.3	32.5	37	29.7	29.7	26.9	28.4	43.9	55.9	82.6	69.3	**537.2**
2005-2014		45.4	36.8	40.1	27.5	39.1	32.6	28.9	29.7	54	69.8	77.8	66.1	**547.7**
2015/16		**40.8**	**19.8**	**66.4**	**104.2**	**10.2**	**80**	**28.8**	**33.8**	**76.2**	**70.4**	**142.4**	**24**	**697**
Deviation	Multi annual average	-15.2	-34.5	33.9	67.2	-19.5	50.3	1.9	5.4	32.3	14.5	59.8	-45.3	**159.8**
	Last decade	-4.6	-17	26.3	76.7	-28.9	47.4	-0.1	4.1	22.2	0.6	64.6	-42.1	**149.3**
2016/17		**53.4**	**10.2**	**212**	**69.8**	**20.6**	**323.6**	**13.8**	**107**	**140.4**	**72.8**	**71.6**	**84.4**	**1179.6**
Deviation	Multi annual average	-2.6	-44.1	179.5	32.8	-9.1	293.9	-13.1	78.6	96.5	16.9	-11	15.1	**642.4**
	Last decade	8	-26.6	171.9	42.3	-18.5	291	-15.1	77.3	86.4	3	-6.2	18.3	**631.9**
2017/18		**61.8**	**23.2**	**69.8**	**20.6**	**48.2**	**18.8**	**24.8**	**56.8**	**18**	**16.8**	**216**	**136.6**	**717.6**
Deviation	Multi annual average	5.8	-31.1	37.3	-16.4	18.5	-10.9	-2.1	28.4	-25.9	-39.1	133.4	67.3	**180.4**
	Last decade	16.4	-13.6	29.7	-6.9	9.1	-13.8	-4.1	27.1	-36	-53	138.2	70.5	**169.9**
2018/19		**1.2**	**21**	**3.4**	**32.8**	**41**	**16.8**	**48**	**40.4**	**62.6**	**125.2**	**113.8**	**24.2**	**530.4**
Deviation	Multi annual average	-54.8	-33.3	-29.1	-4.2	11.3	-12.9	21.1	12	18.7	69.3	31.2	-45.1	**-6.8**
	Last decade	45.4	36.8	40.1	27.5	39.1	32.6	28.9	29.7	54	69.8	77.8	66.1	**-17.3**
2019/20		**51.4**	**60**	**35**	**10.4**	**14.6**	**5.4**	**66**	**22.2**	**4**	**84**	**84**	**36.8**	**473.8**
Deviation	Multi annual average	-4.6	5.7	2.5	-26.6	-15.1	-24.3	39.1	-6.2	-39.9	28.1	1.4	-32.5	**-63.4**
	Last decade	6	23.2	-5.1	-17.1	-24.5	-27.2	37.1	-7.5	-50	14.2	6.2	-29.3	**-73.9**

Table 2

Monthly air average temperatures (^{0}C) during wheat growing season at Ezareni Farm

Month		VIII	IX	X	XI	XII	I	II	III	IV	V	VI	VII	Average
Phenophases		Uncultivated land	Sowing - Emergency			Winter reserve				Increased growth-flowering		Ripening	Uncultivated land	
1990-2000		20.50	15.90	10.00	4.10	-0.80	-3.50	-1.80	3.10	10.20	16.00	19.50	21.20	**9.53**
2005-2014		21.93	16.57	10.36	5.76	-0.02	-2.15	-1.47	4.63	11.34	17.15	20.8	22.91	**10.65**
2015/16		**23.04**	**19.23**	**9.37**	**6.37**	**2.04**	**-2.54**	**5.26**	**6.52**	**13.33**	**15.32**	**20.86**	**22.64**	**11.79**
Deviation	Multi annual average	2.54	3.33	-0.63	2.27	2.84	0.96	7.06	3.42	3.13	-0.69	1.36	1.44	**2.26**
	Last decade	1.11	2.66	-0.99	0.61	2.06	-0.39	6.73	1.89	1.99	-1.84	0.06	-0.27	**1.14**
2016/17		**21.38**	**18.27**	**8.15**	**4.03**	**0.35**	**-4.89**	**-0.81**	**8.00**	**10.05**	**16.07**	**21.11**	**21.64**	**10.28**
Deviation	Multi annual average	0.88	2.37	-1.85	-0.07	1.15	-1.39	0.99	4.90	0.15	0.07	1.61	0.44	**0.75**
	Last decade	-0.55	1.70	-2.21	-1.73	0.37	-2.74	0.66	3.37	-1.29	-1.08	0.31	-1.27	**-0.37**
2017/18		**21.95**	**17.18**	**10.96**	**5.85**	**3.00**	**-0.84**	**-1.75**	**1.18**	**15.43**	**18.67**	**20.78**	**21.3**	**11.14**
Deviation	Multi annual average	1.45	1.28	0.96	1.75	3.80	2.66	0.05	-1.92	5.23	2.67	1.28	0.10	**1.61**
	Last decade	0.02	0.61	0.60	0.09	3.02	1.31	-0.28	-3.45	4.09	1.52	-0.02	-1.61	**0.49**
2018/19		**22.64**	**16.85**	**12.29**	**3.01**	**-0.90**	**-2.60**	**2.16**	**7.35**	**10.58**	**16.05**	**21.90**	**21.15**	**10.87**
Deviation	Multi annual average	2.14	0.95	2.29	-1.09	-0.10	0.90	3.96	4.25	0.38	0.05	2.40	-0.05	**1.34**
	Last decade	0.71	0.28	1.93	-2.75	-0.88	-0.45	3.63	2.72	-0.76	-1.10	1.10	-1.76	**0.22**
2019/20		**21.93**	**16.99**	**11.68**	**8.76**	**2.68**	**0.60**	**4.42**	**7.35**	**11.01**	**14.29**	**20.97**	**22.42**	**11.93**
Deviation	Multi annual average	1.43	1.09	1.68	4.66	3.48	4.10	6.22	4.25	0.81	-1.71	1.47	1.22	**2.40**
	Last decade	0.00	0.42	1.32	3.00	2.70	2.75	5.89	2.72	-0.33	-2.86	0.17	-0.49	**1.28**

Yields obtained in 2020 were much lower than those normally obtained in this area. If the Glosa variety consistently obtained a production between 5 and 6 t/ha^{-1} (Gafencu A.M. *et al*, 2019), this year yields were at least 50-60% lower (table 3 A]).

Table 3

Yields recorded by winter wheat cultivars in 2019/2020

A] Yield recorded by Glosa variety

Variety	Seed treatment	Yield (kg/ha^{-1} 14% U)			Meaning
		Average (kg/ha^{-1})	Difference from control		
			(kg/ha^{-1})	%	
Glosa	Systiva 333 FS	2021.7±143.0	340.8	120.3	NS
	Premis	1382.2±104.7	-298.8	82.2	NS
	Biosild Top	1854.2±352.3	173.3	110.3	NS
	Difend Extra	2212.3±147.7	531.4	131.6	NS
	Redigo Pro 170 Fs	2279.0±307.8	598.1	135.6	NS
	Bariton Super 97,5	1691.2±95.1	10.2	100.6	NS
	Bariton Super 97,5 + Peridiam	1821.9±200.9	141.0	108.4	NS
	Celest Super	2809.9±375.1	1129.0	167.2	**
	Sponsor 6 FS	3067.4±484.7	1386.5	182.5	***
	Royal Flo 42S	1713.8±212.8	32.9	102.0	NS
	Amiral Proffy 6 FS	1905.5±216.0	224.6	113.4	NS
	Amiral Proffy 6 FS +AG40R	2137.1±89.4	456.2	127.1	NS
	Difend Extra + Wuxal Terios Mn+	2011.0±94.3	330.1	119.6	NS
	Control (untreated)	**1680.9±86.6**	**-**	**100.0**	**Cv**

B] Yield recorded by Izvor variety

Variety	Seed treatment	Yield (kg/ha^{-1} 14% U)			Meaning
		Average (kg/ha^{-1})	Difference from control		
			(kg/ha^{-1})	%	
Izvor	Systiva 333 FS	1285.7±349.4	77.7	106.4	Ns
	Premis	1473.9±153.3	265.9	122.0	Ns
	Biosild Top	590.3±83.3	-617.8	48.9	Ns
	Difend Extra	1078.5±239.5	-129.6	89.3	Ns
	Redigo Pro 170 Fs	664.2±92.7	-543.8	55.0	Ns
	Bariton Super 97,5	1455.6±346.9	247.6	120.5	Ns
	Bariton Super 97,5 + Peridiam	1465.1±364.5	257.1	121.3	Ns
	Celest Super	1373.4±109.8	165.4	113.7	Ns
	Sponsor 6 FS	1516.1±138.6	308.1	125.5	Ns
	Royal Flo 42S	1327.4±149.9	119.4	109.9	Ns
	Amiral Proffy 6 FS	1309.2±68.0	101.2	108.4	Ns
	Amiral Proffy 6 FS +AG40R	1632.1±260.2	424.1	135.1	Ns
	Difend Extra + Wuxal Terios Mn+	1455.7±444.5	247.7	120.5	Ns
	Control (untreated)	**1208.0±86.6**	**-**	**100.0**	**Cv**

C] Yield recorded by Miranda variety

Variety	Seed treatment	Yield (kg/ha^{-1} 14% U)			Meaning
		Average (kg/ha^{-1})	Difference from control		
			(kg/ha^{-1})	%	
Miranda	Systiva 333 FS	2063.5±233.5	626.4	143.6	*
	Premis	1406.1±62.1	-31.1	97.8	Ns
	Biosild Top	2391.8±370.9	604.7	142.1	**
	Difend Extra	1846.0±95.2	408.9	128.5	Ns
	Redigo Pro 170 Fs	1325.7±178.8	-111.5	92.2	Ns
	Bariton Super 97,5	1983.1±232.6	546.0	138.0	Ns
	Bariton Super 97,5 + Peridiam	1951.9±200.4	514.8	135.8	Ns
	Celest Super	1714.5±245.9	277.4	119.3	Ns
	Sponsor 6 FS	2414.7±109.6	977.6	168.0	**
	Royal Flo 42S	1782.1±348.0	345.0	124.0	Ns
	Amiral Proffy 6 FS	1135.0±99.0	-302.2	79.0	Ns
	Amiral Proffy 6 FS +AG40R	1681.9±102.9	244.8	117.0	Ns
	Difend Extra + Wuxal Terios Mn+	2370.2±241.7	933.1	164.9	**
	Control (untreated)	**1437.1±132.6**	**-**	**100.0**	**Cv**

Table 3 – contination

D] Yield recorded by Apache variety

Variety	Seed treatment	Yield (kg/ha^{-1} 14% U)			Meaning
		Average (kg/ha^{-1})	Difference from control		
			(kg/ha^{-1})	%	
Apache	Systiva 333 FS	1004.4±200.0	220.5	128.1	Ns
	Premis	868.6±63.7	84.7	110.8	Ns
	Biosild Top	910.2±144.7	126.3	116.1	Ns
	Difend Extra	1085.0±67.7	301.1	138.4	Ns
	Redigo Pro 170 Fs	872.3±87.1	88.4	111.3	Ns
	Bariton Super 97,5	790.1±151.3	6.2	100.8	Ns
	Bariton Super 97,5 + Peridiam	657.0±140.8	-126.9	83.8	Ns
	Celest Super	628.4±119.5	-155.5	80.2	Ns
	Sponsor 6 FS	1027.8±115.0	243.9	131.1	Ns
	Royal Flo 42S	1303.8±260.3	519.9	166.3	*
	Amiral Proffy 6 FS	767.0±153.1	-16.9	97.8	Ns
	Amiral Proffy 6 FS +AG40R	939.6±189.3	155.7	119.9	Ns
	Difend Extra + Wuxal Terios Mn+	829.5±105.1	45.6	105.8	Ns
	Control (untreated)	**783.9±147.6**	**-**	**100.0**	**Cv**

E] Yield recorded by Mulan variety

Variety	Seed treatment	Yield (kg/ha^{-1} 14% U)			Meaning
		Average (kg/ha^{-1})	Difference from control		
			(kg/ha^{-1})	%	
Mulan	Systiva 333 FS	1311.2±82.2	-98.5	93.0	Ns
	Premis	1238.5±217.1	-171.3	87.9	Ns
	Biosild Top	2009.5±266.9	599.8	142.5	*
	Difend Extra	1327.9±113.3	-81.9	94.2	Ns
	Redigo Pro 170 Fs	1408.1±332.0	-1.7	99.9	Ns
	Bariton Super 97,5	1142.0±151.8	-267.7	81.0	Ns
	Bariton Super 97,5 + Peridiam	1367.7±195.1	-42.0	97.0	Ns
	Celest Super	1465.6±207.6	55.9	104.0	Ns
	Sponsor 6 FS	1057.5±76.4	-352.2	75.0	Ns
	Royal Flo 42S	1362.2±186.4	-46.5	96.7	Ns
	Amiral Proffy 6 FS	2048.4±375.4	638.7	145.3	*
	Amiral Proffy 6 FS +AG40R	1407.5±146.6	-2.2	99.8	Ns
	Difend Extra + Wuxal Terios Mn+	1600.9±211.5	191.2	113.6	Ns
	Control (untreated)	**1409.7±123.4**	**-**	**100.0**	**Cv**

Ns – not significant (P>0.05)
* – significant (P > 0.01)
** – distinctly significant (P > 0.001)
*** – very significant (P < 0.001)

The same situation was observed in the case of the other four wheat crops studied.

In the agricultural year 2020, wheat yields were reduced by at least 50%, but crop losses of up to 70% were observed, as in the case of the Apache variety where the yields obtained were at most 1 t/ha^{-1} (table 3 D]). These results show us that foreign wheat varieties, in critical situations, such as those in 2020, do not rise to the level of local Romanian cultivars in terms of production.

The same situation was observed in the case of the Mulan variety. Although it registered higher yields than the Apache variety, the value of the yields did not approach those registered in the case of the Romanian varieties: Glosa, Miranda and Izvor.

Regarding pesticide products used for seed treatment, it was observed that there are differences in terms of production obtained, but these differences were in few cases statistically assured.

In the case of the Izvor variety, the differences compared to the control variant were not ensured in any of the cases from a statistical point of view.

In the case of the Apache variety, only one variant, represented by the one treated with Royal Flo 42S, was statistically assured, being significant.

Two situations each, where the yield difference was statistically assured, they were identified in the case of Glosa and Mulan cultivars.

In the case of the Mulan variety, both differences were significant, being recorded by the seed treatment do with Biosild Top and Admiral Proffy 6FS.

In the case of the Glosa variety, the differences from the control variant were distinctly significant when the seed treatment was done with Celest Super, respectively very significant, when the seed treatment was done with Sponsor 6FS.

Most statistically assured differences were observed in the case of the Miranda variety. Four situations were observed. In three of them the difference was distinctly significant, and in one situation the differences were significant.

It should be noted that in all cases where the difference in production was statistically assured, the production yield was superior to the control variant.

CONCLUSIONS

Climate elements, such as temperature and atmospheric precipitation, are driving factors in plant development and vary widely between years. Weather factors play a decisive role in achieving higher yields.

The influence of extreme situations caused by extreme weather conditions was strongly observed in 2020.

Due to the lack of atmospheric precipitation, cultivated plants were subjected to severe water stress, which is why the yields were about 50-60% lower than the normal years.

The results obtained in this study show that the Romanian varieties behaved better in these extreme situations, recorded superior yield values compared to foreign varieties. This shows us that in crisis situations, local varieties can lead to satisfactory yields.

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THE INFLUENCE OF TREATMENTS WITH VARIOUS PHYTOSANITARY PRODUCTS (FUNGICIDES) ON THE ATTACK OF SOME PHYTOPATHOGENIC FUNGI ON BARLEY HARVEST, DONAU 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 barley, among which we mention: mildew (*Blummeria graminis* f.sp. *hordei*), leaf stripe (*Pyrenophora graminea*) and barley's rust (*Puccinia hordei*). Also, the influence of applying these fungicides on the harvest was monitored, as compared to the untreated control variant. For this study, an experiment with 6 treatment variants was created, in which the following phytosanitary products were used, as follows: ACANTO PLUS (picoxystrobin 200 g/l + cyproconazole 80 g/l); MYSTIC 250 EC (tebuconazole 250 g/l); FALCON PRO (prothioconazole 53 g/l+tebuconazole 148 g/l + spiroxamine 224 g/l); CAPALO (fenpropimorph 200g/l, epoxiconazole 62.5 g/l, metrafenon 75g/l). The treatment variants were the following: V1 - ACANTO PLUS 0.5 L/HA, 1 treatment applied at spike's release - blooming (5.05. 2019); V2 - ACANTO PLUS 0.5 L/HA, 1 treatment applied in "bellows" phase (20.04.2019) + 1 treatment applied at the beginning of kernel's filling (27.05.2019); V3 - CAPALO 1.0 L/HA, 1 treatment applied at spike's release - blooming (5.05. 2019); V4 - MYSTIC 250 EC 0.5 L/HA + 1 CAPALO 0.5 L/HA treatment applied in "bellows" phase (20.04.2019) + 1 treatment applied at the beginning of kernel's filling (27.05.2019); V5 - FALCON PRO 0.6 L/HA, 1 treatment applied at spike's release - blooming (5.05.2019); V6 - ACANTO PLUS 0.5 L/HA +- FALCON PRO 0.5 L/HA, 1 treatment applied in "bellows" phase (20.04.2019), 1 treatment applied at the beginning of kernel's filling (27.05. 2019), V7 – Untreated control variant. The experiment was placed in Latin square; the 7 variants being placed in 7 repetitions. The first two leaves placed under the spike had been analysed for the above. Among the pathogenic agents under monitoring, the greatest attacks were produced by *Pyrenophora graminea* fungus which produces barley leaf stripe disease. The harvests of the variants were the following: V1 - 5634 kg/ha, V2 - 5951 kg/ha, V3 - 5669 kg/ha, V4 - 5658 kg/ha, V5 - 5494kg/ha, V6 - 5704 kg/ha and V7 (untreated control variant) - 5506 kg/ha.

Key words: *Pyrenphora*, cyproconazole, latin square

Hordeum vulgare barley is under attack of many pathogenic agents, such as: mildew - *Blumeria graminis* f.sp. *hordei*, leaf stripe - *Pyrenophora graminea*, leaf blotch - *Rhynchosporium secalis*, rust - *Puccinia hordei* (Iacob V. *et al*, 1998). The first half of the year 2019 was very good for barley. For example, in April, the average temperature registered was 10.4°C and the rainfalls summed up to 60.0 l/m². In May, the average temperature registered was 17.7°C, and the rainfalls summed up to 100.6 l/m². Also, March was very rich in rainfalls (60 l/m^2). However, the autumn of the year 2018 was poor in rainfalls. Barley's springing in the autumn of the year 2018 was difficult due to this cause and it took place after the date of 15th November. The winter between the years 2018 and 2019 was relatively warm, fact which allowed the plants not to freeze, barley being a variety sensitive to cold as compared to wheat.

Among the pathogenic agents which emerged, we mention *Pyrenophora graminea* fungus which produces the disease called leaf stripe at barley. This pathogenic agent attacks barley crops each year, at attack intensities which vary each and every year. The other pathogenic agents mentioned had occurred sporadically in the year 2019 in barley's experiment.

MATERIAL AND METHOD

For performing the observations, an experiment with 7 study variants was conceived. This experiment comprised 6 variants of phytosanitary treatment (fungicide products, their combinations, number of treatments) and a control variant not treated.

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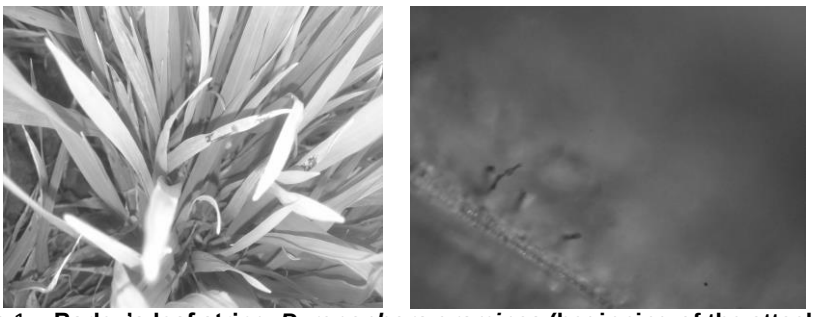

Figure 1 **– Barley's leaf stripe, *Pyrenophora graminea* (beginning of the attack): a – attack on leaves, b – conidia (original)**

Figure 2 **– Aspects from the experiment field (original)**

The variants of the experiment were the following (tab.1):

- V1 ACANTO PLUS 0.5 L/HA, 1 treatment applied at spike's release – blooming (5.05.2019);
- V2 ACANTO PLUS 0.5 L/HA, 1 treatment applied at "bellows" phase (20.04 2019) + 1 treatment applied at the beginning of kernel's filling (27.05.2019);
- V3 CAPALO 1.0 L/HA, 1 treatment applied at spike's release - blooming (5.05.2019);
- V4 MYSTIC 250 EC 0.5 L/HA + 1 CAPALO 0,5 L/HA treatment applied at "bellows" phase (20.04.2019) + 1 treatment applied at the beginning of kernel's filling (27.05.2019);
- V5 FALCON PRO 0.6 L/HA, 1 treatment applied at spike's release - blooming (5.05.2019);
- V6 ACANTO PLUS 0.5 L/HA + FALCON PRO 0.5 L/HA, 1 treatment applied at "bellows" phase (20.04.2019), 1 treatment applied at the beginning of kernel's filling (27.05.2019);
- V7 Untreated control variant.

Tabel 1

The results of the experiment with fungicide products (6 variants of treatment + untreated control variant) in what concerns the attack (D.A. %) of *Pyrenophora graminea* fungus at barley ("flag" leaf and the next leaf). The observations were performed on the date of May 21st 2019

	"flag" leaf			The second leaf		
Variant	D.A%	Difference as compared to the control variant	Signif.	D.A%	Difference as compared to the control variant	Signif.
V1 ACANTO PLUS 0.5 L/HA, 1 treatment applied at spike's release - blooming (5.05.2019)	2.10	41.70	**	5.95	8.15	**
V2 ACANTO PLUS 0.5 L/HA, 1 treatment applied at "bellows" phase (20.04 2019) + 1 treatment applied at the beginning of kernel's filling (27.05.2019)	7.20	36.60	**	3.57	10.53	**
V3 CAPALO 1.0 L/HA, 1 treatment applied at spike's release - blooming (5.05.2019)	8.80	35.00	**	2.65	11.45	**
V4 MYSTIC 250 EC 0.5 L/HA + 1 CAPALO 0.5 L/HA treatment applied at "bellows" phase (20.04.2019) + 1 treatment applied at the beginning of kernel's filling (27.05.2019)	8.40	35.40	**	4.34	9.76	**
V5 FALCON PRO 0.6 L/HA, 1 treatment applied at spike's release - blooming (5.05.2019)	3.00	40.80	**	3.92	10.18	**
V6 ACANTO PLUS 0.5 L/HA + -FALCON PRO 0.5 L/HA, 1 treatment applied at "bellows" phase (20.04.2019), 1 treatment applied at the beginning of kernel's filling (27.05.2019)	5.30	38.50	**	2.91	11.19	**
V7 -Untreated control variant.	43.80	-	-	14.10	-	-

LD D.A.% for the „flag leaf"
LD 5% = 0.75%
LD 1% = 1.02%

LD D.A.% for the second leaf:
LD 5% = 4.85%
LD 1% = 6.54%

Table 2

The results of the experiment with fungicide products (6 variants of treatment + untreated control variant) in what concerns the harvest (t/ha) obtained at the variants treated as compared to the untreated control variant

Variant	Harvest (kg/ha)	Difference as compared to the control variant (kg/ha)	Significance
V1 ACANTO PLUS 0.5 L/HA, 1 treatment applied at spike's release - blooming (5.05.2019)	5634	128	Not significant
V2 ACANTO PLUS 0.5 L/HA, 1 treatment applied at "bellows" phase (20.04 2019) + 1 treatment applied at the beginning of kernel's filling (27.05.2019)	5951	445	**
V3 CAPALO 1.0 L/HA, 1 treatment applied at spike's release - blooming (5.05.2019)	5669	163	*
V4 MYSTIC 250 EC 0.5 L/HA + 1 CAPALO 0.5 L/HA treatment applied at "bellows" phase (20.04.2019) + 1 treatment applied at the beginning of kernel's filling (27.05.2019)	5658	152	Not significant
V5 FALCON PRO 0.6 L/HA, 1 treatment applied at spike's release - blooming (5.05.2019)	5494	-12	Not significant
V6 ACANTO PLUS 0.5 L/HA + FALCON PRO 0.5 L/HA, 1 treatment applied at "bellows" phase (20.04.2019), 1 treatment applied at the beginning of kernel's filling (27.05.2019)	5704	198	*
V7 Untreated control variant.	5506	-	-

LD 5% = 159.60 kg/ha
LD 1% = 215.16 kg/ha

We mention that FALCON 460 EC product is homologated for barley in a dosage of 0.6 l/ha. For V6, a smaller dose of 0.5 l/ha was used, due to the fact that it was tried a combination with ACANTO PLUS product in a dosage of 0.5 l/ha.

The experiment was placed in randomized blocks. These 7 variants were placed in 7 repetitions. Each experimental plot had an area of 15 m^2 (5 x 3m). The total number of experimental plots was of 49. The area 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 were executed manually, with a machine of "vermorel" type. "Trend" adjuvant product was added in the irrigation solution, in concentration of 0.03%. Weeds control was done with the help of Rival Star 75 GD herbicide, in a dosage of 15 g/ha. The experiment had as purpose establishing the efficiency of the mentioned phytosanitary products, reported to their price, as well as the efficiency and respectively the lucrativeness of applying one or two phytosanitary treatments during the barley's vegetation period.

The evaluation of the attack's frequency (F%), of the intensity of the attack (I%) and respectively, of the degree of attack (D.A.%) was done separately, on each and every experimental plot, analyzing 10 plants / experimental plot. To them it was assessed the degree of affectation (the intensity of the attack I %) of the last 2 leaves, especially of the "flag" leaf, which has the biggest contribution to the production of a spike at cereals. The phytosanitary analyses of the plants samples were done with the help of the stereomicroscope and of the optic microscope at Brăila Phytosanitary Office's laboratory – Phytosanitary National Authority, institution subordinated to the Ministry of Agriculture and Rural Development. These analyses had revealed the presence of *Pyrenophora graminea* fungus in the samples analyzed, which produces the barley's leaf stripe.

In order to assess the harvest of each variant under study, kernel samples from each experimental plot, 5 samples / plot, had been analysed on a percentage sample basis. Each sample comprised 10 plants, so, from each experimental plot, 50 plants were taken over, from which the harvest was manually weighted. The demarcation of each sample was performed with a metric frame with the area of 0.25 m^2 (0.5/0.5m). The average of the experimental plot samples had served for calculating the production of each and every experimental plot. The statistic interpretation had been done with the help of the limit differences (LD %) (Săulescu N., 1967).

Donau variety was used. This is a new German variety of barley for beer, traded by Soufflet French Company. The variety is forward, of small size. It has a good resistance to fall, cold and barley's specific diseases (Soufflet. Agro Romania 2019).

Assessing the attack of a damaging agent can be done with the help of values (Prognosis and Warning Methods, 1980):

- Attack frequency (F %);
- Attack intensity (I %);
- Degree of attack (D.A %).

- Attack frequency represents the relative value of the number of plants or organs of the plant under attack (n) reported to the number of plants or organs observed (N). The value of the frequency is established through direct observations on a number of plants or organs, according to the case and to the conditions, existing different methods of

collecting the samples and of performing the observations. In the case of our observations regarding the foliar diseases, there had been taken into consideration the number of organs of plants attacked from the total of organs of plants observed (leaves), establishing thus the frequency of the attack expressed in percentages %. In case of blights, the number of spikes attacked, reported to the total number of spikes observed, had been used. The frequency was calculated with the help of the formula F%= nx100/N.

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

The assessment of the area attacked had been done with the naked eye or with the magnifying glass, assessing the percentage occupied by spots or burns caused by the pathogenic agent. The damage percentage can be recorded or grades can be awarded for each plant or organ attacked by the disease or/and by the pest. Grades usage can ease up greatly data summarizing. It can be used a scale with 6 degrees of intensity, as follows:

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

After summarizing the data, the attack intensity had been determined with the following formula:

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

Where:

I% – Attack intensity (in %);

i – The intensity according to the grade awarded to the organ or plant attacked;

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

n – The number of plants attacked.

In the case of our experiment, grades from 1 to 6 had been awarded, separately, to “flag” leaf and to the next leaf situated below it.

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

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

In most of the 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 agricultural year 2018 – 2019 was a complicated year for barley’s crop. It must be underlined the very important fact that barley (*Hordeum vulgare*) is a variety more sensitive to the attack of the diseases and to overwintering than wheat. As we already mentioned, March, April and May months were rich in rainfalls and the average temperatures recorded in these months were favorable to the attack of some pathogenic agents specific to barley. However, the autumn of the year 2018 was very droughty, the plants emerging after the date of 15th November.

In what concerns the dynamic of the occurrence of the pathogenic attacks at barley, we mention the following aspects:

– *Pyrenophora graminea* had affected the barley in a higher extent, fact which made necessary the application of phytosanitary treatments. The degree of attack (D.A. %) was of 43.8% at variant V7 - untreated control variant on the date of 21st May 2019, at the “flag” leaf. It must be underlined the fact that this pathogen had proven to be the most dangerous pathogenic agent of barley, like in the previous years.

– *Rhyncosporium secalis* (leaf scald) and *Blumeria* (*Erysiphe*) graminis f. sp. *Hordei (mildew)* had not significantly affected the barley in the spring of the year 2019 (D.A. < 0.9%).

– Barley’s rust (*Puccinia hordei*) was not signaled in the experiment.

If we analyse the data from Table 1, we observe that the degree of attack of *Pyrenophora graminea* fungus was differentiated as follows:

– V1 ACANTO PLUS 0.5 L/HA, 1 treatment applied at spike’s release - blooming (5.05.2019) had determined a degree of attack of *Pyrenophora graminis* fungus of 2.10% to the “flag” leaf and 5.95% to the second leaf, so smaller by 41.70% and respectively by 8.15% as compared to the untrated control variant (V7).

– V2 ACANTO PLUS 0.5 L/HA, 1 treatment applied at “bellows” phase (20.04.2019) + 1 treatment applied at the beginning of kernel’s filling (27.05.2019) had determined a degree of attack of *Pyrenophora graminis* fungus of 7.20% to the “flag” leaf and 3.57% to the second leaf, so smaller by 36.60% and respectively by 10.53% as compared to the untreated control variant (V7).

– V3 CAPALO 1.0 L/HA, 1 treatment applied at spike’s release - blooming (5.05.2019) had determined a degree of attack of *Pyrenophora graminis* fungus of 8.80% to the “flag” leaf and 2.65% to the second leaf, so smaller by 35.00% and respectively by 11.45% as compared to the untreated control variant (V7).

– V4 MYSTIC 250 EC – 0.5 L/HA + 1 CAPALO 0.5 L/HA treatment applied at "bellows" phase (20.04 2019) + 1 treatment applied at the beginning of kernel's filling (27.05.2019) had determined a degree of attack of *Pyrenophora graminis* fungus of 8.40 % to the "flag" leaf and 4.34% to the second leaf, so smaller by 35.40% and respectively by 9.76% as compared to the untreated control variant (V7).

– V5 FALCON PRO 0.6 L/HA, 1 treatment applied at spike's release - blooming (5.05.2019) had determined a degree of attack of *Pyrenophora graminis* fungus of 3.00% to the "flag" leaf and 3.92% to the second leaf, so smaller by 40.80% and respectively by 10.18% as compared to the untreated control variant (V7).

– V6 ACANTO PLUS 0.5 L/HA + FALCON PRO 0.5 L/HA, 1 treatment applied at "bellows" phase (20.04.2019), 1 treatment applied at the beginning of kernel's filling (27.05.2019) had determined a degree of attack of *Pyrenophora graminis* fungus of 5.30% to the "flag" leaf and 2.91% to the second leaf, so smaller by 38.50% and respectively by 11.19% as compared to the untrated control variant (V7).

– V7 The untreated control variant was affected by *Pyrenophora graminis* with values of the degree of attack (D.A.%) of 43.80% for the "flag" leaf and 14.10% to the second leaf.

From the analysis of Table 2, production differences as compared to the untreated control variant, V7, can be observed, as follows:

– V1 ACANTO PLUS 0.5 L/HA, 1 treatment applied at spike's release - blooming (5.05.2019), has achieved a harvest of 5634 kg/ha, respectively an increment of 128 kg/ha as compared to the untreated control variant (V7).

– V2 ACANTO PLUS 0.5 L/HA, 1 treatment applied at "bellows" phase (20.04.2019) + 1 treatment applied at the beginning of kernel's filling (27.05.2019) has achieved a harvest of 5951 kg/ha, respectively an increment of 445 kg/ha as compared to the untreated control variant (V7).

– V3 CAPALO 1.0 L/HA, 1 treatment applied at spike's release - blooming (5.05.2019) has achieved a harvest of 5669 kg/ha, respectively an increment of 163 kg/ha as compared to the untreated control variant (V7).

– V4 MYSTIC 250 EC – 0.5 L/HA + 1 CAPALO 0.5 L/HA treatment applied at "bellows" phase (20.04.2019) + 1 treatment applied at the beginning of kernel's filling (27.05.2019) has achieved a harvest of 5658 kg/ha, respectively an increment of 152 kg/ha as compared to the untreated control variant (V7).

– V5 FALCON PRO 0.6 L/HA 1 treatment applied at spike's release - blooming (5.05.2019) has achieved a harvest of 5494 kg/ha, respectively a negative increment of -12 kg/ha as compared to the untreated control variant (V7).

– V6 ACANTO PLUS 0.5 L/HA + FALCON PRO 0.5 L/HA, 1 treatment applied at "bellows" phase (20.04.2019), 1 treatment applied at the beginning of kernel's filling (27.05.2019) has achieved a harvest of 5704 kg/ha, respectively an increment of 198 kg/ha as compared to the untreated control variant (V7).

– V7 The untreated control variant has achieved a harvest of 5506 kg/ha.

The harvest differences presented statistical assurance distinctly significant in V2 (**) and significant in V3 and V6 (*). The harvest increments achieved by V1 (128 kg/ha) and V4 (152 kg/ha) has no statistical assurance, minimally accepted by the experimental technique and must not be taken into consideration. V5 achieved a harvest practically equal to control variant V7, the negative difference of only -12 kg/ha being very small.

CONCLUSIONS

The observations performed in the spring of the year 2019 on the barley crop, in the pedoclimatic conditions of the Eastern Baragan had led to the following conditions and recommendations:

1. The most dangerous pathogenic agent of barley had proven to be in 2019 the *Pyrenophora graminea* fungus which produces the disease under the popular name of "leaf stripe". The attack of this fungus was higher than in the previous years. The harvest differences between the treated variants and the untreated control variant were quite small (maximum 445 kg/ha at V2).

2. Insignificant attacks of the fungi which attack the foliage, such as *Blumeria graminis* f.sp. *hordei* fungus, producing barley's mildew, were observed. *Puccinia hordei* fungus, producing barley's rust had not been observed in the barley experiment performed in 2019.

3. Donau barley beer variety has proved to be quite tolerant to the diseases specific to barley in the climatic conditions of the spring of the year 2019. In conditions of 0 treatments with fungicides (V7), this variety achieved in 2019 a good harvest of 5506 kg/ha. However, due to late emergence (after 15th November 2018), the plants entered the spring poorly entwined, the harvests being relatively small (below 6000 kg/ha) as compared to the potential of the variety. This variety seems to have a better tolerance to the diseases specific to barley as compared to other varieties. It has obtained a better harvest, in conditions of zero

phytosanitary treatments, the differences up against the treated variants V1, V3, V4, V5 and V6 being small or even quite equal (V5).

4. For a secure protection against the attack of the pathogenic agents specific to barley, it is recommended the application, in the difficult years (rainy and chilly), of 2 phytosanitary treatments with fungicides homologated products for barley. Combinations of fungicide products can be used, such as the one between FALCON PRO (prothioconazole 53 g/l+tebuconazole 148 g/l + spiroxamine 224 g/l) in a dosage of 0.5 l/ha and MYSTIC 250 EC (tebuconazole 250 g/l) in dosage of 0.5 l/ha. The application of a single treatment, in difficult years, is not recommended, because the barley is a more sensitive variety to the attack of specific pathogenic agents than wheat.

5. In the years with rainy springs, favourable to the attack of the disease, like 2019, the application of two phytosanitary treatments is recommended. In the conditions where in 2020 it is foreseen a price of 0.75 lei/kg of barley for beer, the increments of 163 kg/ha and 198 kg/ha achieved by the variants V3 and especially V6 (two phytosanitary treatments) are not justified from economic point of view. For example, the price of a liter of FALCON PRO is approx. 180 lei/l and is applied in dosages of 0.6 – 0.7 l/ha. It can be used in a dosage of 0.5 l/ha, in combination with another fungicide which has at basis a single active substance, such as, for example, tebuconazole. Mystic 250 EC Product (250 g tebuconazole/l) costs 120 lei/l and a dosage of 0.5 l/ha is applied. CAPALO Fungicide costs in the year 2019 approximatively 190 lei/l and a dosage of 1 l/ha is applied, so the cost per ha/treatment is 190 lei. Unfortunately, ACANTO PLUS product, which has given the best results (V2 - 2 treatments) in the experiment performed in 2019, cannot be traded and used in Romania any longer, starting with December 2018.

6. The exchange currency Leu/€ for the first 7 months of the year 2020 was 4.8180 lei/1€, according to the Romanian National Bank's website.

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OBSERVATIONS ON THE EXISTING CARBIDE SPECIES IN THE APPLE ORCHARDS

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Abstract

In this paper new contributions are made to the knowledge of the species of carabids in a fruit tree apple of Delesti in the Vaslui country. The material was collected from May to September throughout the research period, using Barber traps. From the biological material collected, all species collected have been listed and determined and only the species belonging to the Carabidae family have been selected afterwards. In the period of the observations were collected throughout 1573 specimens of harmful and useful insects, so 795 were collected in 2018 for 11 species, and 778 were collected in 2019 for 33 species. Analysis of the collected material was found the most frequevence species was: *Carabus coriaceus L., Pseudophonus rufipes Mull., Opatrum sabulosum L., Phyllotreta vittula F., Phyllotreta nemorum L., Formicomus pedestri Anysodactilus binotatus, Harpalus distinguendus, Harpalus calceatus, Harpalus tenebrosus, Harpalus griseus, Amara crenata, Harpalus tardus, Metabletus truncatelus, Amara aenea si Harpalus pubescens*.

Key words: species of carabids, Barber traps, apple

In the pedo-climatic conditions of Romania, due to the high yields that can be obtained on the surface unit, apple cultivation is one of the most profitable agricultural crops.

Regarding the culture systems and the types of orchards, in the second half of the century. XX has increasingly accentuated the tendency of intensification of the tree culture, which has led to new ways of conducting, directing and maintaining the crown, to cope with the increase of tree density per hectare (Talmaciu M. *et al*, 2016).

Plant protection is a key link in apple cultivation technology with an important role in achieving high yields and constant, being known that the production potential of these systems horticultural can be decreased 20-30%, or sometimes total compromise due to the attack of diseases and pests (Baban E., 2006).

There is currently more obvious manifestation of global attitudes towards the environment and to human health, the sustainable use of natural resources and especially agriculture as a key factor in changing environment.

This paper presents the results of researches on the epigeos entomofauna existing in the apple orchards of the SC Loturi Service SRL Delesti, Vaslui farm.

MATERIAL AND METHOD

The researches aimed to determine the useful entomofauna of carabids from apple orchards in the area of Moldova.

The collection of entomological material (Neculiseanu *et al*, 2000) using soil traps was first used by Barber in 1931, who proposed the use of fixing liquids in traps to collect insects (Talmaciu M., 2005).

Various containers (jars, boxes, plastic cups, etc.) with a volume of 400 to 800 ml can be used as a trap, which are buried in the ground so that the upper part of it is at ground level. A lid is placed on top of the container to protect the trap against precipitation, plant debris, lumps of soil etc.

In this case, (*figure 1*) were used the plastic boxes with a volume of 500 ml and a diameter of 10 cm, in which a solution of formalin in conc. of 4%.

In the studied biotope were placed 10 traps, in 2 rows, installed from the edge to the inside, at a distance of 10 m between rows and 6 m between traps in a row.

The samples were collected in each of the 2 years of research (2018 and 2019) during April-September, at intervals of about 10-14 days.

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Figure 1 **Installation of soil traps in experimental plots**

RESULTS AND DISCUSSIONS

In 2018, the experimental group with the following working variants was placed in the research stationary:

- V1 - existing plant carpet (control);
- V2 - vegetable carpet overgrown with pebbles (*Lotus corniculatus*);
- V3 - vegetal carpet covered with white clover (*Trifolium repens*);

The collection of the entomological material from the Barber-type soil traps was done between May and September, at intervals of about 7-10 days, at the following dates: Harvest I. 23.05., Harvest II. 08.06., Harvest III. 21.06., Harvest IV. 08.07., Harvest V. 22.07., Harvest VI.02.08., Harvest VII. 16.08., Harvest VII. 30.08., Harvest IX. 10.09. si Harvest X. 21.09.

By variants and harvests, in 2018, the situation is presented as follows:

In variant 1, existing vegetal carpet (control), in 2018, regarding the species and the number of carabids collected, the situation is presented as follows:

- A number of 9 species of carabids were collected, totaling 320 copies (*table 1*).

- Carabids species with the largest number of specimens collected were *Harpalus calceatus* 121 copies, 48 copies *Anysodactilus binotatus*, *Harpalus tenebrosus* 41 copies, 40 copies *Harpalus pubescens.*

Tabel 1

The structure of the carabid species at variant 1 in 2018

No. crt.	Species	Harvest										Total
		I	II	III	IV	V	VI	VII	VIII	IX	X	
1	*Anysodactilus binotatus*	7	21		4	15					1	48
2	*Harpalus aeneus*							1				1
3	*Harpalus calceatus*	10	54		5	13	9	21	4		5	121
4	*Harpalus distinguendus*	9		4	5	10			2		4	34
5	*Harpalus griseus*	2	21	1				2			3	29
6	*Harpalus pubescens*	9		1	2	1	24	3				40
7	*Harpalus tardus*		1	1							2	4
8	*Harpalus tenebrosus*			3		20		18				41
9	*Metabletus truncatelus*				1			1				2
TOTAL 9 specimens		**37**	**97**	**10**	**17**	**59**	**33**	**46**	**6**	**0**	**15**	**320**

In variant 2, a carpet of vegetation overgrown with pebbles (*Lotus corniculatus*), in 2018, as regards the species and the number of collected carabids, the situation is presented as follows: - It has collected a total of 10 species of carabids which totaled 277 copies (*table.2*).

- Carabids species collected in this experimental variant are: *Amara aenea, Anysodactilus binotatus, Harpalus azureus, Harpalus calceatus, Harpalus distinguendus, Harpalus griseus, Harpalus pubescens, Harpalus tardus, Harpalus tenebrosus, Metabletus truncatelus.*

In variant 3, vegetal carpet overlaid with white clover, in 2018, as regards the species and the number of collected carabids, the situation is presented as follows:

- In experimental version 3, a number of 10 species of carabids were collected, totaling 248 copies (*table 3*).

- Carabids species collected in this experimental variant are: *Amara aenea, Anysodactilus binotatus, Harpalus azureus,*

Harpalus calceatus, Harpalus distinguendus, Harpalus griseus, Harpalus pubescens.

Table 2

The structure of the carabid species at variant 2 in 2018

No. crt.	Species	Harvest										Total
		I	II	III	IV	V	VI	VII	VIII	IX	X	
1	*Amara aenea*								2			2
2	*Anysodactilus binotatus*	11	12		11	11		2		1		48
3	*Harpalus azureus*	2	3									5
4	*Harpalus calceatus*	2	12	4	13	17	9	18				75
5	*Harpalus distinguendus*	7	4	5	1	5		3		2	2	29
6	*Harpalus griseus*	4	4	4	6			1				19
7	*Harpalus pubescens*	4	18	1	15		3		6	2		49
8	*Harpalus tardus*		2	2								4
9	*Harpalus tenebrosus*			7		7	5	9	12	3		43
10	*Metabletus truncatelus*							3				3
TOTAL 10 specimens		**30**	**55**	**23**	**46**	**40**	**17**	**36**	**20**	**8**	**2**	**277**

Table 3

The structure of the carabid species at variant 3 in 2018

No. crt.	Species	Harvest										Total
		I	II	III	IV	V	VI	VII	VIII	IX	X	
1	*Amara aenea*					2						2
2	*Anysodactilus binotatus*	4	28		6	7				4		49
3	*Harpalus azureus*	1										1
4	*Harpalus calceatus*	9	6	5	18	15	10	15				78
5	*Harpalus distinguendus*	1	8			6		5	2			22
6	*Harpalus griseus*	6	5		9							20
7	*Harpalus pubescens*			8	15	1						24
8	*Harpalus tardus*			3						6		9
9	*Harpalus tenebrosus*					24		12	3			39
10	*Metabletus truncatelus*	3			1							4
TOTAL 10 specimens		**24**	**47**	**16**	**49**	**55**	**10**	**32**	**5**	**10**	**0**	**248**

In 2018, the most abundant species of carabids were common to the three experimental variants are: *Harpalus calceatus, Anysodactilus binotatus, Harpalus tenebrosus, Harpalus pubescens, Harpalus distinguendus, Harpalus griseus, Harpalus tardus, Metabletus truncatelus*.(*figure 2*).

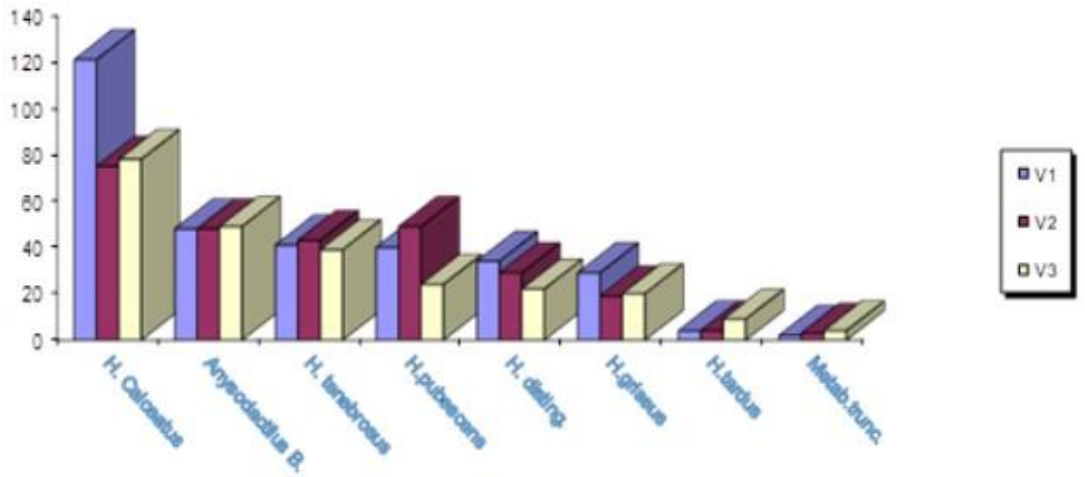

Figure 2 **Abundance of the species of carabids in the three experimental variants in 2018**

Regarding the number of carabids collected in 2018, it is observed that variant V 1 (Control variant, existing vegetable carpet) recorded the highest copies (320 copies), and the smallest number of copies collected had the variant V 3 (248 copies) (*figure 3*)

By variants and harvests, in 2019, the situation is presented as follows: *At first variant*, in 2019, regarding the number of carabids species collected, the situation is presented as follows: - In this experimental variant, it has collected a total of 20 species of carabids which totaled 302 copies (*table 4).* - The carabids species collected in this experimental variant are: *Amara crenata, Anisodactilus binotatus, Harpalus azureus, Harpalus calceatus, Harpalus distinguendus*.

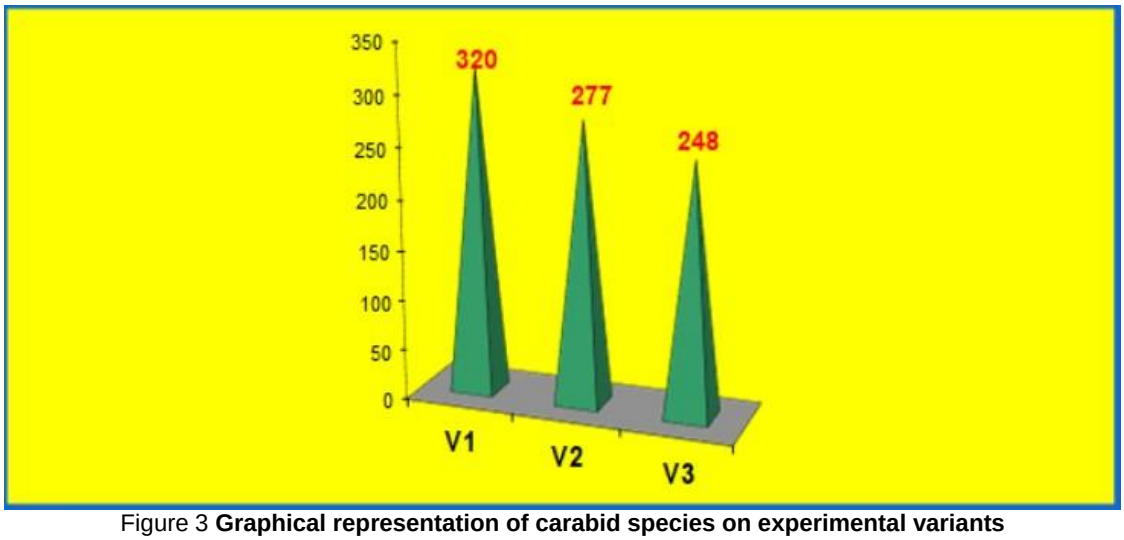

Figure 3 **Graphical representation of carabid species on experimental variants**

In variant 2, vegetal carpet overlaid with guides, in 2019, as regards the species and the number of collected carabids, the situation is presented as follows: - In this experimental variant, it has collected a total of 14 species of carabids which totaled 225 copies (*table 5).*- The species of collected carabids in this experimental starionary we mention: *Amara aenea, Anatis ocellata, Anysodactilus binotatus, Harpalus calceatus, Harpalus distinguendus, Harpalus tenebrosus, Metabletus truncatelus.*

Tabel 4

The structure of the carabid species at variant 1 in 2019

No. crt.	Species	Harvest										Total
		I	II	III	IV	V	VI	VII	VIII	IX	X	
1	*Amara aenea*					3			1			4
2	*Amara crenata*		4		1	1	2					8
3	*Anysodactilus binotatus*		24	24	7	2	12	6	10	1	1	87
4	*Brachynus explodens*						1					1
5	*Harpalus azureus*									3	3	6
6	*Harpalus calceatus*		30		3			1	6			40
7	*Harpalus distinguendus*		41	15	4	1	5	2	16	1	1	86
8	*Harpalus griseus*		2					4	3			9
9	*Harpalus pubescens*				2		2					4
10	*Harpalus rufipes*		4									4
11	*Harpalus tardus*		1			1		3	1			6
12	*Harpalus tenebrosus*		16		3	2		3	5			29
13	*Idichroma dorsalis*								1			1
14	*Metabletus truncatelus*		1	1		3						5
15	*Microlestes maurus*								5			5
16	*Ophonus obscurus*			1								1
17	*Ophonus sabulicola*						2					2
18	*Pseudophonus pubescens*				1							1
19	*Pterostichus cupreus*						1					1
20	*Pterostichus niger*						1			1		2
TOTAL 20 specimens		0	123	41	21	13	26	19	48	6	5	**302**

In variant 3, vegetal carpet overlaid with white clover, as regards the species and the number of collected carabids, the situation is presented as follows:

- In this experimental version, a number of 14 species of carabids were collected, totaling 251 copies (*table 6*).- Carabids of species collected in this experimental we mention: *Amara aenea, Anysodactilus binotatus, Harpalus calceatus, Harpalus distinguendus, Harpalus tenebrosus, Metabletus truncatelus, Calathus fuscipes, Carabus coriaceus*.

In 2019, the most abundant species of Carabids were common the three experimental variants are: *Anysodactilus binotatus, Harpalus distinguendus,*

Harpalus calceatus, Harpalus tenebrosus, Harpalus griseus, Amara crenata, Harpalus

tardus, Metabletus truncatelus, Amara aenea si Harpalus pubescens.(*figure. 4*).

Regarding the number of carabids collected in 2019, it is observed that variant V 1 (Control variant, existing vegetable carpet) recorded the highest number of copies (302 copies), and the smallest number of copies collected had the variant V2 (225 copies).(*figure 5*).

Tabel 5

The structure of the carabid species at variant 2 in 2019

No. crt.	Species	Harvest										Total
		I	II	III	IV	V	VI	VII	VIII	IX	X	
1	*Amara aenea*			1	2		8					11
2	*Anysodactilus binotatus*		48	16	5		8		3			80
3	*Brachynus explodens*			1								1
4	*Harpalus aeneus*							2				2
5	*Harpalus azureus*								1			1
6	*Harpalus calceatus*		1		3	1			7			12
7	*Harpalus distinguendus*		21	17	8		3	5	19			73
8	*Harpalus griseus*								3			3
9	*Harpalus tardus*		4								6	10
10	*Harpalus tenebrosus*							8	8			16
11	*Metabletus truncatelus*		5		1	1	4	1	1			13
12	*Microlestes maurus*								1			1
13	*Ophonus obscurus*			1								1
14	*Pterostichus cupreus*									1		1
TOTAL 14 specimens		**0**	**79**	**36**	**19**	**2**	**23**	**16**	**43**	**1**	**6**	**225**

Table 6

The structure of the carabid species at variant 3 in 2019

No. crt.	Species	Harvest										Total
		I	II	III	IV	V	VI	VII	VIII	IX	X	
1	*Amara aenea*			1		2						3
2	*Amara crenata*				1			1				2
3	*Anthichus floralis*				1		2					3
4	*Anysodactilus binotatus*	12	37	35	18	2	1	4	14			123
5	*Calathus fuscipes*		1				1					2
6	*Carabus coriaceus*						1					1
7	*Carabus scabriusculus*		1									1
8	*Harpalus calceatus*				6			2	3			11
9	*Harpalus distinguendus*	3	33	6	10	3	1	6	8			70
10	*Harpalus pubescens*								1			1
11	*Harpalus tenebrosus*		4					6			11	21
12	*Metabletus truncatelus*	1	1	1		2	2	1				8
13	*Ophonus obscurus*			2		2						4
14	*Ophonus tenebrosus*	1										1
TOTAL 14 specimens		**17**	**77**	**45**	**36**	**11**	**8**	**20**	**26**	**0**	**11**	**251**

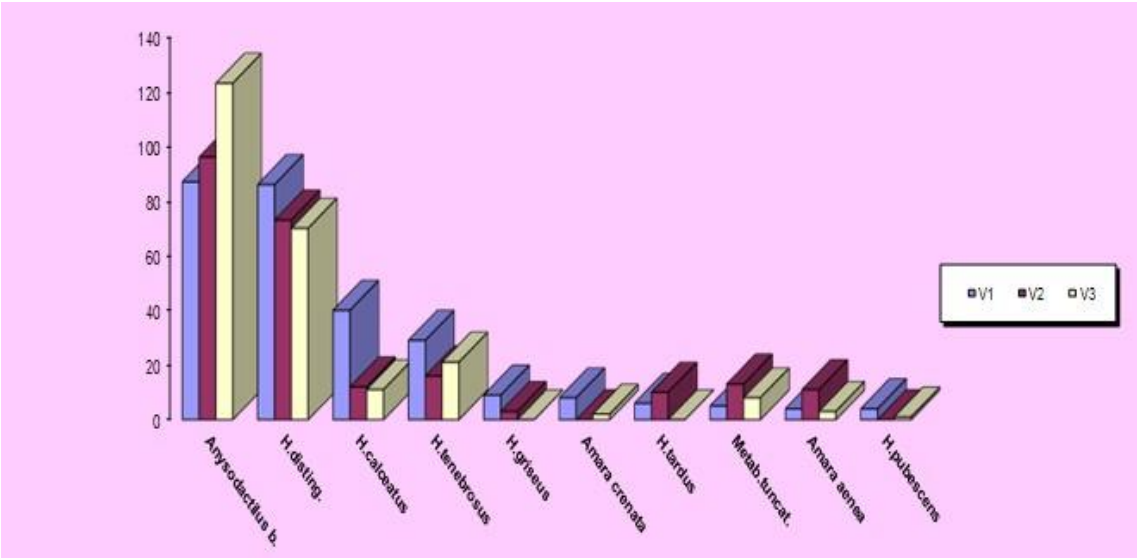

Figure 4 **Carabids abundance species in the three experimental variants in 2019**

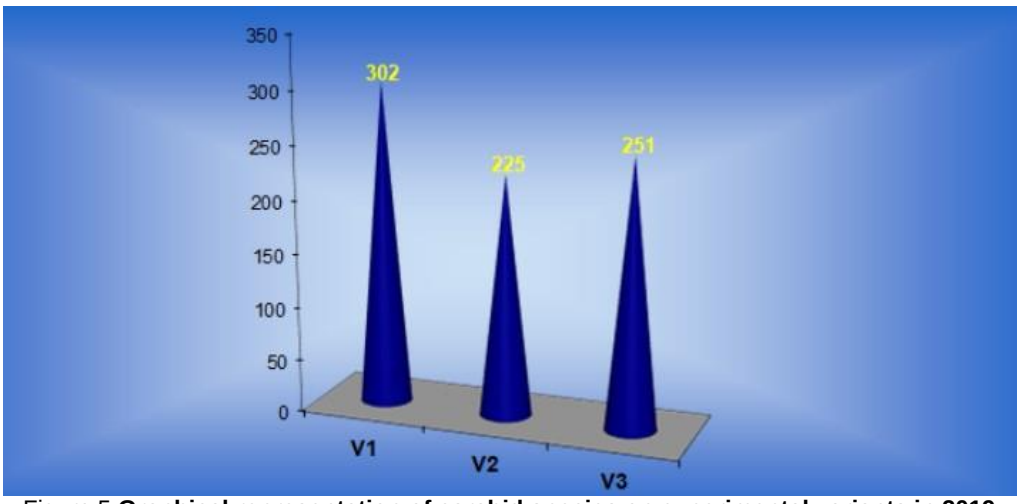

Figure 5 **Graphical representation of carabid species on experimental variants in 2019**

CONCLUSIONS

1. During the two years of research, 2018 and 2019, the collection of the samples was done periodically, at intervals between 10 and 14 days, each 10 collections in each of the two years, at the following dates, as follows: Harvest I on 23.05, respectively 25.05;the harvesting of II on the date of 8.06, respectively, 7.06;the harvesting of the III on the date of 21.06 respectively, 20.06; IV harvest on 8.07, respectively 4.07;V harvesting on 22.07, respectively, 16.07;harvesting of the VI on the date of 04.07, respectively, 31.07; the harvesting of VII on the date of 16.08, respectively, 12.08;the harvesting of VIII on the date of 30.08, respectively, 23.08;the harvesting of IX on 10.09, respectively, 12.09;X harvesting on 21.09, respectively, 26.09;

2. In the year 2018, following the ten harvests, a number of 845 specimens were obtained, in the three experimental variants:

• **V1** - existing vegetal carpet, totaled 320 copies;
• **V2** - vegetable carpet overgrown with pebbles, totaled 277 samples of carabids; •**V3** - vegetal carpet covered with white clover totaled 248 samples of carabids; It is noted that **the largest number of copies** collected in 2018, was registered variant **V1** (Control variant, existing vegetable carpet), with 320 copies, and the smallest number of copies collected had variant V 3 with 248 samples of carabids.

3. In the year 2019, following the ten harvests, a number of 778 specimens were obtained, in the three experimental variants:• **V1** - (control), totaled 302 copies;• **V2** - (*Lotus corniculatus*), totaled 225 samples of carabids;• **V3** - (*Trifolium repens*) totaled 251 samples of carabids;

4. It is noted that the largest number of copies collected in 2019, was registered also variant V1 with 302 copies, and the smallest number of copies collected had variant V2 with 225 samples of carabids.

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RESEARCH ON THE BIODIVERSITY OF HARMFUL AND USEFUL SPECIES FROM SOME AGRICULTURAL AND HORTICULTURAL CROPS IN 2018

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Abstract

Observations were made during the research period of the year 2018 in the apple tree plantation, and in the cabbage crop and maize crop belonging to Vasile Adamachi and Ezareni farm, from Iasi county.The aim of the paper was to make a comparison regarding the entomofauna of the three very different cultures as technology and agroecosystem conditions. The collection of the material was carried out using the soil traps type Barber method from June to September inclusive. The collected material was cleaned of the vegetable debris was then prepared for identification up to the level of the spece only for coccinamide. From the analysis of the collected material it follows that the specimens of coleopters species belong to the: *Coccinella septempunctata, Adalia bipunctata, Propylaea quatordecimpunctata, Hippodamia variegata, Harmonia axyridis, Nephus quadrimaculatus, Carabidae, Scarabaeidae, Elateridae* In terms of the abundance of entomofauna, on the crops, it is found that most specimens were collected and determined from the cabbage crops (649), from the apple orchard a number of 362 specimens. and 540 specimens in the maize crop from Ezareni.

Key words: entomofauna; horticultural crops; abundance, dinamics

Coleoptera is one of the orders with the most predatory species with s major importance in pest reduction.

Of all arthropod species, coccinellids are more numerous, common in all crops and throughout the growing season. They have a particular importance in reducing the number of aphids, mites, trips and other species of harmful insects, both larvae and adults feeding abundantly throughout period of evolution (Cozma *et al*, 2006).

Useful fauna is represented by the existence of animal species such as: predators and parasites. While predators feed on live food, parasites feed on it develops on account of other species, inside (endoparasites) or on the surface of the body (ectoparasites). The special importance of beetles as zoophagous insects has been emphasized since the early nineteenth century (Baicu and Săvescu 1978, Baicu, 1992).

The coccinellids are some of the most useful insects, they are represented by a number of over 1,000 species on the surface of the earth, live on trees and feed both in the larval stage (Ciochia, 1997) and in the adult stage with plant fleas and coccidia that are very harmful to fruit trees.

MATERIAL AND METHOD

The research aimed to identify useful and harmful entomofauna from the crops studied in the Ezareni and Vasile Adamachi farm in Iasi County.

As a method of collecting entomological material, we used Barber-type soil traps.

Barber floor traps are 500 ml plastic boxes that have a diameter of 10 cm and a height of 8 cm. A solution of detergent in water in a concentration of 20% was placed in these traps (Tălmaciu *et al,* 2010). The traps were buried at ground level (*figure 1*). The pits were made with the help of a spade, and the traps were buried carefully, so that the edge of the trap was at ground level so that the insects could easily enter them (Ionescu and Apetrei, 1988).

A fixing liquid (detergent solution with a water concentration of 20%) was introduced into the Barber type floor traps.

The traps were installed at a distance of about 5 m between them. 6 traps were set for each of the following crops: apple, corn and cabbage. In 2018, the traps were installed on 30.05, the first collection being on 03.06.2018.

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Figure 1. Barber soil trap

RESULTS AND DISCUSSIONS

In the research year 2018, a number of 15 periodic collections were carried out for the harvesting of biological material for apple, corn and cabbage crops in the two stations at the following dates: 03.06, 07.06, 13.06, 20.06, 30.06, 05.07, 09.07, 14.07, 20.07, 25.07, 01.08., 07.08, 14.08, 21.08, 01.09.

In the case of **apple plantation**, the situation is as follows (*table 1*):

- at the first collection on 03.06, 30 specimens belonging to the order were identified *Coleoptera*-families: *Carabidae* (6) and *Coccinellidae* (24);

-at the second collection on 07.06, 12 specimens of the order Coleoptera-families were identified: Carabidae (3) and Coccinellidae (9);

-the 34 specimens were identified at the third collection on 13.06 belong to the order Coleoptera-families: Carabidae (5) and Coccinellidae (29);

- at the fourth collection on 20.06, 29 specimens belonging to the order Coleoptera-families were identified: Carabidae (5) and Coccinellidae (24);

-the 41 specimens registered at the fifth collection on 30.06 belong to the order Coleoptera-families: Carabidae (8) and Coccinelidae (33);

-at the sixth collection from 05.07 the 21 specimens belong to the order Coleoptera-families: Coccinellidae (13), family Carabidae (6) and Scarabeidae (2);

- at the seventh collection from 09.07, 23 specimens belonging to the order Coleoptera-

families were identified: Carabidae (13) and Coccinellidae (10);

- at the eighth collection on 14.07, 14 specimens belonging to the order Coleoptera-families were identified: Coccinellidae (8) and Carabidae (6);

- at the ninth collection on 20.07, a number of 16 specimens of the order Coleoptera-families were identified: Carabidae (10) and Coccinellidae (6);

- at the tenth collection on 25.07, a number of 26 specimens of the order Coleoptera were identified - families: Coccinellidae (19) and Carabidae (7);

- the 11 specimens registered at the eleventh collection on 01.08 belong to the order Coleoptera-family Coccinellidae;

- at the twelfth collection on 07.08, a number of 32 specimens of the order Coleoptera – families were identified: Carabidae (5) and Coccinellidae (27);

- at the thirteenth collection dated 14.08, a number of 30 specimens of the order Coleoptera-families were identified: Carabidae (9) and Coccinellidae (21);

- at the fourteenth collection on 21.08, a number of 24 specimens of the order Coleoptera – family Coccinellidae were identified;

-at the fifteenth collection on 01.09, a number of 19 specimens of the order Coleoptera-families were identified: Carabidae (2) and Coccinellidae (17).

Table 1

Structure, abundance, dynamic of Coleopteras sampled within the apple orchards—Barber-2018

No of harvest	Data	Species	Trap						Total
			1	2	3	4	5	6	
I	03.06	1. *Coccinella septempunctata*	5	4	3	-	2	-	14
		2. *Adalia bipunctata*	-	-	4	5	-	1	10
		Carabidae	1	-	2	-	1	2	6
TOTAL exemplare coleoptere			6	4	9	5	3	3	30
II	07.06	1. *Coccinella septempunctata*	-	3	-	2	4	-	9
		Carabidae	1	-	-	-	-	2	3
TOTAL exemplare coleoptere			1	3	-	2	4	2	12
III	13.06	1. *Coccinella septempunctata*	4	-	-	5	3	1	13
		2. *Propylaea quatordecimpunctata*	-	-	-	6	7	3	16
		Carabidae	1	2	-	-	-	2	5
TOTAL samples of coleopters			5	2	-	11	10	6	34
IV	20.06	1. *Coccinella 10-punctata*	9	-	-	-	-	-	9
		2. *Propylaea quatordecimpunctata*	6	9	-	-	-	-	15
		Carabidae	1	1	-	1	1	1	5
TOTAL samples of coleopters			16	10	-	1	1	1	29
V	30.06	1. *Coccinella septempunctata*	9	-	7	5	-	-	21
		2. *Adalia bipunctata*	7	-	4	-	-	1	12
		Carabidae	3	-	-	3	-	2	8
TOTAL samples of coleopters			19	-	11	8	-	3	41
VI	05.07	1. *Coccinella septempunctata*	-	-	4	-	3	6	13
		Carabidae	2	-	-	-	-	4	6
		Scarabaeidae	2	-	-	-	-	-	2
TOTAL samples of coleopters			4	-	4	-	3	10	21
VII	09.07	1. *Coccinella septempunctata*	-	2	-	5	3	-	10
		Carabidae	-	-	7	3	2	1	13
TOTAL samples of coleopters			-	2	7	8	5	1	23
VIII	14.07	1. *Coccinella septempunctata*	-	6	-	2	-	-	8
		Carabidae	-	-	2	-	2	2	6
TOTAL samples of coleopters			-	6	2	2	2	2	14
IX	20.07	1. *Propylaea quatordecimpunctata*	-	-	-	3	1	2	6
		Carabidae	-	-	-	4	5	1	10
TOTAL samples of coleopters			-	-	-	7	6	3	16
X	25.07	1. *Hippodamia variegata*	-	-	-	6	2	6	14
		2. *Harmonia axyridis*	-	-	5	-	-	-	5
		Carabidae	3	-	2	-	-	2	7
TOTAL samples of coleopters			3	-	7	6	2	8	26
XI	01.08	1. *Coccinella septempunctata*	3	-	-	-	-	-	3
		2. *Harmonia axyririds*	5	-	-	-	-	-	5
		3. *Propylaea quatordecimpunctata*	-	3	-	-	-	-	3
TOTAL samples of coleopters			8	3	-	-	-	-	11
XII	07.08	1. *Nephus quadrimaculatus*	3	-	-	-	-	-	3
		2. *Adalia bipunctata*	15	-	-	-	-	-	15
		3. *Coccinella septempunctata*	-	9	-	-	-	-	9
		Carabidae	-	-	4	-	1	-	5
TOTAL samples of coleopters			18	9	4	-	1	-	32
XIII	14.08	1. *Coccinella 10-punctata*	3	-	-	-	-	-	3
		2. *Propylaea quatordecimpunctata*	12	-	-	-	-	-	12
		3. *Coccinella septempunctata*	-	-	-	6	-	-	6
		Carabidae	-	-	-	4	3	2	9
TOTAL samples of coleopters			15	-	-	10	3	2	30
XIV	21.08	1. *Coccinella septempunctata*	-	7	-	-	-	-	7
		2. *Adalia bipunctata*	-	-	9	-	-	-	9
		3. *Harmonia axyridis*	-	-	8	-	-	-	8
TOTAL samples of coleopters			-	7	17	-	-	-	24
XV	01.09	1. *Adalia bipunctata*	-	-	-	6	-	-	6
		2. *Coccinella 10-punctata*	-	-	-	7	-	-	7
		3. *Coccinella septempunctata*	-	-	-	-	4	-	4
		Carabidae	1	-	-	-	1	-	2
TOTAL samples of coleopters			1	-	-	13	5	-	19
Total			362 sapmples						

For **maize crop**, in 2018, the situation is as follows (*table 2*):

- at the first collection on 03.06, 49 specimens were identified belonging to the order Coleoptera - families: Coccinellidae (27) and Carabidae (22);

- at the second collection dated 07.06 were identified 42 specimens belonging to the order Coleoptera - families: Coccinellidae (22) and Carabidae (20);

- the 47 specimens identified at the third collection on 13.06 belong to the order Coleoptera-families: Carabidae (32) and Coccinellidae (15);

- at the fourth collection on 20.06, 45 specimens belonging to the order Coleoptera – family Carabidae (33) and Coccinellidae (12) were identified;

- the 39 specimens identified at the fifth collection on 30.06 belong to the order Coleoptera: families: Scarabeidae (9), Carabidae (8) and Coccinellidae (22);

- at the sixth collection on 05.07, the 36 specimens belong to the order Coleoptera: the families Carabidae (14) and Scarabiedae (4) and Coccinellidae (18);

- at the seventh collection on 09.07, 25 specimens of the order Coleoptera-families were identified: Coccinelidae (19) and Carabidae (6);

- at the eighth collection on 14.07, 27 specimens belonging to the order Coleoptera-families were identified: Scarabeidae (10), Carabidae (6) and Coccinellidae (11);

- at the ninth collection from 20.07 a number of 26 specimens was identified. The order Coleoptera was represented by 5 specimens from the Carabidae family and 21 specimens belonging to the Coccinellidae family;

- at the tenth collection on 25.07, a number of 37 specimens of the order Coleoptera represented by the families: Coccinellidae (30) and Carabidae (7) were identified;

- the 37 specimens identified at the eleventh collection from 01.08.2016 belong to the order Coleoptera-families: Coccinellidae (20), Scarabeidae (12 specimens) and Carabidae (5);

- at the twelfth collection on 07.08, a number of 27 specimens was identified. The order Coleoptera family Carabidae was represented by 6 specimens and the family Coccinellidae by 21 specimens;

- at the thirteenth collection on 14.08, a number of 59 specimens belonging to the order Coleoptera-families Carabidae (18), Scarabeidae (14) and Coccinellidae (27) were identified;

- at the fourteenth collection on 21.08, a number of 19 specimens of the order Coleoptera – families were identified: Carabidae (4) and Coccinellidae (15 specimens);

- at the fifteenth collection on 01.09 a number of 25 specimens was identified. Of the order Coleoptera, the family Carabidae was represented by 4 specimens, while the family Coccinellidae was represented by 21 specimens.

Table 2

Structure, abundance, dynamic of Coleopters sampled within the maize crop-2018

No of harvest	Data	Species	Trap						Total
			1	2	3	4	5	6	
I	03.06	1. *Coccinella septempunctata*	6	3	-	7	-	-	16
		2. *Adalia bipunctata*	-	5	-	2	-	4	11
		Carabidae	10	-	7	2	-	3	22
TOTAL samplesof coleopters			16	8	7	11	-	7	49
II	07.06	1. *Coccinella septempunctata*	-	4	-	7	1	-	12
		2. *Propylaea quatordecimpunctata*	-	-	5	-	3	2	10
		Carabidae	-	-	9	5	4	2	20
TOTAL samples of coleopters			-	4	14	12	8	4	42
III	13.06	1. *Harmonia axyridis*	2	-	-	-	1	-	3
		2. *Propylaea quatordecimpunctata*	-	-	-	7	-	-	7
		3. *Adalia bipunctata*	-	-	-	-	5	-	5
		Carabidae	21	-	7	-	2	2	32
TOTAL samples of coleopters			23	-	7	7	8	2	47
IV	20.06	1. *Coccinella septempunctata*	3	-	-	-	-	-	3
		2. *Adalia bipunctata*	-	-	6	-	-	-	6
		3. *Harmonia axyridis*	-	-	3	-	-	-	3
		Carabidae	27	-	2	-	2	2	33
TOTAL samples of coleopters			30	-	11	-	2	2	45
V	30.06	1. *Coccinella var 5-punctata*	4	-	-	-	-	-	4
		2. *Coccinella septempunctata*	-	9	-	-	-	-	9
		3. *Coccinella 10-punctata*	-	-	6	-	-	-	6
		4.*Adalia bipunctata*	-	-	3	-	-	-	3
		Carabidae	3	-	3	-	1	1	8
		Scarabaeidae	7	-	2	-	-	-	9
TOTAL samples of coleopters			14	9	14	-	1	1	39

VI	05.07	1. *Coccinella septempunctata*	12	-	-	-	-	-	12
		2. *Coccinella hieroglyphica*	-	3	-	-	-	-	3
		3. *Adalia bipunctata*	-	-	-	-	3	-	3
		Carabidae	-	-	6	4	3	1	14
		Scarabaeidae	4	-	-	-	-	-	4
TOTAL samples of coleopters			16	3	6	4	6	1	36
VII	09.07	1. *Coccinella septempunctata*	4	7	-	-	-	-	11
		2. *Propylaea quatordecimpunctata*	-	-	-	-	8	-	8
		Carabidae	3	-	2	1	-	-	6
TOTAL samples of coleopters			7	7	2	1	8	-	25
VIII	14.07	1. *Coccinella septempunctata*	6	-	-	-	-	-	6
		2. *Propylaea quatordecimpunctata*	-	5	-	-	-	-	5
		Carabidae	6	-	-	-	-	-	6
		Scarabaeidae	3	-	2	5	-	-	10
TOTAL samples of coleopters			15	5	2	5	-	-	27
IX	20.07	1. *Coccinella var.5-punctata*	-	-	6	-	-	-	6
		2. *Coccinella septempunctata*	-	-	-	6	-	-	6
		3. *Adalia bipunctata*	-	-	-	-	9	-	9
		Carabidae	4	-	-	1	-	-	5
TOTAL samples of coleopters			4	-	6	7	9	-	26
X	25.07	1. *Coccinella septempunctata*	9	3	-	-	-	-	12
		2. *Calvia decemguttata*	-	2	-	-	7	-	9
		3. *Coccinella 10-punctata*	-	3	-	-	-	-	3
		4 .*Adalia bipunctata*	-	-	-	-	6	-	6
		Carabidae	1	-	2	1	1	2	7
TOTAL samples of coleopters			10	8	2	1	14	2	37
XI	01.08	1. *Coccinella septempunctata*	10	4	-	-	-	-	14
		2. *Propylaea quatordecimpunctata*	-	6	-	-	-	-	6
		Carabidae	4	1	-	-	-	-	5
		Scarabaeidae	6	-	1	3	2	-	12
TOTAL samples of coleopters			20	11	1	3	2	-	37
XII	07.08	1. *Coccinella hieroglyphica*	6	-	-	-	-	-	6
		2. *Adalia bipunctata*	6	-	9	-	-	-	15
		Carabidae	1	-	-	4	-	1	6
TOTAL samples of coleopters			13	-	9	4	-	1	27
XIII	14.08	1. *Coccinella septempunctata*	12	-	-	-	-	-	12
		2. *Adalia bipunctata*	9	-	-	-	-	-	9
		3. *Coccinella 10-punctata*	-	6	-	-	-	-	6
		Carabidae	-	-	11	-	5	2	18
		Scarabaeidae	-	-	7	-	3	4	14
TOTAL samples of coleopters			21	6	18	-	8	6	59
XIV	21.08	1. *Coccinella septempunctata*	5	-	-	-	-	4	9
		2. *Coccinella 10-punctata*	3	-	-	-	-	-	3
		3. *Coccinella 10-punctata var.subpunctata*	3	-	-	-	-	-	3
		Carabidae	1	-	-	1	1	1	4
TOTAL samples of coleopters			12	-	-	1	1	5	19
XV	01.09	1. *Coccinella septempunctata*	6	-	-	-	-	-	6
		2. *Harmonia axyridis*	-	6	-	-	-	-	6
		3. *Adonia variegata*	-	-	9	-	-	-	9
		Carabidae	2	2	-	-	-	-	4
TOTAL samples of coleopters			8	8	9	-	-	-	25
Total			540 specimens						

In the case of cabbage cultivation, in 2018, the situation is as follows (*table 3*):

- at the first collection on 03.06, 44 specimens belonging to the order Coleoptera – families were identified: Coccinellidae (27), Carabidae (12), Elateridae (5);

- at the second collection on 07.06, 57 specimens of the order Coleoptera-families were identified: Coccinellidae (37), Carabidae (17) and Scarabeidae (3);

- the 32 specimens identified at the third collection on 13.06 belong to the order Coleoptera represented by the family Coccinellidae. The following species were identified: Coccinella septempunctata (11 specimens), Adalia bipunctata (9 specimens), Coccinella 10-punctata (6 specimens) and Harmonia axyridis (6 specimens);

- at the fourth collection on 20.06, 45 specimens belonging to the order Coleoptera represented by the families: Carabidae (20),

Chrysomelidae (10 specimens) and Coccinelidae (15) were identified;

- the 26 specimens identified at the fifth collection on 30.06 belong to the order Coleoptera-families: Coccinellidae (13) and Chrysomelidae (13);

- at the sixth collection on 05.07, 41 specimens were identified belonging to the order Coleoptera represented by the families: Scarabeidae (5), Carabidae (2) and Coccinellidae (34);

- at the seventh collection on 09.07, 39 specimens of the order Coleoptera represented by the families were identified: Chrysomelidae (12), Carabidae (2), Elateridae (one specimen) and Coccinellidae (24);

- at the eighth collection dated 14.07 from the total of 31 specimens collected belonging to the order Coleoptera-family Carabidae (12) and family Coccinellidae (19);

- at the ninth collection on 20.07, a number of 49 specimens of the order Coleoptera-families were identified: Carabidae (2), Chrysomelidae (11) and Coccinellidae (36);

- at the tenth collection on 25.07, a number of 31 specimens of the order Coleoptera-families were identified: Carabidae (2), Elateridae (3) and Coccinellidae (26);

- the 59 specimens identified at the eleventh collection from 01.08. belong to the order Coleoptera-families: Carabidae (32) and Coccinellidae (27);

- at the twelfth collection on 07.08, a number of 63 specimens belonging to the order Coleoptera-families were identified: Carabidae (24), Elateridae (3) and Coccinellidae (36);

- at the thirteenth collection on 14.08, a number of 41 specimens belonging to the order Coleoptera-families were identified: Carabidae (13) and Coccinellidae (28);

- at the fourteenth collection on 21.08, a number of 49 specimens were identified that belonged to the order Coleoptera-families: Carabidae (14) and Coccinellidae (35);

- at the fifteenth collection on 01.09, a number of 42 specimens were identified that belonged to the order Coleoptera-families: Carabidae (22) and Coccinellidae (20);

Table 3

Structure, abundance, dynamic of Coleopteras sampled within the cabbage crop-2018-Barber traps

No of harvest	Data	Species	Trap						Total
			1	2	3	4	5	6	
I	03.06	1. *Coccinella septempunctata*	5	-	9	-	1	-	15
		2. *Harmonia axyridis*	-	3	2	-	-	2	7
		3. *Propylaea quatordecimpunctata*	5	-	-	-	-	-	5
		Carabidae	5	-	-	4	-	3	12
		Elateridae	1	-	-	3	1	-	5
TOTAL samples of coleopters			16	3	11	7	2	5	44
II	07.06	1. *Coccinella septempunctata*	-	2	-	5	-	-	7
		2. *Coccinella 10-punctata*	-	6	-	-	5	-	11
		3. *Harmonia axyridis*	-	-	9	-	-	-	9
		4. *Adalia bipunctata*	-	-	5	-	-	-	5
		5. *Calvia decemguttata*	-	-	-	4	1	-	5
		Carabidae	4	3	1	-	3	6	17
		Scarabaeidae	3	-	-	-	-	-	3
TOTAL samples of coleopters			7	11	15	9	9	6	57
III	13.06	1. *Coccinella septempunctata*	-	9	-	2	-	-	11
		2. *Coccinella 10-punctata*	-	-	-	6	-	-	6
		3. *Adalia bipunctata*	-	3	-	-	-	6	9
		4. *Harmonia axyridis*	-	-	-	-	6	-	6
TOTAL samples of coleopters			-	12	-	8	6	6	32
IV	20.06	1. *Adalia bipunctata*	-	3	3	-	-	-	6
		2. *Propylaea quatordecimpunctata*	-	6	-	-	-	3	9
		Carabidae	6	-	7	-	5	2	20
		Chrysomelidae	2	-	6	-	-	2	10
TOTAL samples of coleopters			8	9	16	-	5	7	45
V	30.06	1. *Adalia bipunctata*	4	-	-	-	-	-	4
		2. *Propylaea quatordecimpunctata*	-	9	-	-	-	-	9
		Chrysomelidae	-	-	-	-	9	4	13
TOTAL samples of coleopters			4	9	-	-	9	4	26
VI	05.07	1. *Coccinella septempunctata*	-	-	9	-	-	-	9
		2. *Coccinella 10-punctata*	-	-	4	-	-	-	4
		3. *Propylaea quatordecimpunctata*	-	-	-	15	-	-	15
		4. *Harmonia axyridis*	-	-	-	6	-	-	6

No of harvest	Data	Species	Trap						Total
			1	2	3	4	5	6	
		Carabidae	2	-	-	-	-	-	2
		Scarabaeidae	2	-	2	-	-	1	5
TOTAL samples of coleopters			4	-	15	21	-	1	41
VII	09.07	1. *Coccinella septempunctata*	-	12	-	-	-	-	12
		2. *Adalia bipunctata*	9	-	-	-	-	-	9
		3. *Coccinella 10-punctata var.subpunctata*	-	3	-	-	-	-	3
		Carabidae	-	-	2	-	-	-	2
		Chrysomelidae	9	-	1	2	-	-	12
		Elateridae	-	-	1	-	-	-	1
TOTAL samples of coleopters			18	15	4	2	-	-	39
VIII	14.07	1. *Coccinella septempunctata*	-	8	-	-	-	-	8
		2. *Hippodamia variegata*	-	5	-	-	-	-	5
		3. *Propylaea quatordecimpunctata*	-	-	6	-	-	-	6
		Carabidae	-	-	4	-	3	5	12
TOTAL samples of coleopters			-	13	10	-	3	5	31
IX	20.07	1. *Coccinella septempunctata*	9	-	-	-	-	-	9
		2 *Adalia bipunctata*	9	-	-	-	-	-	9
		3. *Harmonia axyridis*	-	3	-	-	-	-	3
		4. *Propylaea quatordecimpunctata*	-	-	15	-	-	-	15
		Carabidae	1	1	-	-	-	-	2
		Chrysomelidae	4	-	4	-	2	1	11
TOTAL samples of coleopters			23	4	19	-	2	1	49
X	25.07	1. *Coccinella septempunctata*	8	-	6	-	-	-	14
		2. *Adalia bipunctata*	9	-	-	-	-	-	9
		3. *Harmonia axyridis*	-	-	3	-	-	-	3
		Carabidae	-	-	-	-	2	-	2
		Elateridae	-	-	2	-	1	-	3
TOTAL exemplare coleoptere			17	-	11	-	3	-	31
XI	01.08	1. *Coccinella 10-punctata*	-	5	-	-	-	-	5
		2. *Adalia bipunctata*	-	4	-	-	-	-	4
		3. *Propylaea quatordecimpunctata*	-	-	6	-	-	-	6
		4. *Harmonia axyridis*	-	-	-	12	-	-	12
		Carabidae	-	-	-	17	8	7	32
TOTAL samples of coleopters			-	9	6	29	8	7	59
XII	07.08	1. *Coccinella septempunctata*	-	-	-	-	10	-	10
		2. *Harmonia axyridis*	-	-	-	-	6	-	6
		3. *Adalia bipunctata*	-	-	-	-	-	5	5
		4. *Coccinella 10-punctata var subpunctata*	-	-	-	-	-	6	6
		5. *Propylaea quatordecimpunctata*	-	-	-	-	-	9	9
		Carabidae	11	-	-	-	7	6	24
		Elateridae	2	-	1	-	-	-	3
TOTAL samples of coleopters			13	-	1	-	23	26	63
XIII	14.08	1. *Coccinella septempunctata*	-	-	8	6	-	-	14
		2. *Harmonia axyridis*	-	-	-	-	8	-	8
		3. *Adalia bipunctata*	-	-	6	-	-	-	6
		Carabidae	-	9	-	1	3	-	13
TOTAL samples of coleopters			-	9	14	7	11	-	41
XIV	21.08	1. *Coccinella septempunctata*	-	-	6	-	-	-	6
		2. *Adalia bipunctata*	-	12	-	-	-	-	12
		3. *Coccinella 10-punctata*	-	-	5	-	-	-	5
		4. *Harmonia axyridis*	-	-	6	-	6	-	6
		Carabidae	8	-	3	3	-	-	14
TOTAL samples of coleopters			8	12	20	3	6	-	49
XV	01.09	1. *Coccinella septempunctata*	-	-	7	-	-	-	7
		2. *Adalia bipunctata*	3	6	-	-	-	-	9
		3. *Harmonia axyridis*	-	-	-	4	-	-	4
		Carabidae	11	8	-	2	-	1	22
TOTAL samples of coleopters			14	14	7	6	-	1	42
Total			649 samples						

CONCLUSIONS

In 2018, in 15 harvesting of entomological material were performed for each culture studied, being identified a number of 1551 specimens.

- In the **apple culture**, 362 specimens were identified, most belonging to the species: Coccinella septempunctata*; Adalia bipunctata and Propylaea quatordecimpunctata; Hippodamia variegata, Harmonia axyririds, Coccinella 10-punctata* and *Carabidae.*

- In maize crop, 540 specimens were identified, most belonging to the species: *Coccinella septempunctata; Adalia bipunctata, Propylaea quatordecimpunctata, Coccinella var 5-punctata, Coccinella 10-punctata, Coccinella hieroglyphica, Calvia decemguttata, Carabidae* and *Scarabaeidae.*

- In the **cabbage culture**, 649 specimens were identified, most belonging to the species: *Coccinella septempunctata, Adalia bipunctata, Harmonia axyridis, Coccinella 10-punctata, Carabidae,* and *Elateridae*

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RESULTS CONCERNING *TANYMECUS DILATICOLLIS* CONTROL IN A COMMERCIAL FARM FROM THE SOUTH-EAST OF ROMANIA, IN THE CONDITIONS OF THE YEAR 2020

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Abstract

The maize leaf weevil (*Tanymecus dilaticollis* Gyllenhal, 1834) represent one of the most destructive pests of maize crops in Romania, especially in the south and south-east of the country. Every year was attacked more than 1 million hectares cultivated with maize. This pest is very dangerous when maize is in early vegetation stages, from plant emergence until four leaves (BBCH 10-BBCH 14). After the ban of the seeds treatment with neonicotinoids in the Europe Union, no alternatives for seed treatment to control this pest remain available in our country. In this article, it has assessed both, seeds treatment with neonicotinoids and possible alternatives for controlling of the maize leaf weevil in conditions of the commercial farm located in the south-east of Romania. Seeds treatment with imidacloprid (600 g/l), cyantraniliprole (625 g/l) active ingredients, maize foliar treatment with acetamiprid (20 %), lambda-cyhalothrin (50 g/l) active ingredients, granules application at maize sowing, with chlorpyrifos (5 %), lambda-cyhalothrin (4 g/kg) active ingredients or two granules application, at maize sowing and after plants emergence with cypermethrin (0.8 %) active ingredients were assessed. The efficacy of the applied insecticides was determined by evaluating weevils attack intensity at the maize plants, at BBCH 14 stage, using a scale from 1 (plant not attacked) to 9 (plant destroyed). In the spring of 2020, weather conditions from the experimental site, during assessments period were unfavorable for weevils activity at the soil surface. Even if the pest density from the experimental location was high (10-15 insects/m^2) however weevils attack at maize plants was low. At variant with seeds treated with imidacloprid active ingredient, maize attack intensity at maize plant was 3.86, at untreated variant attack intensity was 4.47 while at rest of the experimental variants, attack intensity ranged between 4.29 and 4.46. It has registered significant statistical differences between weevils attack at maize plants from variant with seeds treated with imidacloprid active ingredient and the rest of the variants from this assessment ($p<0.05$). In the weather conditions of the year 2020, from the experimental location from the south-east of Romania, there weren't registered significant statistical differences between seeds treatment with cyantraniliprole active ingredient, maize foliar treatment with acetamiprid, lambda-cyhalothrin active ingredients, granules application with chlorpyrifos, cypermethrin, lambda-cyhalothrin active ingredients, and untreated variant ($p<0.05$).

Key words: maize, weevils, control, alternatives, farm

Maize leaf weevil (*Tanymecus dilaticollis* Gyllenhal, 1834) is one of the most dangerous and destructive pest of the maize crops from Romania (Paulian F., 1972; Voinescu I., 1985; Barbulescu A. *et al*, 2001; Cristea M. *et al*, 2004; Vasilescu V.S. *et al*, 2005; Popov C. and Barbulescu A., 2007; Rosca I. and Istrate R., 2009; Trotus E. *et al*, 2011; Georgescu E. *et al*, 2014). The same authors mentioned that the main favorable area for this pest occurred in the south and south-east of Romania, but in some years, weevils produce damages at the maize crops in the south-west too. According to Popov C. *et al* (2006), in these areas, climatic conditions from spring are most favorable for weevils activity and feeding process. Maize leaf weevil is a thermo-xerophilous insect; thus, the weevils are very active at high air temperatures and low air humidity. New researches make in evidence higher attack of the *Tanymecus dilaticollis* at the maize plants, in areas considered until now, unfavorable for weevils activity, such as Transylvania (Antonie I. *et al*, 2012). Possible explication for extending the weevils area to northern latitudes is increases of *the temperatures (*Camprag D., 2007; Olesen J.E. et al, 2011). Recent studies made at NARDI Fundulea, make in evidence atypical behavior of the maize leaf weevil, in spring, as a result of the daily rainfall and temperature distribution in the spring (Georgescu E. *et al*, 2014, 2015). Maize leaf weevil is a polyphagous pest, with a range of 34 host plants in Romania (Paulian F., 1972). Maize is the main host of this pest, but sunflower, soybean,

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wheat or barley can be a good food source for weevils (Rosca I. and Istrate R., 2009). Damages are caused by weevils that feeding with maize leaves. The attack is dangerous when maize is in early vegetation stages, from plant emergence until four leaves stage (Paulian F., 1972; Barbulescu A., 2001). In the case of weevils high attack, maize plants can be destroyed and farmers must sow again (Popov C. and Barbulescu A., 2007). After four leaves stage (BBCH 14) the pest attack is less economically important, the weevils consume only leaves margins and plants survive of the attack (Rosca I. and Istrate R., 2009). Recent studies make in evidence that in Romania, every year, one million hectares cultivated with maize are attacked by *T. dilaticollis* weevils, with different attack intensity degrees (Barbulescu A. *et al*, 2001; Popov C. *et al*, 2002, 2004, 2007a). According to Paulian F. (1972), in case of pest density ranged between 25 and 30 weevils/m^2, average maize yield losses can reach at 34%. Data from the literature make in evidence that in the last 30 years, in the south-east of Romania, pest density ranged between 15 and 80 weevils/m^2 (Barbulescu A. *et al*, 1993, 1997; Barbulescu A., 2001, Popov C. *et al*, 2004). In some favorable years, there were extreme cases when it had recorded a pest density of 160 weevils/m^2, in the Dobrogea area (Voinescu I., 1987 cited by Rosca I. and Istrate R., 2009). Analyzing the data between 2011 and 2018 from 15 locations placed in East, South-East, South and South-West of Romania, Badiu A.F. *et al* (2019) concluded that maize plant losses ranged from 25 to 50 %. However, in this paper, the author didn't make references to maize yield losses only to plant density losses. Maize monoculture, for several years, favored weevlis attack (Voinescu I. and Barbulescu A., 1998). Crop rotation has a low impact in decreasing of the weevils attack, because insects can migrate from plots sowed, the previous year with maize (Popov C. and Barbulescu A., 2007). High areas cultivated both with maize and sunflower is concentrated in the south-east of Romania (Lup A. *et al*, 2017). A low number of crops from rotation, increasing of the areas with maize monoculture, higher areas cultivated both, with maize and sunflower, in the most pest favorable areas from the south-east of Romania represent favorable conditions for increasing of the weevils population in our country. The suppression of these insects largely relies on chemical protection with systemic insecticides used for maize seeds treatment (Voinescu I., 1985; Barbulescu A. *et al*, 2001; Vasilescu V.S. *et al*, 2005; Popov C. *et al*, 2007b, Trotus E. *et al* l, 2011; Georgescu E. *et al*, 2014). As result of the European Commission regulations 218/783, 218/784 and 218/785, the use of the imidacloprid, clothianidin and thiamethoxam active ingredients will be total banned in UE, starting from 2019 (Official Journal of the European Union, 2018a,b,c). After these regulations, in Romania, no insecticides will remain available for maize seed treatment to control weevils attack. Lack of the seed treatment alternatives of the maize crops can have negative impact in Romanian agriculture, in next years (Ionel I.I., 2014). In this paper our goal was to evaluate the effectiveness of the possible alternatives to the maize seed treatment with neonicotionids, in conditions of the high pest pressure, in a commercial farm located in the south-east of the Romania.

MATERIAL AND METHOD

In 2020, a field trial were conducted in Romania at the commercial farm Sopema SRL, located at Mihail Kogalniceanu, Ialomita County, Romania (latitude: 44°42'N, longitude: 27°40', altitude: 18 m a.s.l). Over the course of the trial, the average temperatures and precipitation were recorded daily. The experiments were carried out according to the standard of the European and Mediterranean Plant Protection Organization (EPPO) (2012a, 2012b, 2014) methods for the data analysis, efficiency evaluation trials, and phytotoxicity. At trial location from the commercial farm Sopema, the area of each experimental plot was of 8000 m^2. Maize was sowed in 17 April and plants emergence were recorded on 2 May. For this trial, it has been used P0900 maize hybrid (FAO 480). In 2019, the previous crop was soybean. Experimental variants are presented in *table* 1. It has tested foliar spray with acetamiprid (20 %) and lambda-cyhalothrin (50 g/l) active ingredients (variants 2-3), seed treatment with imidacloprid (600 g/l) and cyantraniliprole (625 g/l) active ingredients (variants 4-5), granules application at sowing and plants emergence, with cypermethrin (0.8 %) active ingredient (variant 7) and granules application at plants emergence with chlorpyrifos (5 %) and lambda-cyhalothrin (4 g/kg) active ingredients (variants 6 and 8).

Assessments: when maize plants were in early vegetation stages (BBCH 11-12 and BBCH 14-16) it has assessed plant densities. On each variant, it has established four assessment points. At each assessment point, it has counted emerged maize plants from 20 row meters (80 row meters/variant).

Attack intensity was evaluated when maize plants were in four leafs stage, according to a scale from 1 to 9, elaborated and improved by Paulian F. (1972), as follows: note 1-plant not attacked; note 2-plant with 2-3 simple bites on the leaf edge; note 3-plants with bites or clips on all leaves edge; note 4-plants with leaves chafed in a proportion of 25 %; note 5-plants with leaves

chafed in a proportion of 50 %; note 6-plants with leaves chafed in a proportion of 75 %; note 7-plants with leaves chafed almost at the level of the stem; note 8-plants with leaves completely chafed and beginning of the stem destroyed; note 9-plants destroyed, with stem chafed close to soil level. At each variant, it has established four assessment points. At each assessment point, it has evaluated 50 maize plants, from five rows (10 plants/row). Before the assessment, plants were marked with sticks, in the stair system.

Table 1

Active ingredients used for controlling of the *Tanymecus dilaticollis* Gyll in commercial farm conditions, from south-east of the Romania, in 2020

Variant	Active ingredients	Rate	Rate type	Application type
1	—	—	—	—
2	acetamiprid (20 %)	0.10	kg/ha	B
3	lambda-cyhalothrin (50 g/l)	0.15	l/ha	B
4	imidacloprid (600 g/l)	2.20	µl/grain	A
5	cyantraniliprole (625 g/l)	2.00	µl/grain	A
6	chlorpyrifos (5 %)	16.00	kg/ha	D
7	cypermethrin (0.8 %)	12.00	kg/ha	C, D
8	lambda-cyhalothrin (4 g/kg)	12.00	kg/ha	D

A-Seed treatment (BBCH 00); **B**-Foliar applications (BBCH 11-12); **C**-Granules application at sowing time (BBCH 00), **D**-Granules application after plants emergence (BBCH 09-10)

Table 2

Results of foliar and granules application for controlling of the *Tanymecus dilaticollis*, in commercial farm conditions, from south-east of the Romania, in 2020

Active ingredients	Plants (no/Rm) 13.05.2020	Phytoxicity (%) 20.05.2020	Incidence (%) 20.05.2020	Attack (I:1-9) 20.05.2020	Plants (no/Rm) 20.05.2020
control (untreated)	5.57a	**0a**	**100a**	4.47a	5.40a
acetamiprid (20 %)	5.59a	**0a**	**100a**	4.42a	5.51a
lambda-cyhalothrin (50 g/l)	5.61a	**0a**	**100a**	4.46a	5.54a
Imidacloprid (600 g/l)	5.60a	**0a**	**100a**	3.86b	5.57a
cyantraniliprole (625 g/l)	5.50a	**0a**	**100a**	4.29a	5.45a
chlorpyrifos (5 %)	5.51a	**0a**	**100a**	4.32a	5.51a
cypermethrin (0.8 %)	5.54a	**0a**	**100a**	4.39a	5.50a
lambda-cyhalothrin (4 g/kg)	5.35a	**0a**	**100a**	4.40a	5.29a
LSD (P=.05)	0.313	0	0	0.289	0.356
Standard deviation (SD)	0.213	0	0	0.196	0.242
Coefficient of variation (CV)	3.840	0	0	4.540	4.420

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

Statistical analysis. The results of the field trial were presented as the absolute and mean values for maize plants density, phytotoxicity, attack incidence and weevils attack intensity, the standard deviation from the average values (SD) and the coefficient of variation (CV). Data were statistically analyzed using Student-Newman-Keuls test (Student, 1927; Neuman D., 1939; Keuls M., 1952).

RESULTS AND DISCUSSIONS

In April and May, weather conditions recorded at the experimental site, were unfavorable for weevils activity at the soil surface and feeding process. The average air temperature recorded in April was close to the multiyear average, while in May, average air temperature was below the multiyear average (*figure 1*). Even if the rainfalls amount recorded in April and May were below the multiyear average (*figure 2*), temperatures recorded when maize plants were in early vegetation stages (BBCH 10-BBCH 14) were lower than normal. Also, it has registered higher differences between minimum and maximum daily temperatures (more than 20 °C).

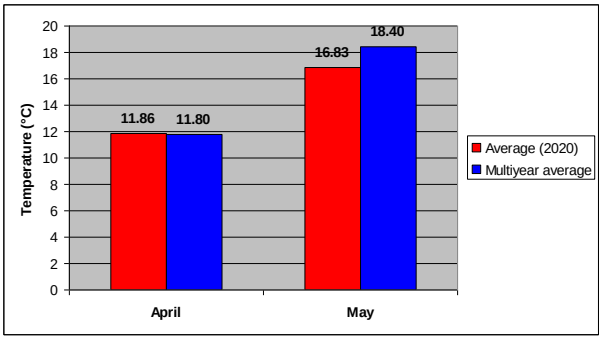

Figure 1 **Average air temperatures registered at Sopema farm, in April and May, 2020**

In first 15 days of May, minimum temperature was 3.85 °C while maximum temperature was bellow 27 °C. As result, maize

plants have a slow development, in early vegetation stage. In the same time, the interval with optimum temperature, during the day, for weevils activity at soil surface, was low. As result, the attack intensity of the weevils at maize plants, at Sopema farm, was low compared with the previous years. Badiu A.F. *et al*. (2019) mentioned that higher temperatures differences from the spring period can have an impact in reducing the maize leaf weevil attack intensity, because of the shorting of the weevils active period during the day. However, further studies are necessary to elucidate this aspect.

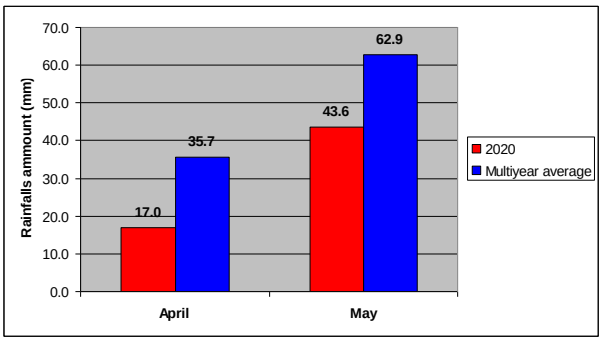

Figure 2 **Rainfalls amount registered at Sopema farm, in April and May, 2020**

In 2020, at the experimental location from Sopema farm, first assessment was made on 13 May, when maize plants were in two leaves stage and the second assessment was made at 20 May, when maize plants were in four leaves stage (BBCH 14). The two assessments make in evidence a high pest population level at the experimental site, with a density ranged from 10 to 15 weevils/m^2. Even if the pest density was smaller compared with previous years (Georgescu E *at al*, 2018), however, it was higher than economic damages limits for this specie (5 weevils/m^2 according to Rosca I. and Istrate R., 2009; 3 weevils/m^2 according to Badiu A.F. *et al.*, 2019).

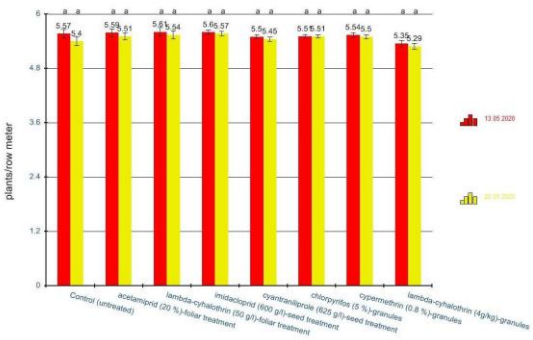

Figure 3 **Maize plants density, at experimental location from Sopema farm (2020)**

Regard as maize plants density, data from the *table* 2 make in evidence slight variability of this parameter between experimental variants, at first assessment. At the untreated variant it has recorded 5.57 plants/row meter, while in the case of the treated variants, plants density ranged from 5.35 to 5.61 plants/row meter. At the second assessment, made one week later, when maize plants were in four leaves stage (BBCH 14), it has ascertained a slight decrease of the plants density comparative with the previous assessment (*figure* 3). However, maize plants density was higher at all experimental variants than the 5.25 plants/row meter. According Student-Newman-Keuls (SNK) test, there weren't recorded significant statistical differences between plants density at control (untreated) variant and treated variants ($p<0.05$).

In 2020, at the experimental location, from Sopema farm, it hasn't recorded phytotoxicity at treated variants (*table* 2). Both seed treatment and foliar treatment hasn't a negative effect on maize plants in early vegetation stages. Also, insecticides applied like granules, both at sowing and after plants emergence does not affect maize plants.

Regarding of the attack incidence, all assessed plants from this field trial was attacked by the weevils, with different intensity of the attack.

In the weather conditions of the spring of 2020, at experimental site from Sopema farm, weevils attack intensity at maize plants, on a scale from 1 to 9, was 4.47 at untreated variant (*figure* 4). Most of the maize untreated plants from this experiment have leaf chaffed in proportion of 25-50% as result of weevils feeding process. Some plants have leaves completely chafed and beginning of the stem destroyed. However the majority of the plants from this field trial survived.

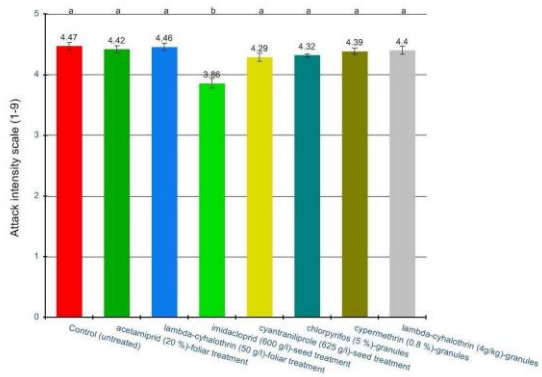

Figure 4 **Attack intensity of *Tanymecus dilaticollis* weevils at maize plants, at Sopema farm (2020)**

At variants with foliar treatment (without seed treatment), made when maize plants were in BBCH 11-12 stage, attack intensity was 4.42 (in case of variant sprayed with acetamiprid active ingredient) and 4.46 in case of variant sprayed with lambda-cyhalothrin active ingredient). The lower value of the attack intensity has been recorded

incase of the variant with imidacloprid active ingredient (seed treatment). Attack intensity was 3.86, which means maize plants have leaves chaffed in the proportion of 5-15%, and some plants have leaves chaffed in the proportion of 25 %. In case of the variant with maize seeds treated with the cyantraniliprole active ingredient, weevils attack intensity was higher comparative with variant treated with imidacloprid active ingredient and lower than the control variant. Regard to variants treated with granule insecticides, it has ascertained slight differences of the weevils attack intensity at the maize plants comparative with untreated variant. Also, two applications of granules, with cypermethrin active ingredient, both at sowing and after plants emergence hasn't impact in reducing of the weevils attack intensity at maize plants. According Student-Newman-Keuls (SNK) test, in the field trial from Sopema farm, in weather conditions of the spring of year 2020, it has registered significant statistical differences between weevils attack intensity at maize plants from variant treated with imidacloprid active ingredient (seeds treatment) and attack intensity at untreated maize plants (control variant). At the same time, it hasn't registered significant statistical differences between weevils attack intensity at variants with foliar treatment, variants with granules application, variant with seed treated with the cyantraniliprole active ingredient and untreated variant ($p<0.05$). In this field trial, treatment with lambda-cyhalothrin active ingredient apply like spraying or granules after plants emergence didn't have any impact in reducing of the weevils attack intensity at maize plants. Also, foliar spraying with insecticides with different mode of actions didn't have any impact in reducing of the weevils attack intensity at maize plants. Regard as granules treatments, both single application, after plants emergence and two applications, at sowing and after plants emergence didn't have any impact in reducing of the weevils attack intensity at maize plants. In the case of seeds treated with the cyantraniliprole active ingredient, even if it has ascertained a slight decreasing of the weevils attack intensity at maize plants comparative with control variant, however, it hasn't registered significant statistical differences comparative with untreated plants. At this conclusion, we arrive in previous studies effectuated both in the field and laboratory conditions (Georgescu E. *et al*, 2015, 2016). Results from this study and from previous studies make in evidence lack of the alternatives to seed treatments with neonicotionids systemic insecticides for control of *T. dilaticollis* weevils attack at maize plants (Georgescu E. *et al*, 2014, 2018).

CONCLUSIONS

In 2020, weather conditions from the spring period (April-May) at the experimental site (Sopema farm, Ialomita County) were unfavorable for maize leaf weevil (*Tanymecus dilaticollis* Gyll) attack. In conditions of high pest pressure (10-15 weevils/m^2) from experimental site, the attack intensity of the weevils at maize plants was low, as result of the unfavorable weather conditions from period when maize plants were in early vegetation stages (BBCH 10-BBCH 14). Most of the maize plants survive of the attack. In this field trial, foliar treatment with acetamiprid, lambda-cyhalothrin active ingredients, granules application with chlorpyrifos, cypermethrin, lambda-cyhalothrin active ingredients and seed treatment with cyantraniliprole active ingredient didn't have effectiveness in controlling of the maize leaf weevil attack.

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OBSERVATIONS REGARDING THE STRUCTURE AND DYNAMICS OF THE EXISTING EPIGEUS ENTOMOFAUNA IN THE APPLE FRUIT TREE PLANTATIONS

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Abstract

Observations on epigeus entomofauna were made during 2019 in a apple fruit tree plantation owned by SC Loturi Service SRL, Delesti, Vaslui County. The harvesting of the biological material was done with soil traps type Barber and with the beeting method, from May to August inclusive. The collected material was cleaned from plant debris and then prepared for identification at order of insects, and in the coleoptera species these were determined to species level. The analysis of the collected material shows that the specimens collected belong to the *Hexapoda* class. Most of the specimens collected belong to the *Insecta* class. The most common species were: *Dermestes laniarius*, *Anysodactilus binotatus*, *Harpalus distinguendus*, *Cantharis fusca*, *Tachyusa coarctata*, *Otiorhynchus pinastri*, *Amara aenea* and *Microlestes minutulus*.

Key words: epigeous; apple orchards; dynamics

Among the most important insect families belonging to both the useful and harmful entomofauna Arthropods are animals to which appear the articulated legs. They belong to several classes, namely: *Crustacea*, *Arachnida*, *Miriapoda* and *Insecta*.

The *Crustacea* class (crustaceans) are the arthropods that have the hard skin, covered with a crust. Most of them are aquatic species, but there are also harmful species that live on land. These belong to the order of *Isopoda* and the prefall of the *Armadillidium vulgare* species.

Among the arthropods, the most numerous specimens belong to the Class Insecta (*Hexapoda*) (Radu G.V., 1967).

In the *Arahnida* class are both harmful and useful species. The harmful species belong to the *Acari* order, and the useful species belong to the order of *Aranea* (spiders) (Boguleanu G. *et al*, 1980).

In this paper are brought some contributions to the knowledge of these groups of animals in different orchards.

MATERIAL AND METHOD

The collection of arthropods was made with the soil traps type Barber in the year 2019 on the following dates: 15.05, 30.05, 30.06 and 15.07.

The species of epigeous entomofauna were colected with the help of the soil traps type Barber using the formalin solution with 3-4%.(*figure 1*) (Talmaciu M., 2011) The biological materials from the trap were collected every 7-10 days. At each harverst, the Formalin solution was completed or replaced, if necesary. The collected material was brought in the laboratory where we separated the species and determinated them.

In the apple orchards of SC Loturi Service SRL in the year of research there were placed a number of 42 Barber soil traps. Depending on the number of collections on year, and depending on the climatic conditions and the state of the traps, in 2019, we are realized 4 harvesting of the biological material.

RESULTS AND DISCUSSIONS

At the first harvest from 15.05.2019 were collected 161 specimens, belonging to a number of 9 taxons (*table 1*).

Most belong to the insect class at the following orders: *Hymenoptera* with most specimens, 48, *Coleoptera* with 41 specimens and *Diptera* with 31 specimens.

In the 2nd harvest dated 30.05.2019, the specimens of arthropods belonging to 10 taxons were collected (*table 2).* The greatest

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representation had a hyenopters with 173 specimens, arachnids with 39 specimens, heteropters with 36 specimens and coleopters with 35 specimens.

Figure. 1. **The collection and determination of the collected material**

Table 1

Situation of collections on 15.05.2019

No.	Name of taxon	Samples						Total
		1	2	3	4	5	6	
1	Diptere	-	4	-	19	2	7	32
2	Himenoptere	10	-	1	32	-	5	48
3	Coleoptere	8	5	5	12	3	8	41
4	Miriapode		1	-	5	-	-	6
5	Arahnide	3	1	-	13	-	-	17
6	Heteroptere	5	-	-	-	-	5	10
7	Homptere	2	-	-	-	-	-	2
8	Lepidoptere	1	-	1	1	-	1	4
9	Ortoptere	-	-	-	1	-	-	1
TOTAL								161

Table 2

Situation of collections on 30.05.2019

No.	Name of taxon	Samples						Total
		1	2	3	4	5	6	
1	Coleoptere	9	6	10	-	8	2	35
2	Heteroptere	6	5	17	-		8	36
3	Diptere	13	-	-	-	13	3	29
4	Himenoptere	18	45	53		22	35	173
5	Dermaptere	2	-	-	-	-	-	2
6	Crisopide	1	-	-	-	-	-	1
7	Arahnide	13	5	8	-	5	8	39
8	Miriapode	2	-	1	-		2	5
9	Lepidoptere	2	-	-	-	2	2	6
10	Homoptere	3	-	3	-	-	3	9
Total								335

At the 3rd harvest of 15.06.2019, 171 specimens of arthropods were collected belonging to the following taxon groups (*table 3): Coleoptera, Heteroptera, Hymenoptera, Diptera, Miriapoda, Colembola* and *Arachnida*. The most well represented were himenopters with a number of 49 specimens, followed by coleopters with 46 specimens.

At the 4th Harvest of 30.06.2019 were collected 55 specimens of arthropods belonging to 7 taxons (*table 4*). It was best to represent the order of *Hymenoptera* with 15 specimens collected.

Table 3

Situation of collections on 15.06.2019

No.	Name of taxon	Samples						Total
		1	2	3	4	5	6	
1	Coleoptere	19	-	-	6	-	18	43
2	Heteroptere	15	-	-	10	-	1	26
3	Himenoptere	28	-	-	14	-	7	49
4	Diptere	3	-	-	8	-	6	17
5	Homoptere	5	-	-	-	-	2	7
6	Miriapode	3	-	-	-	-	-	3
7	Colembole	17	-	-	-	-	-	17
8	Arahnide	-	-	-	5	-	4	9
Total								171

Table 4

Situation of collections on 30.06.2018

No.	Name of taxon	Samples						Total
		1	2	3	4	5	6	
1	Heteroptere	5	-	-	-	-	6	11
2	Cicade	2	-	-	-	-	-	2
3	Arahnide	3	-	-	-	-	-	3
4	Himenoptere	10	-	-	-	5	-	15
5	Lepidoptere	1	-	-	-	-	1	1
6	Coleoptere	11	-	-	-	-	3	14
7	Diptere	-	-	-	-	2	7	9
Total								55

At the 5th Harvest of 15.07.2019, only 72 specimens were collected (*table 5*). The largest number of specimens had the himenopters with 27 specimens and the coleopters with 17specimens.

Table **5**

Situation of collections on 15.07.2018

No.	Name of taxon	Samples						Total
		1	2	3	4	5	6	
1	Dermaptere	1	-	-	-	-	-	1
2	Homoptere	2	3	-	-	-	1	5
3	Heteroptere	4	7	-	-	-	5	16
4	Diptere	8	4	-	-	-	2	14
5	Himenoptere	2	2	-	-	-	23	27
6	Coleoptere	1	11	-	-	-	5	17
7	Arahnide		4	-	-	-	-	7
8	Lepidoptere	-	-	-	-	-	1	1
Total								72

During the observation in 2019, a total of 795 specimens belonging to collected arthropods fauna (*table 6*). Most specimens belonged to the Insecta class and to the following groups: *Hymenoptera* (308 specimens), *Coleoptera* (167 specimens), *Heteroptera* (99 specimens) and *Diptera* with 98 specimens.

Table 6

Situation of collections on 2019

No.	Name of taxon	Samples						Total
		1	2	3	4	5	6	
1	Diptere	24	8	-	26	15	25	98
2	Himenoptere	68	47	54	46	22	75	308
3	Coleoptere	37	50	15	18	15	36	171
4	Miriapode	5	1	1	5	-	-	12

5	Arahnide	16	10	8	18	5	15	72
6	Heteroptere	35	12	17	10	-	25	99
7	Homoptere	9	3	3	-	-	6	18
8	Lepidoptere	4	-	1	1	2	5	13
9	Ortoptere	-	-	-	1	-	-	1
10	Dermaptere	3	-	-	-	-	-	3
TOTAL								795

CONCLUSIONS

1. The most numerous arthropods that were collected belong to the insect class. The most numerous insect groups belong to *Hymenoptera* and *Diptera*.

2. In total, 795 specimens of arthropods belonging to a number of 10 taxons were collected

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OBSERVATIONS REGARDING THE ENTOMOFAUNA OF COLEOPTERAS WITHIN SOME AGRICULTURAL CROPS FROM THE NORTH-EAST PART OF PORTUGAL

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Abstract

The aim of this research was that to identify the entomofauna of *Carabidae* existing within the agricultural crop taken into the study: vineyard groove by the mean of soil traps. Each 5 traps were mounted inside 3 subplots, namely: leguminosae+graminias, leguminosae and natural. The area of work was about 1.30 ha, each subplot having a surface of 4.000 $m^{2.}$ The researches were carried out within Quinta da Granja farm which is located very close to Alijo city, at two dates: May 18th and May 22nd of 2017. To prevent the maceration of insects, a solution consisting of water and formalin was added inside each trap. After carrying out the experiments within the field, the insects were brought in the Laboratory of Entomology in order to be counted and identified. From the *Coleoptera* order, species with the biggest number of samples were: -within the leguminosae+graminias subplot: *Carabidae* family (92), *Scarabaeidae* (45), *Staphylinidae* (25) and *Dermestidae* (12). From the *Carabidae* family, species with the biggest number of samples were: *Harpalus tardus*-33 and *Carabus violaceus*-12 (for the date of May 18th); Carabus violaceus-24 (for May 22nd); -within the leguminosae subplot: *Carabidae* (154), *Staphylinidae* (101) and *Scarabaeidae* (71) and *Cerambycidae* (32) and *Chrysomelidae* (27) and *Dermestidae* (19). From the *Carabidae* family, species with the biggest number of samples were: *Pterostichus vernalis*-63 and *Poecilus versicolor*-32 (for May 18th); *Pterostichus cupreus*-26 (for May 22nd); -within the natural sublot: *Carabidae* (128),*Chrysomelidae* (72) and *Scarabaeidae* (54) and *Dermestidae* (22). From the *Carabidae* family, species with the biggest number of samples were: *Brachimus crepitans*-24 (for May 18th); *Anisodactylus binotatus*- 48 (for May 22nd).

Key words: soil traps, *Carabidae*, *Scarabaeidae*, *Dermestidae*

Ground beetles (*Carabidae*) are a large, cosmopolitan family of beetles, with more than 40,000 species around the world, apromaximatelly 2,000 being found in North America and about 2,700 in Europe. Although their body shapes and coloring vary somewhat, most are shiny black or metallic and have ridged wing covers (elytra). The elytra are fused in some species, particularly the large Carabinae, rendering the beetles unable to fly.

Dermestidae are a family of Coleoptera that are commonly referred to as skin beetles. There are about 500-700 species worldwide. They can rage in size from 1 to 12 mm. Key characteristics for adults are round oval shaped bodies covered in sclales or setae. The usually clubbed antennae feet into deep grooves. The hind femora also fites into recesses of the coxa. Larvae are scarabaeiform and also have setae.

Scarabaeidae consists of more than 30,000 species of beetles worldwide, they are often called scarab beetles. They are stout bodied beetles, many with bright metallic colours, measuring between 1.5 and 160 mm. They have distinctive clubbed antennae composed of plates called lamellae which can be compressed into a ball or fanned out like leaves to sense odours. The front legs of many species are broad and adapted for digging.

MATERIAL AND METHOD

In order to carry out the researches, the insects were sampled from one station: Quinta da Granja, belonging to University of Tras os Montes e Alto Douro, by using the method of soil traps.

The experiments were carried out at May 18th and May 22nd of 2017. Each 5 traps were placed within 3 subplots: leguminosae+graminias, leguminosae and natural. In order for insects to be well conserved, a liquid of water+formalina was adeed.

After finishing the experiments, the insects were brought into the Laboratory of Entomology to be counted and identified.

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RESULTS AND DISCUSSIONS

The samples of the biological material were carried out at May 18th and May 22nd of May of 2017. Within the leguminosae+graminias subplot, the situation looks as follows:

- At the date of May 18th of 2017: there were 103 samples identified from Coleoptera order, belonging to *Carabidae* family (55), *Scarabaeidae* (21), *Staphylinidae* (19) and *Dermestidae* (8).

- From the *Carabidae* family, 33 samples belong to *Harpalus tardus* species, 12 samples belong to *Carabus violaceus* species, 6 samples belong to *Loricera pilicornis* species and 4 samples belong to *Anisodactylus binotatus* species;

At the date of May 22nd of 2017: there were 71 samples identified from *Coleoptera* order, belonging to *Carabidae* family (37), *Scarabaeidae* (24), *Staphylinidae* (6) and *Dermestidae* (4).

- From the *Carabidae* family, 24 samples belong to *Carabus violaceus* species, 7 samples belong to *Harpalus tardus* species, 5 samples belong to *Loricera pilicornis* species and 1 sample belongs to *Brachinus crepitans* species.

Within the leguminosae subplot, the situation looks as follows:

- At the date of May 18th of 2017: there were 204 samples identified from *Coleoptera* order, belonging to *Carabidae* family (104), *Staphylinidae* (80), *Scarabaeidae* (51), *Cerambycidae* (18) and *Chrysomelidae* (17) and *Dermestidae* (14);

- From the *Carabidae* family, 63 samples belong to *Pterostichus vernalis* species, 32 samples belong to *Poecilus versicolor* species and 9 samples belong to *Amara aenea* species.

At the date of May 22nd of 2017: there were 120 samples identified from *Coleoptera* order, belonging to: *Carabidae* family (50), *Staphylinidae* (21), *Scarabaeidae* (20), *Cerambycidae* (14), *Chrysomelidae* (10) and *Dermestidae* (5).

- From the *Carabidae* family, 26 samples belong to *Pterostichus cupreus*, 11 samples belong to *Anisodactylus binotatus*, 8 samples belong to *Brachinus crepitans*, 3 samples belong to *Bembidion properans*, and 2 samples belong to *Bembidion lampros*.

Table 1

Entomofauna of Coleopteras (Coleoptera) sampled within leguminosae-graminias at 18th of May of 2017

CURRENT NUMBER	FAMILY	SPECIES	NUMBER OFSAMPLES	TOTAL SAMPLES
1.	*CARABIDAE*	*HARPALUS TARDUS*	33	55
		CARABUS VIOLACEUS	12	
		LORICELA PILICORNIS	6	
		ANISODACTYLUS BINOTATUS	4	
2.	*SCARABAEIDAE*	-	21	21
3.	*STAPHYLINIDAE*	-	19	19
4.	*DERMESTIDAE*	-	8	8
TOTAL ENTOMOFAUNA OF COLEOPTERAS				**103**

Within the natural subplot, the situation looks as follows:

- At the date of May 18th of 2017: there were 151 samples identified from *Coleoptera* order, belonging to *Carabidae* family (60), *Chrysomelidae* (38), *Scarabaeidae* (35) and *Dermestidae* (18).

- From the *Carabidae* family, 24 samples belong to *Brachinus crepitans*, 16 samples belong to *Amara aenea* and 12 samples belong to *Amara ovata* and 8 samples to *Harpalus tardus* species.

- At the date of May 22nd of 2017: there were 125 samples identified from *Coleoptera* order, belonging to *Carabidae* family (68), *Chrysomelidae* (34), *Scarabaeidae* (19) and *Dermestidae* (4).

- From the *Carabidae* family, 48 samples belong to *Anysodactilus binotatus*, 12 samples belong to *Brachinus crepitans*, 6 samples belong to *Harpalus latus* and 2 samples belong to *Anisodactylus signatus*.

Table 2

Entomofauna of Coleopteras (Coleoptera) sampled within leguminosae-graminias at 22nd of May of 2017

CURRENT NUMBER	FAMILY	SPECIES	NUMBER OF SAMPLES	TOTAL SAMPLES
1.	*CARABIDAE*	*CARABUS VIOLACEUS*	24	37
		HARPALUS TARDUS	7	
		LORICERA PILICORNIS	5	
		BRACHINUS CREPITANS	1	
2.	*SCARABAEIDAE*	-	24	24
3.	*STAPHYLINIDAE*	-	6	6
4.	*DERMESTIDAE*	-	4	4
TOTAL ENTOMOFAUNA OF COLEOPTERAS				**71**

Table 3

Entomofauna of Coleopteras (Coleoptera) sampled within leguminosae subplot at 18th of May of 2017

CURRENT NUMBER	FAMILY	SPECIES	NUMBER OF SAMPLES	TOTAL SAMPLES
1.	*CARABIDAE*	*PTEROSTICHUS VERNALIS*	63	104
		POECILUS VERSICOLOR	32	
		AMARA AENEA	9	
2.	*STAPHYLINIDAE*	-	80	80
3.	*SCARABAEIDAE*	-	51	51
4.	*CERAMBYCIDAE*	-	18	18
5.	*CHRYSOMELIDAE*	-	17	17
6.	*DERMESTIDAE*	-	14	14
TOTAL ENTOMOFAUNA OF COLEOPTERAS				**204**

Table 4

Entomofauna of Coleopteras (Coleoptera) sampled within leguminosae subplot at 22ND of May of 2017

CURRENT NUMBER	FAMILY	SPECIES	NUMBER OF SAMPLES	TOTAL SAMPLES
1.	*CARABIDAE*	*PTEROSTICHUS CUPREUS*	26	50
		ANISODACTYLUS BINOTATUS	11	
		BRACHINUS CREPITANS	8	
		BEMBIDION PROPERANS	8	
		BEMBIDION LAMPROS	2	
2.	*STAPHYLINIDAE*	-	21	21
3.	*SCARABAEIDAE*	-	20	20
4.	*CERAMBYCIDAE*	-	14	14
5.	*CHRYSOMELIDAE*	-	10	10
6.	*DERMESTIDAE*	-	5	5
TOTAL ENTOMOFAUNA OF COLEOPTERAS				**120**

Table 5

Entomofauna of Coleopteras (Coleoptera) sampled within natural subplot at 18th of May of 2017

CURRENT NUMBER	FAMILY	SPECIES	NUMBER OF SAMPLES	TOTAL SAMPLES
1.	*CARABIDAE*	*BRACHINUS CREPITANS*	24	60
		AMARA AENEA	16	
		AMARA OVATA	12	
		HARPALUS TARDUS	8	
2.	*CHRYSOMELIDAE*	-	38	38
3.	*SCARABAEIDAE*	-	35	35
4.	*DERMESTIDAE*	-	18	18
TOTAL ENTOMOFAUNA OF COLEOPTERAS				**151**

Table 6

Entomofauna of Coleopteras (Coleoptera) sampled within natural subplot at 22ND of May of 2017

CURRENT NUMBER	FAMILY	SPECIES	NUMBER OF SAMPLES	TOTAL SAMPLES
1.	*CARABIDAE*	*ANISODACTYLUS BINOTATUS*	48	68
		BRACHINUS CREPITANS	12	
		ANISODACTYLUS BINOTATUS	6	
		HARPALUS LATUS	6	
2.	*CHRYSOMELIDAE*	-	34	34
3.	*SCARABAEIDAE*	-	19	19
4.	*DERMESTIDAE*	-	4	4
TOTAL ENTOMOFAUNA OF COLEOPTERAS				**125**

CONCLUSIONS

As well as conclusions, within the leguminosae+graminias subplot, during the day of May 18th of 2017, from a total of 103 samples of *Coleopteras*, the most significant number belongs to *Carabidae* family (55), followed by *Scarabaeidae* family (21) and *Staphylinidae* family (19), while the leastest number of samples belongs to *Dermestidae* family (8). From the *Carabidae* family, the biggest number of samples belongs to *Harpalus tardus* species (33).

During the day of May 22nd of 2017, within the same subplot, from a total of 71 samples of Coleopteras, the most significant number belongs to *Carabidae* family (37), followed by *Scarabaeidae* family (24), From the *Carabidae* family, the biggest number of samples belongs to *Carabus violaceus* species (24).

Within the leguminosae subplot, during the day of May 18th of 2017, from a total of 204 samples of Coleopteras, the most significant number belongs to *Carabidae* family (104), followed by *Staphylinidae* family (80). From the *Carabidae* family, the biggest number of samples belongs to *Pterostichus vernalis* species (63).

During the day of May 22nd of 2017, within the same subplot, from a total of 120 samples of *Coleopteras*, the most significant number of samples belongs also to *Carabidae* family (50), followed by *Staphylinidae* family (21). From the *Carabidae* family, the biggest number of samples belongs to *Pterostichus cupreus* species (26).

Within the natural subplot, at the date of May 18th of 2017, from a total of 151 samples of*Coleopteras*, the most significant number of samples belongs to *Carabidae* family (60), followed by *Chrysomelidae* family (38). From the *Carabidae* family, the biggest number of samples belongs to *Brachinus crepitans* species (24).

Within the same subplot, at the date of May 22nd of 2017, from a total of 125 samples of *Coleopteras*, the most significant number of samples belongs to *Carabidae* family (68), followed by *Chrysomelidae* family (34). From the *Carabidae* family, the biggest number of samples belongs to *Anisodactylus binotatus* species (48)

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THE EFFECT OF BIOSTIMULANTS ON THE PROCESS OF PHOTOSYNTHESIS AT THE LETTUCE

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Abstract

This study followed the effect of two organic biostimulants on the photosynthesis process in two salad varieties grown in the greenhouse. At the same time, the aim was to establish the most effective way to apply biostimulants to increase production. Application of growth regulators was done every ten days by foliar spraying and root application. The first application being made at the appearance of the first leaves, and the last application was made ten days before harvest. The biostimulants used in this study were *Wuxal Ascofol* with a high content of algae extract and *Black Jack* based on humic acids. The photosynthesis process was evaluated by determining the total chlorophyll content and by evaluating the content of photosynthetic pigments in the leaves. The study showed that the applied organic treatments stimulated the photosynthesis process in both varieties of salad, which was correlated with an increase in head of salad. Chlorophyll content of 431 nm and chlorophyll b 453 nm, components of the absorption center that capture light energy and transfer it to the reaction center recorded the highest values in the variant treated with *Wuxal Ascofol*, which shows an intense transport of assimilated to foliar system. It was also noted that the foliar application of biostimulants to lettuce gives much better results than the application at the root level.

Key words: lettuce, photosynthesis, biostimulants

Salad is grown for leaves, which are eaten mostly fresh. In recent years there has been an increase in production due to it's beneficial effects on: health, short growing season, relatively simple cultivation technology, capitalization of high-priced products and the inclusion of lettuce in various low-calorie diets.

In order to obtain high yields, both in terms of quantity and quality, plants need favorable growing conditions and a nutrition regime that ensures sufficient amounts of water, carbon dioxide, macro and microelements. In this regard, there is a growing interest in the use of biostimulants that are naturally used to increase the production of horticultural and agricultural crops (Kurepin *et al*, 2003; Rapacz *et al*, 2003).

Bioactive substances guide the growth and evolution of vegetable plants by developing plant protection systems and obtaining economically viable production (Lyszkowska *et al*, 2008; Lagunovschi-Luchian *et al*, 2016).

MATERIAL AND METHOD

Two early lettuce varieties for curly leaves were studied*: Lollo Rosso* and *Lollo Bionda*. The culture was established in the greenhouse, through the control of vegetation factors. The planting was donein pots in a homogeneous mixture of earth and peat, in a ratio of 1: 1. Biostimulants were administered in different doses: Blackjak biostimulants 2.5 ml / 500 ml water, 10 ml root / plant was administered and Wuxal Ascofol Biostimulants 3 ml / 500 ml water, was administered foliar. The two treated variants were compared with the control group watered only with water.

Experimental variants

V0- watered with water;

V1- fertigation with the Blackjak biotimulants;

V2- foliar sprays with the Wuxal Ascofol biostimulants.

Each variant included 3 repetitions. Biostimulants were applied differently every ten days. Blackjack treatment was distributed foliar, and Wuxal Ascofol to the root. The first application was made when the first leaves appeared, and the last ten days before harvest.

Blackjak is a biostimulant based on 100% natural humic acids, with a role in restoring soil fertility and accelerated rooting, by increasing the humus content, stimulating microbial activity and unlocking nutrients in the soil. As a chemical composition it is a concentrated suspension, obtained from leonardite very rich in humus.

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Wuxal Ascofol is a premium organic leaf biostimulant, with concentrated content of brown algae extract species *Ascophyllum nodosum*. The fertilizer is in the form of a suspension, making it easy to use, compared to powder fertilizers - hardly soluble. Contains seaweed, nitrogen, potassium, boron, manganese, zinc, optionally may contain - calcium, magnesium, copper, iron and bioactive compounds - cytokinins, auxins, gibberellins and betaines

The study followed the process of photosynthesis under the direct action of biostimulats. It was evaluated by determining the total chlorophyll content and by evaluating the photosynthetic pigment content of 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 by the acetonic extract (1%), analyzed on the computer-generated spectrophotometer.

RESULTS AND DISCUSSIONS

The photosynthesis process was evaluated in terms of the chlorophyll content index (CCI) and the content of photosynthetic pigments in the leaves of lettuce plants.

Dynamics of the chlorophyll content index (CCI) under the action of biostimulators

The average chlorophyll content was analyzed at intervals of ten days after the application of biostimulators, performing three readings.

The first reading of the total chlorophyll content performed 10 days after the application of the two biostimulants, indicates an increase in the values for the treated variants (*figure 1*) for both salad varieties. The *Lollo Rosso* variety showed the highest chlorophyll content in plants treated with *Wuxal Ascofal*, applied by foliar spraying, and the *Lollo Bionda* variety had a higher chlorophyll content index in the case of the root-treated *Black Jack* variant.

After 20 days on the application of biostimulants, both varieties had the highest values in the variants treated with *Black Jack*.

After the application of the last treatment, a return to the behavior that the plants showed 10 days after the application of biostimulants is observed. The *Lollo Rosso* variety stands out with the highest values of the total chlorophyll content in the variant treated with *Wuxal Ascofol* and the plants treated with *Black Jack* in the *Lollo Bionda* variant.

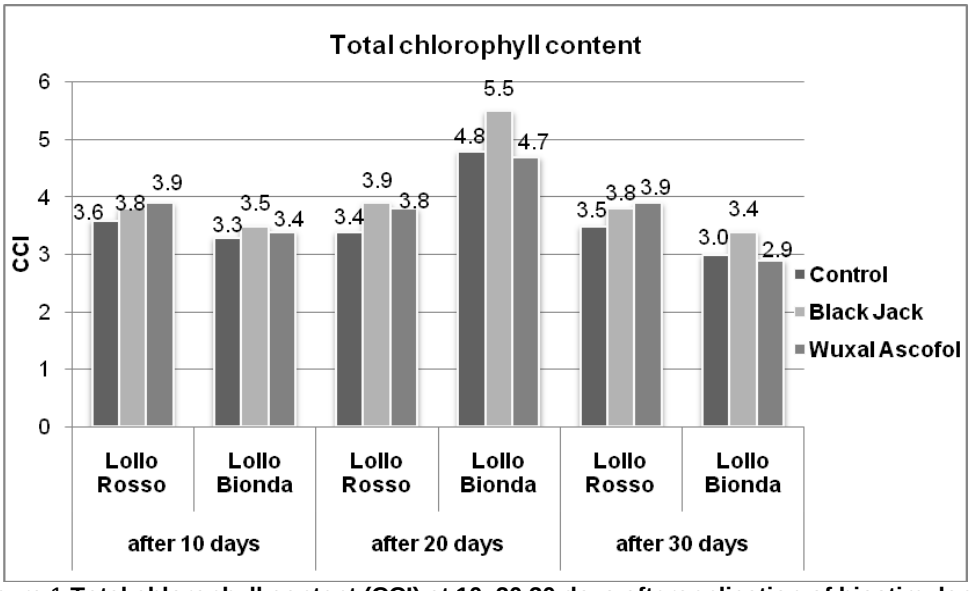

Figure 1 **Total chlorophyll content (CCI) at 10, 20,30 days afterapplication of biostimulants**

The *Lollo Rosso* variety stands out with the highest values of the total chlorophyll content, results that can be correlated with the higher number of leaves within the first phenophases analyzed (*figure 2*).

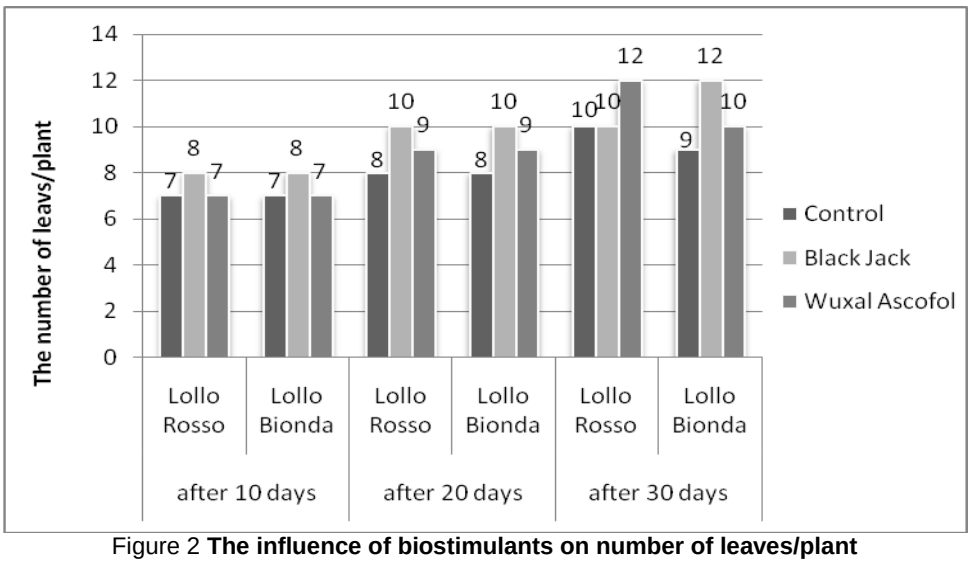

Figure 2 **The influence of biostimulants on number of leaves/plant**

Dynamics of the content of photosynthetic pigments in lettuce leaves

In the process of photosynthesis, the absorption of light energy and it's transformation into chemical energy is achieved with the participation of photosynthetic systems (SF I and SF II). The photosynthetic system consists of a complex of assimilating pigments, which consists of an absorption center and a reaction center, making up 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 components of the reaction center (Jităreanu and Marta, 2020).

The specrophotometric analysis of the content of assimilating pigments in the leaves was performed during the vegetative growth period, the stage of ten leaves. The results obtained in the variants treated with biostimulants show high values for both the components of the absorption center and for the components of the reaction center, which indicates a high storage capacity of light energy and a high potential for accumulation of organic substances that will ensure the premise. high production. The recorded values ranged between 0.5 u.a for the *Lollo Bionda* control variant variety and 1.05 u.a, for the *Lollo Rosso* group treated with *Wuxal Ascofol*.

The *Lollo Rosso* variety stands out with the highest values of the chlorophyll content of 431 nm in the variant treated with *Wuxal Ascofol* (*figure 3*), and *Lollo Bionda* in the group treated with *Black Jack*. Regarding chlorophyll *b 453* nm, both varieties behaved similarly, recording the highest values in the case of *Black Jack* plants.

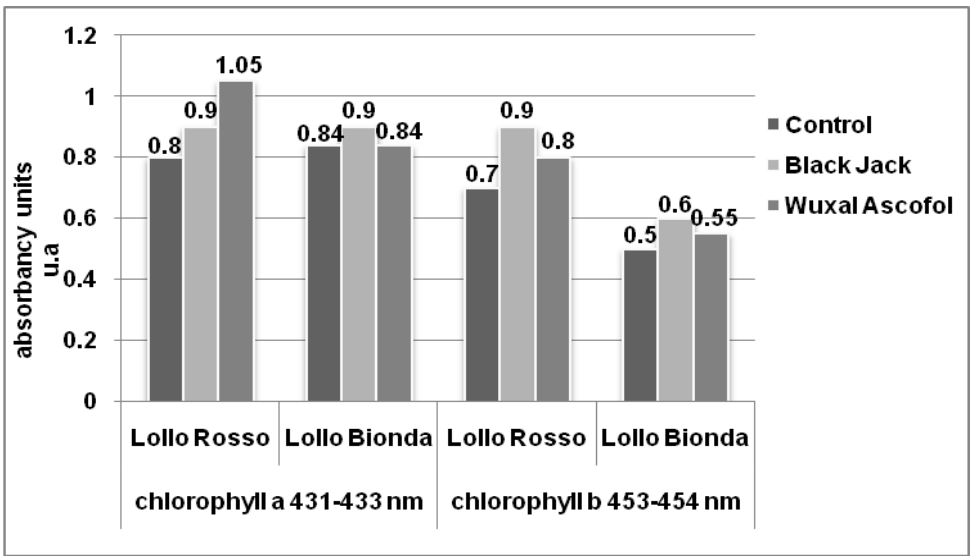

Figure 3 **The effect of biostimulants on chlorophyll content a 431 nm and b 453 nm**

Analysis of the chlorophyll content of 662 nm and chlorophyll b 616 nm components of the reaction center in the photosynthetic systems showed that the variants treated with biostimulants

also recorded higher values than the plants in the control group. The absorbance recorded for these two types of chlorophyll ranged from 0.01 to 0.8 u.a. In the case of chlorophyll at 662 nm, the response to the treatment applied for the two varieties studied was stronger for the plants sprayed with *Wuxal Ascofol*, as evidenced by the high values recorded (*figure 4*). The *Black Jack* biostimulant determined an obvious increase of the chlorophyll content of 662 nm compared to the control group. The analysis of chlorophyll *b 616* nm highlights this time the *Lollo Bionda* variety, with the highest value determined by the root application of the *Black Jack* biostimulant.

The results obtained after the analysis of the chlorophyll *a* and *b* content show significant differences between the variants treated with biostimulants and the control group. The values shown in *figure 4* show that the *Lollo Rosso* variety reacted better in terms of chlorophyll content to the treatment with *Wuxal Ascofol* administered by foliar sprays, and the *Lollo Bionda* variety to the root application treatment with the *Black Jack* biostimulant.

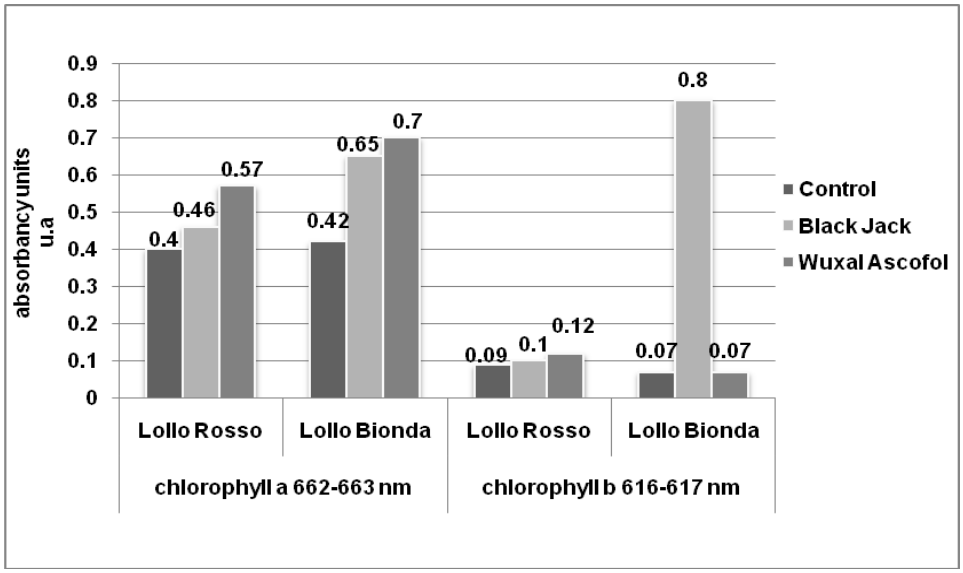

Figure 4 **The effect of biostimulants on chlorophyll content a 662 nm and b 616 nm**

The high photosynthetic intensity in plants treated with biostimulant correlates with the weight of the captains, a fact found at the end of the experiment. The higher values of the weight of the foliar system (*figure 5*) from the two varieties studied under the action of biostimulants *Blackjak* and *Wuxal Ascofol* show an intense transport of assimilates, which led to a higher weight of the captains in the plants of the treated variants.

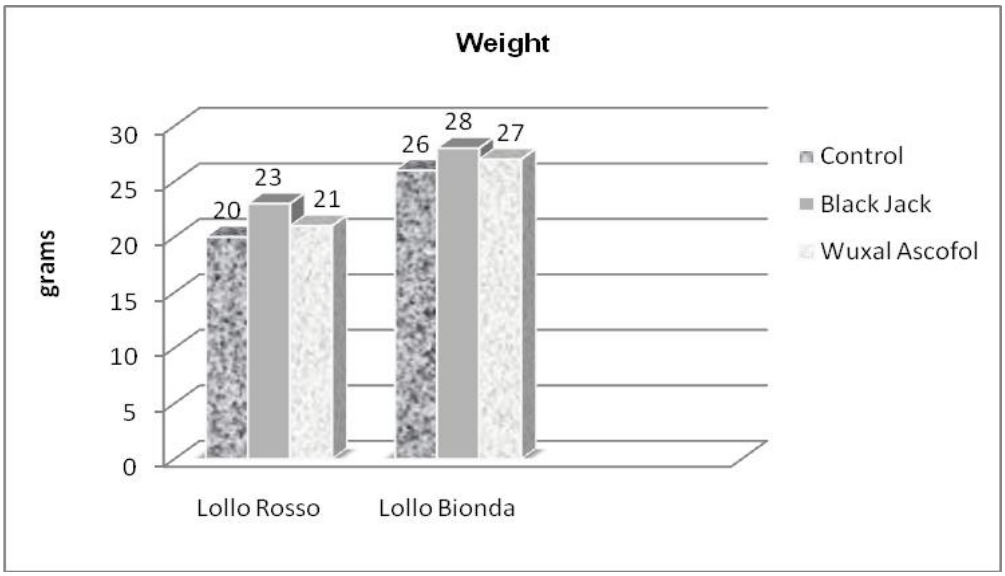

Figure 5 **The effect of biostimulants on the weight of salated**

Moreover, it is known that production is directly influenced by the intensity of photosynthesis which has the ability to fix light energy in the visible spectrum (Jităreanu and Toma, 2007). It should also be mentioned that the variants treated with biostimulants presented at harvest a firmer appearance of the leaves, a higher consistency and a longer shelf life. Biostimulant not only improve photosynthetic activity, production but also resistance to a number of abiotic and biotic factors that may interfere with the stress resistance mechanism of plants (Boehme *et al*, 2008; Kolomazník *et al*, 2012). This fact is demonstrated by the results obtained from the analysis of the content of flavonoid pigments which according to numerous studies (Lyszkowska *et al*, 2008; Moța *et al*, 2013; Dudaš *et al*, 2016) have the function of protecting the plant from stressors. The two varieties showed the highest values in the variants treated with biostimulants (*figure 6*).

When applying the Wuxal Ascofol biostimulant, the content of flavonoid pigments recorded the highest values, which demonstrates that it has a higher degree of resistance to potential biotic or abiotic stressors for the varieties studied.

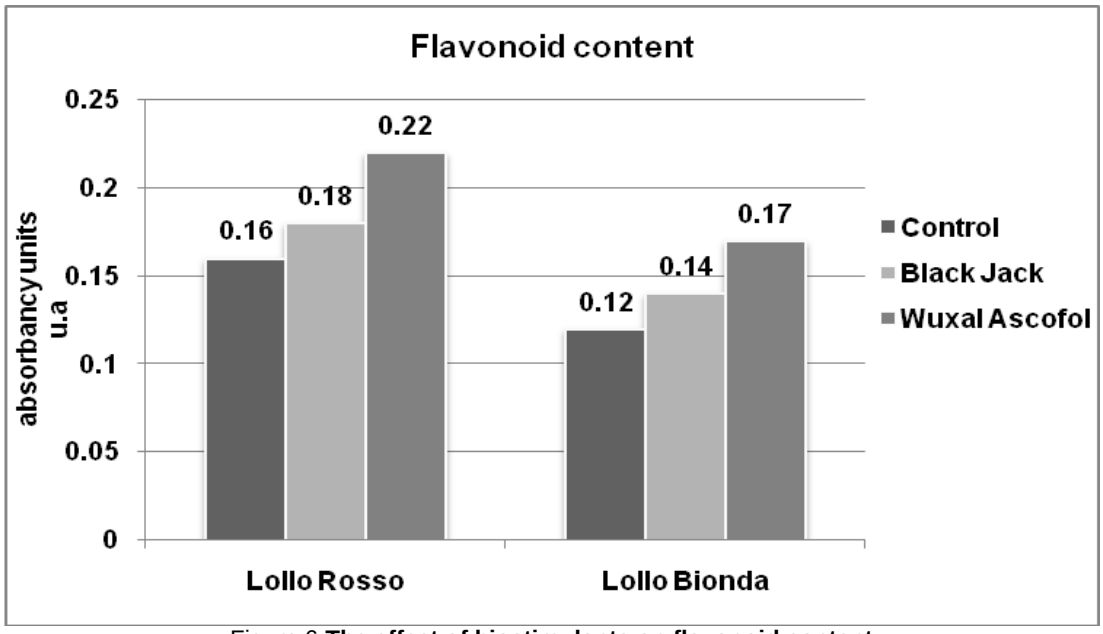

Figure 6 **The effect of biostimulants on flavonoid content**

CONCLUSIONS

Analysis of the total chlorophyll content index showed that the *Lollo Rosso* salad variety performed better in foliar application of the *Wuxal Ascofol* biostimulant, recording the highest values, while the *Lollo Bionda* variety recorded the highest chlorophyll content after root application of *Black Jack* treatment.

Variants treated with biostimulanys show high values for the components of the absorption center as well as for the components of the reaction center within the photosynthetic systems, which indicates a high storage capacity of light energy and a high potential for accumulation of organic substances that will ensure the premise of a high production.

The content of flavonoid pigments was higher in the treated variants, which indicates an increase in the degree of tolerance to stressors abiotics and biotics for the two lettuce varieties studied under the direct action of biostimulants.

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OPTIMIZATION OF SWEET POTATO (*IPOMOEA BATATAS* L.) *IN VITRO* CULTIVATION BY USING THE CONTAMINATED CULTURES FOR OBTAINING NEW SHOOTS IN GREENHOUSE CONDITIONS

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Abstract

The artificial media used for plant tissue cultures contains numerous nutrients that can create favorable conditions for the development of pathogens. As antibiotic use is not encouraged, a new strategy has been tried to reduce the losses caused by the presence of microbial infections in *"in vitro"* cultivation of sweet potato. This consisted in the transplantation in greenhouse conditions of sweet potato plantlets from contaminated *"in vitro"* cultures, in order to obtain new shoots. Five sweet potato varieties were used in this study, and two types of substrate for planting: pearlite and a mixture of peat and pearlite (1:1). The survival rate of the plantlets was 100% on the substrate consisting only of pearlite. The surviving sweet potato plants had a rapid growth rate, the greenhouse conditions being favorable for this culture. Approximately two months after transplantation, the obtained shoots could be used as a source of explants to initiate new *"in vitro"* cultures. Regarding the number of shoots the highest value was obtained by the Yulmi variety. The length of the shoots varied according to the variety, thus the highest value was recorded by the KSC1 variety (98.30 cm) . The number of buds/shoot is strongly influenced by the variety. In some sweet potato varieties the distance between buds is smaller, and in others larger, this being a characteristic of the variety. Regarding this trait the best results were obtained in Juhwangmi variety. By applying this method, the process of sweet potato *"in vitro"* multiplication becomes more economically efficient. After only a few weeks under greenhouse conditions, involving minimal costs, many shoots can be obtained.

Key words: plant tissue culture, microbial contamination, plantlets, greenhouse, sweet potato

Tissue culture has many advantages such as production of disease-free planting materials in large numbers hence permits rapid dissemination of healthy and improved plants within and among countries, as the materials are readily certified as disease-free (Ogero *et al*., 2012; Rahman *et al.*, 2017; Naik and Karihaloo, 2007). Plant tissue culture is uniquely suited for obtaining and maintaining mass propagation of specific pathogen-free plants (Mervat, 2007). Traditionally, cuttings are obtained from the shoots grown from tubers buried in warm, humid soil (25–28 °C) or from plants grown in greenhouses (Ching, 2000; Novac *et al*. 2007; Doliński and Olek, 2013). A solution which makes it possible to produce larger numbers of uniform, healthy plants is ”*in vitro”* culture.

Sweet potato can be propagated by stimulating the development of apical and axillary buds, by means of adventitious buds and by somatic embryogenesis (Gosukonda *et al*., 1995; González *et al*., 1999; Mukherjee, 2002, Doliński and Olek, 2013). This technique is based on the principle that appropriate culture conditions induce the growth of a pre-existent terminal or axillar buds, resulting in a new plantlet. The nutritional and hormonal conditions of the medium break the bud dormancy and promote its rapid growth (Vollmer, 2010). However, sweet potato is highly recalcitrant in generation and response to tissue culture (Abubakar *et al*, 2018). A number of factors including genotypes, nature and doses of different growth regulators are found to determine the rate and nature of regeneration of sweet potato (Shaibu *et al*, 2016).

The use of nodal explants may promote direct regeneration of plantlets (Yadav, 2009). However, microbial contamination would be very high due to large size of the explant (Amissah *et al*, 2016). Studies indicate that ”*in vitro”* cultures of sweet potato are prone to microbial contamination emanating from both endogenous and exogenous sources, which leads to culture mortality (Jena and Samal, 2011; Rojas, 2010).

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MATERIAL AND METHOD

The study was conducted at the National Institute for Research and Development for Potato and Sugar Beet Brasov, within the Research Laboratory for Plant Tissue Cultures. As a biological material, 5 korean sweet potato varieties were used: Juhwangmi, KSP1, KSC1, Yulmi and Hayanmi. The initial material consisted in plantlets from *"in vitro"* cultures contaminated with microbial infections (*figure 1*). Sweet potato plantlets were planted in pots placed in the greenhouse, on two types of substrate: peat and pearlite (1:1) and pearlite. They were about 10-11 cm high, with well developed leaves and roots (f*igure 2*).

Figure 1 **Sweet potato plantlets from "*in vitro*" contaminated culture**

Before planting the roots were carefully cleaned, removing the culture media, without damaging the roots. It is important to remove the culture media because it prevent the absorption of nutrients from the culture substrates by roots. Each pot contained a single sweet potato plantlet. The substrate was kept moist, and two weeks after planting a complex fertilizer NPK 16:16:16+sulfur (12 g/l) was applied. The survival rate of sweet potato plantlets after transplantation was higher when the pearlite substrate was used, compared to the peat and pearlite mixture. Pearlite is a horticultural substrate, an inorganic material, recommended for improving soil quality. Pearlite is obtained by thermal processing of siliceous volcanic rocks. The mineral extracted from the deposits contains 2-5% bound water; heated to 1200 °C, it expands, becoming a porous material, granulated with a bulk density of 130-180 kg/m^3 (Atanasiu, 2007). Substrates containing pearlite are well drained and aerated. The pearlite granules have good physical stability and are chemically inert. The pearlite granules are also used for the preparation of mixed culture substrates by mixing with some organic materials (peat).

Figure 2 **Sweet potato plantlets transplantation in greenhouse conditions**

The surviving plants had a fast growth rate, the greenhouse conditions being favorable for this culture. Approximately two months after transplantation, the obtained shoots could be used as a source of explants to initiate new *"in vitro"* cultures (f*igure 3*).

Figure 3 **Sweet potato shoots obtained in greenhouse conditions starting from *"in vitro"* plantlets (one month after transplantation – top; two and a half months after transplantation – bottom)**

After detaching the shoots from the mother plant, they are washed with tap water to remove soil and other impurities, then the leaves are removed, keeping a small part of the petiole, which has the role of protecting the buds during sterilization. The shoots are fragmented into uninodal stem cuttings. Sterilization consists of immersing explants in sodium hypochlorite solution (1%) for 15 minutes followed by immersion in ethyl alcohol (70%) for 5 minutes. After sterilization, the cuttings are rinsed in 3-4 rounds with sterile distilled water and then inoculated on the culture

media. After approximately 3-4 weeks of cultivation under controlled conditions (24-26 °C; photoperiod of 16 hours light and 8 hours dark) new sweet potato plantlets can be obtained (f*igure 4*).

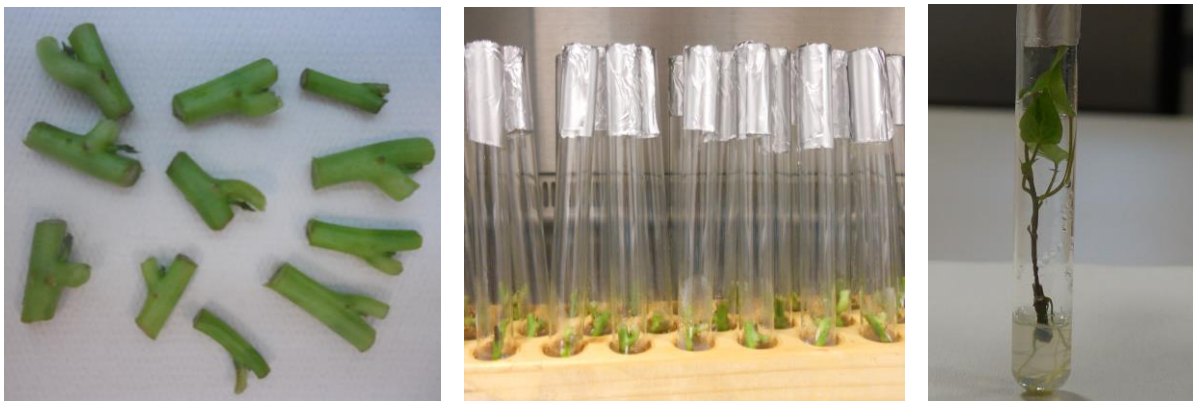

Figure 4 **Inoculation of explants on culture media and obtaining healthy sweet potato plantlets from shoots grown in greenhouse conditions**

RESULTS AND DISCUSSIONS

In order to optimize the sweet potato micropropagation technology, a cheap and easy method of obtaining shoots under greenhouse conditions was tested starting with plantlets from *"in vitro"* cultures contaminated with microbial infections. Thus, the losses caused by microbial contamination can be reduced by using these plantlets, which would otherwise have been eliminated, in order to obtain a source of explants.

In this study several aspects were pursued: the percentage of survival, on the two types of substrate, of plantlets from contaminated *"in vitro"* cultures, following their transplantation under greenhouse conditions, as well as the number of shoots obtained according to variety, shoots length and number of buds.

The survival rate of sweet potato plants was 100% in the case of using pearlite as substrate, for all 5 studied varieties. Regarding the use as substrate of peat and pearl mixture, for some varieties (Yulmi, Hayanmi and KSC1) the survival rate was 50%, while for other varieties (KSP1 and Juhwangmi) the survival percentage was 100% (*table 1*).

Table 1

The survival rate of sweet potato plantlets after tranplantation in greenhouse conditions

Variety	The survival rate of plantlets (%)	
	Peat+pearlite (1:1)	Pearlite
Yulmi	50	100
Hayanmi	50	100
KSC1	50	100
KSP1	100	100
Juhwangmi	100	100

In addition to the survival rate of plantlets after transplanting under greenhouse conditions, other growth parameters were followed: the number of shoots, shoots length and the number of buds/shoot. The average of the five varieties was considered the control variant. In *tables 2, 3* and *4* are presented the results regarding the evolution of these traits, three and a half months after planting. Regarding the number of shoots, there were no significant differences between the analyzed varieties (*table 2*). However, the highest number of shoots was obtained by the Yulmi variety, and the lowest was recorded in the KSC1 and KSP1 varieties.

Table 2

Effect of sweet potato variety on shoots number/pot

Variety	Shoot number		
	Average number	Diff.	Signif.
Mean (Ct)	1.47	-	-
Yulmi	2.33	0.86	ns
Hayanmi	1.33	-0.14	ns
KSC1	1.00	-0.47	ns
KSP1	1.00	-0.47	ns
Juhwangmi	1.67	0.20	ns

LSD5% = 0.59 shoots; 1% = 0.83 shoots; 0.1% = 1.18 shoots

Regarding the length of the shoots, there were significant differences between the analyzed varieties (*table 3*). Thus, the best results were recorded by the KSC1 variety (98.30 cm), which presented a distinct positive difference (35.72 cm) compared to the control, and the lowest values were recorded by the Hayanmi variety (32.98 cm), which presented a distinct negative difference (-29.60 cm).

Table 3

Effect of sweet potato variety on shoots length

Variety	Shoots length (cm)		
	Average length (cm)	Diff. (cm)	Signif.
Mean (Ct)	62.58	-	-
Yulmi	61.09	-1.49	ns
Hayanmi	32.98	-29.60	oo
KSC1	98.30	35.72	**
KSP1	57.80	-4.78	ns
Juhwangmi	62.75	0.17	ns

LSD 5% = 18.07 cm; 1% = 25.37 cm; 0.1% = 35.82 cm

Measurements on the number of buds/shoot were also made (*table 4*). In this case there were a significant positive difference between Juhwangmi variety (7.94 buds/shoot) and control, and a significant negative difference for Yulmi variety (-6.28 buds/shoot).

Table 4

Effect of sweet potato variety on number of buds/shoot

Variety	Number of buds/shoot		
	Average number	Diff.	Signif.
Mean (Ct)	16.89	-	-
Yulmi	10.61	-6.28	o
Hayanmi	22.33	5.44	ns
KSC1	13.67	-3.22	ns
KSP1	12.67	-4.22	ns
Juhwangmi	24.83	7.94	*

LSD5% = 5.68 buds; 1% = 7.98 buds; 0.1% = 11.26 buds

Regarding the number of buds/shoot, this trait is strongly influenced by the variety. In some sweet potato varieties the distance between the buds is smaller, and in others larger, this being a characteristic of the variety. In the case of the varieties analyzed in this study, in Juhwangmi and Hayanmi the buds are arranged closer to each

other, while in Yulmi, KSP1 and KSC1 the buds are farther apart.

Plantlets from contaminated *"in vitro"* cultures, which would otherwise have been eliminated, are used to obtain new sweet potato plants. In this way the technology of ”in vitro” micropropagation of the sweet potato can be optimized successfully).

CONCLUSIONS

The application of plant tissue culture technology has an important contribution to *”in vitro”* production, multiplication and conservation of healty sweet potato plants for commercial, research and other purposes. Sweet potato offers strategic opportunities to improve nutrition and rural incomes in several countries and regions all over the world. It is already an important component of the cropping systems because of its robustness to produce under difficult conditions and it will become more important in the face of a changing climate. Thus, it is very important to make the *”in vitro”* multiplication technology of sweet potato more efficient.

Microbial contamination could occur at any stage of *”in vitro”* micropropagation systems. Sweet potato plantlets from contaminated *"in vitro"* cultures, which can no longer be used in the micropropagation process, can be used to obtain new sweet potato plants by transplantation in greenhouse, using pots with different substrates. Due to the fact that the sweet potato is characterized by the rapid growth and the active formation of the roots that gives a higher survival rate of the plantlets, the process of microplants acclimatization is quick and easy. ”*In vitro”* formed roots have an important role in acclimatization and survival of sweet potato plantlets. These not only survived transfer to the substrate but elongated, formed secondary and tertiary roots, are functional during acclimatization and contributes significantly to the early growth of transplants ”*ex vitro”*.

After only a few weeks of cultivation under greenhouse conditions, involving minimal costs, many shoots can be obtained which, after being removed from the mother plant, are sterilized and reintroduced into the micropropagation process under *"in vitro"* conditions, as nodal cuttings. Only one plantlets was planted in each pot, but three or more plantlets/pot can be planted. Thus, the number of shoots and respectively the number of buds/shoots that can be obtained is higher, and the process becomes more efficient. Mother plants can remain in pots, generating new shoots, until we get the desired number of explants. By applying this method, the process of *"in vitro"* sweet potato multiplication becomes more economically efficient.

Considering the results obtained in this study, the *"in vitro"* sweet potato multiplication process can be optimized by applying this method.

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RESEARCH REGARDING THE INFLUENCE OF GENOTYPE X EPOCH OF SOWING X DISTANCE BETWEEN ROWS ON SEEDS YIELD AT *RICINUS COMMUNIS* L. (CASTOR BEAN)

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Abstract

The researches were organized in 2018-2019 at the Moldoveni Agricultural Society, Neamt County. Analyzing the influence of the distance between rows at castor bean, it results that at greater distances yield deficits are obtained, so when the plant nutrition area is increased, the branching is stronger and the yield obtained from the main raceme decreases, increasing instead the production of secondary racemes. The results obtained on average over the two years of experimentation show us that the highest production was obtained for the variant sown at 70 cm between rows (1460 kg / ha), which indicates that castor bean responds favorably at this distance. The average productions obtained in the analyzed period were directly influenced by the experienced technological factors. These varied in limits between 1036 kg / ha (Rivlas x the fourth epoch x 100 cm between rows) to 1650 kg / ha (Christian x the second epoch x 70 cm between rows).

Key words: yield, castor bean, technological factors

Castor bean (*Ricinus communis* L.) oil is distinct from other vegetable oils, mainly because it consists of up to 90% of a hydroxylated fatty acid called ricinoleic acid (Severino L.S. *et al*, 2012), and it has many applications in the chemical industry, including biodiesel production (Baldwin B.S., Cossar R.D., 2009).

The castor bean plant is tolerant to drought and adapted to many cropping conditions (Babita M. *et al*, 2010; Carvalho E.V. *et al*, 2010). The optimization of row spacing and in-row plant density is a simple procedure with a low cost but has a significant influence on yield (Severino L.S. *et al*, 2006a; Severino L.S. *et al*, 2006b; Severino L.S. *et al*, 2012) and is essential to maximize seed production (Cox W.J., Cherney J.H., 2011). A high plant density may result in overgrown plants (Carvalho E.V. *et al*, 2010) and subsequent lodging, whereas a low plant population may favor weed infestation, late flowering, long lateral branches, and wide stems, which impair mechanical harvesting (Lopes F.F.M. *et al*, 2008; Severino L.S. *et al*, 2006b; Severino L.S. *et al*, 2012). Light interception by plants strongly influences the crop yield when other environmental factors are favorable, and it is modified by the plant spatial distribution in a given area (Severino L.S. *et al*, 2006a; Severino L.S. *et al*, 2006b; Severino L.S. *et al*, 2012).

MATERIAL AND METHOD

A factorial experiment was organized in 2018-2019 at the Moldoveni Agricultural Society, Neamt County, using a subdivided plotsin 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 and the distance between the rows.

Factor A: Genotype, with 4 graduations:

a1 – Dragon variety;

a2 – Rivlas variety;

a3 – Cristian variety;

a4 – Teleorman variety.

Factor B: Epoch of sowing, with 4 graduations:

b1 - sown in the first decade of April;

b2 - sown in the second decade of April;

b3 - sown in the third decade of April;

b4 - sown in the first decade of May.

Factor C: The nutrition space, with 3 graduations:

c1 - 50 cm between rows;

c2 - 70 cm between rows;

c3 - 100 cm between rows.

The obtained results were processed and

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interpreted statistically according to the method of analysis of variance.

Table 1

The influence of the interaction between genotype x sowing season x distance between rows on castor bean bean production, average years

Variety	Epoch of sowing	Distance between rows (cm)	Production (kg/ha)	%	Diff. (kg/ha)	Sign
Dragon	1st epoch	50	1446	98.13	-28	
		70	1492	101.26	19	
		100	1371	93.09	-102	ooo
	2nd epoch	50	1534	104.13	61	**
		70	1623	110.19	150	***
		100	1421	96.44	-53	o
	3rd epoch	50	1399	94.96	-74	oo
		70	1488	101.03	15	
		100	1286	87.27	-188	ooo
	4th epoch	50	1249	84.76	-225	ooo
		70	1338	90.82	-135	ooo
		100	1135	77.06	-338	ooo
Rivlas	1st epoch	50	1346	91.37	-127	ooo
		70	1392	94.49	-81	ooo
		100	1272	86.32	-202	ooo
	2dn epoch	50	1434	97.36	-39	
		70	1524	103.43	51	*
		100	1321	89.67	-152	ooo
	3rd epoch	50	1299	88.20	-174	ooo
		70	1389	94.26	-85	ooo
		100	1186	80.50	-287	ooo
	4th epoch	50	1149	77.99	-324	ooo
		70	1238	84.06	-235	ooo
		100	1036	70.30	-438	ooo
Cristian	1st epoch	50	1472	99.94	-1	
		70	1518	103.07	45	*
		100	1398	94.90	-75	oo
	2dn epoch	50	1561	105.94	88	***
		70	1650	112.00	177	***
		100	1447	98.25	-26	
	3rd epoch	50	1426	96.78	-48	o
		70	1515	102.84	42	*
		100	1312	89.08	-161	ooo
	4th epoch	50	1275	86.57	-198	ooo
		70	1365	92.63	-109	ooo
		100	1162	78.88	-311	ooo
Teleorman	1st epoch	50	1418	96.25	-55	oo
		70	1464	99.38	-9	
		100	1344	91.21	-130	ooo
	2dn epoch	50	1506	102.25	33	
		70	1596	108.32	123	***
		100	1393	94.56	-80	ooo
	3rd epoch	50	1371	93.09	-102	ooo
		70	1461	99.15	-13	
		100	1258	85.39	-215	ooo
	4th epoch	50	1221	82.88	-252	ooo
		70	1310	88.95	-163	ooo
		100	1108	75.19	-366	ooo
Average			1373	100	Ct.	
LSD AXBXC (kg/ha)			5%=41.33; 1%=57.20; 0.01%=79.94			

RESULTS AND DISCUSSIONS

The average productions obtained in the analyzed period were directly influenced by the experienced technological factors. These varied in limits between 1036 kg/ha (Rivlas x 4th epoch of sowing x 100 cm between rows) to 1650 kg/ha (Christian x 2nd epoch of sowing x 70 cm between rows) *(table 1).*

The production increases obtained for the variants sown in the second epoch and at the distance of 70 cm between the rows were between 51 - 177 kg/ha, statistically assured and interpreted as significant and very significant *(table 2).*

On average, over the two years of experimentation, the average height of plants in the Dragon variety in the version sown in the first x 50 cm was 133 cm, but by increasing the distance between rows the height of the plant increases to 173 cm. Also for the Dragon variety, the average length of the main raceme ranged from 25.4 cm (4th epoch x 100 cm) to 39.9 cm (2nd epoch x 70 cm), the average number of capsules / plant was between 36 - 48 and the average number of seeds / plant varied between 109 - 144 *(table 2).*

During the experimented period, on average for the two years, it can be observed that the varieties Rivlas, Cristian and Teleorman obtained the highest number of capsules per plant in the variant sown in the second epoch x 70 cm (47, 52 and 55), and the lowest number of capsules / plant in the variant sown in the 4th epoch x 100 cm (35, 38 and 40) *(table 2).*

Table 2

Biometric measurements performed during the growing season on experienced castor bean varieties, average years

Variety	Epoch of sowing	Distance between rows (cm)	Plant height (cm)	Main racem insert height (cm)	Length of the main raceme (cm)	Branches	No capsule /pl.	Nr. seeds. / pl
Dragon	1st epoch	50	133	79.8	29.1	0	44	132
		70	149	81.5	28.1	0	45	135
		100	163	81	27.6	2	42	126
	2nd epoch	50	153	78.5	29	0	46	137
		70	164	89.3	39.9	0	48	144
		100	173	91.5	28.9	2	43	129
	3rd epoch	50	145	77	27.2	0	43	129
		70	155	82.1	30.8	0	45	136
		100	168	88.5	26.8	1	40	120
	4th epoch	50	140	73.5	25.7	0	39	117
		70	149	76.4	26.6	0	42	125
		100	162	85.5	25.4	0	36	109
Rivlas	1st epoch	50	136	86.3	24.6	0	42	127
		70	151	88.6	27	0	44	131
		100	166	93.4	25.9	1	41	122
	2nd epoch	50	153	88.6	28.6	0	45	135
		70	164	92.3	35.9	0	47	142
		100	174	93.9	27.8	2	42	125
	3rd epoch	50	147	82.5	27.6	0	42	124
		70	157	87.6	31.5	0	44	131
		100	170	91.3	25.4	0	38	115
	4th epoch	50	142	79.3	25.1	0	38	113
		70	151	73.6	31.8	0	41	121
		100	164	82.6	24.6	0	35	104
Cristian	1st epoch	50	143	66.2	29.2	0	47	140
		70	141	69	28.6	0	48	144
		100	170	71.7	25.8	1	45	134
	2nd epoch	50	142	70.2	29.7	0	49	147
		70	160	81	38.9	0	52	154
		100	170	84.9	26.7	1	46	137
	3rd epoch	50	153	61.9	26	0	45	135
		70	142	66.5	30.1	0	48	143
		100	158	75.3	23.9	0	38	113
	4th epoch	50	137	61.9	23.4	0	41	123
		70	145	69.4	28.2	0	43	130
		100	158	75.3	23.9	0	37	112
Te	1st	50	96	39.5	28.1	0	50	150

	epoch	70	105	41	27.1	0	50	149
		100	120	56.2	27.4	2	48	142
	2nd epoch	50	110	42.5	30.1	0	53	158
		70	121	63.9	30.4	0	55	166
		100	131	65.9	27.6	2	49	147
	3rd epoch	50	102	47.4	27.2	0	48	145
		70	112	58.9	29	0	51	154
		100	125	63.8	24.9	1	45	134
	4th epoch	50	97	46.5	24.6	0	42	126
		70	106	49.2	25.4	0	47	140
		100	120	56.5	18.6	0	40	120

CONCLUSIONS

Among the factors that led to the superiority of the variant sown at 70 cm between rows in the study period, we must mention the following: the possibility of mechanical tillage until advanced stages of vegetation without affecting the roots and foliar apparatus, creating access to sunlight at the lower stages of the leaves, earlier harvesting of the capsules and their uniform maturation.

Analyzing the influence of the distance between rows on castor bean, it results that at greater distances production deficits are obtained, so when the plant nutrition area is increased, the branching is stronger and the production obtained from the main raceme decreases, increasing instead the production of secondary racemes. The density must be set so as to greatly reduce the production of secondary racemes, which do not always reach maturity.

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BOTANY AND CHEMISTRY OF *FOENICULUM VULGARE* VAR. *DULCE* MILL. AND *FOENICULUM VULGARE* VAR. *VULGARE* MILL: A REVIEW

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Abstract

The *Apiaceae* family (*Umbelliferae*) comprises both vegetable and aromatic and medicinal species. Among the most used aromatic species from this family is *Foeniculum vulgare* Mill, which can be cultivated in various climatic conditions. *Foeniculum vulgare* ssp. *vulgare* Mill. can be cultivated using three varieties: *Foeniculum vulgare* var. *azoricum* Mill., also called bulbing fennel or Florence fennel, *Foeniculum vulgare* var. *dulce* Mill. with the common name of sweet fennel and *Foeniculum vulgare* var. *vulgare* Mill., this variety is known as bitter fennel due to the bitter aroma of the seeds.In this review were presented the results of various publications, reported between 1961 and 2019, on two varieties of fennel, var. *dulce* and var. *vulgare*. The publications were selected from the electronic library.Therefor in this article, various botany and chemistry differences between sweet fennel and bitter fennel have been presented.

Key words: *Foeniculum vulgare*, sweet fennel, bitter fennel, chemistry, botany

The *Apiaceae* family (*Umbelliferae*) comprises both vegetable and aromatic and medicinal species. Plants belonging to the *Apiaceae* family can be cultivated mainly in temperate regions, and less often in tropical countries. The main botanical characteristic of the species belonging to this plant family is the way the flowers are arranged, in inflorescences called umbels.

Among the most used aromatic species from this family is *Foeniculum vulgare* Mill, which can be cultivated in various climatic conditions. *Foeniculum vulgare* ssp. *vulgare* Mill. can be cultivated using three varieties: *Foeniculum vulgare* var. *azoricum* Mill., also called bulbing fennel or Florence fennel, *Foeniculum vulgare* var. *dulce* Mill. named sweet fennel and *Foeniculum vulgare* var. *vulgare* Mill., this variety is known as bitter fennel due to the bitter aroma of the seeds (Barros L. *et al*, 2010).

This plant can be grown in many parts of the world, in countries like Russia, Japan, India and China it is commercially cultivated (Damjanović B. *et al*, 2005; Coşge B. *et al*, 2008).

MATERIAL AND METHOD

Different publications presented in journals and books between 1961 and 2019 were summarized in this review. The literature was selected from electronic databases (Science Direct and Research Gate). In total were reviewed 50 scientific studies, which furnish knowledge about the botany and chemistry of 2 varieties of *Foeniculum vulgare* Mill: var. *vulgare* and var. *dulce*. It also showed that from all 50 scientific papers reviewed in this study (*figure 1*), only 20% were reported between 1961 and 2000, in 2000-2010 the literature had a share of 32%, while in the last 9 years (2010-2019) were published 48% from the studies.

RESULTS AND DISCUSSIONS

In this article, several botany and chemistry distinctions between sweet fennel and bitter fennel have been presented.

Botany

From a botanical point of view, *Foeniculum vulgare* Mill. is a perennial herbaceous plant.

The root is pivoting and can have between 20 and 30 cm length.

The stem is 1-2.5 m high, very branched, cylindrical, with fine streaks, hollow inside (*figure*

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2(b)). The leaves present very thin and filiform segments (*figure 2(c)*).

The flowers are small, grouped in large, yellow umbels. The calyx is narrow and the corolla contains 5 ovate petals, angled inwards. The 5 stamens are longer than the petals, and the gynoecium is inferior. The fruit is a greyish-green achene, with a planar convex shape, narrowed at the edge (Gildemeister E., Hoffman F.O.V., 1961).

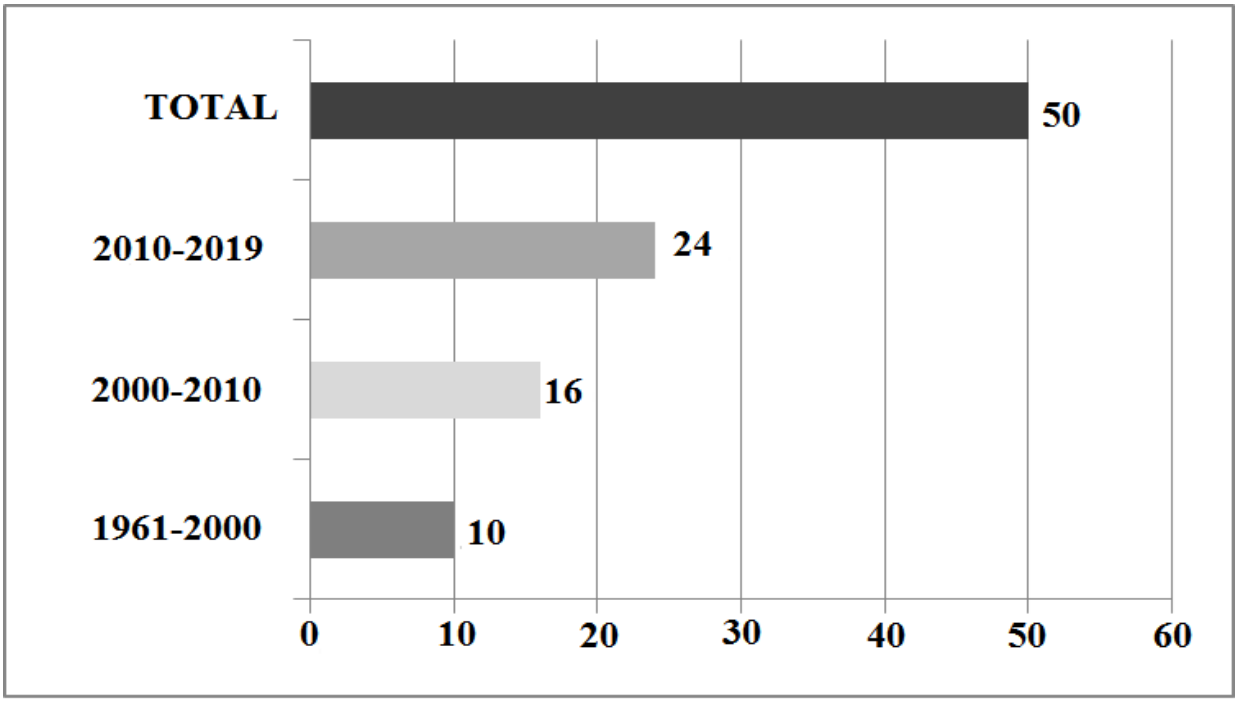

Figure 1 **Publications (1961- 2019) collected from electronic library**

The two varieties of *Foeniculum vulgare* Mill. var. *vulgare* and var. *dulce* can be botanically distinguished due to some differences. The bitter fennel present a stronger root than sweet fennel, so it can resist better during the winter temperatures. The stem height can reach 2 m at var. *vulgare* and at var. *dulce* only 1.3 m. The number of stems for the bitter fennel is 6-7 while the sweet fennel present an individual stem.

The number of umbels also vary, the sweet fennel has less umbels, but their weight is greater than the bitter one.

The vegetation period of sweet fennel is 150-160 days, and of the bitter fennel of 190-200 days, or more depending on the climatic conditions, so that in some years it may not reach maturity (Tchingova B., 1967).

Phytochemistry

Many researches have been accomplished on the chemical composition of fennel oil from various origins (Krishnamurthy K.H., 2011; Grover S. *et al*, 2013). The essential oil content varies depending on the variety and origins.

In some studies published in the literature, the volatile oil content extracted from fennel seeds was between 2 and 6% (Stănescu U. *et al*, 2004), and in other experiments the essential oil content reached up to 8,5% (Istudor V., 2001).

For the bitter variety (var. *vulgare*), the plants from Central and Eastern Europe had 3.44-7.2% volatile oil, some from India, reached 8.5%, and those of Romanian origin 4.3-5.41% volatile oil. Fruits from the sweet variety (var. *dulce*) contained less volatile oil, 1.7-3.5% (Cucu V. *et al*, 1982).

Phytochemical researches carried out on this plant resulted in the isolation of several secondary metabolites: volatile components (volatile oil), fatty acids, phenolic compounds (Gildemeister E., Hoffman F.O.V., 1961; Bodea C., 1982; Rasul A. *et al*, 2012; Bukhari H. *et al*, 2014).

The relative content of essential oil in sweet fennel fruits was about 2.05% by weight, while in case of the bitter fennel the essential oil content was 3.37% (Tchingova-Boiajieva B., 1970).

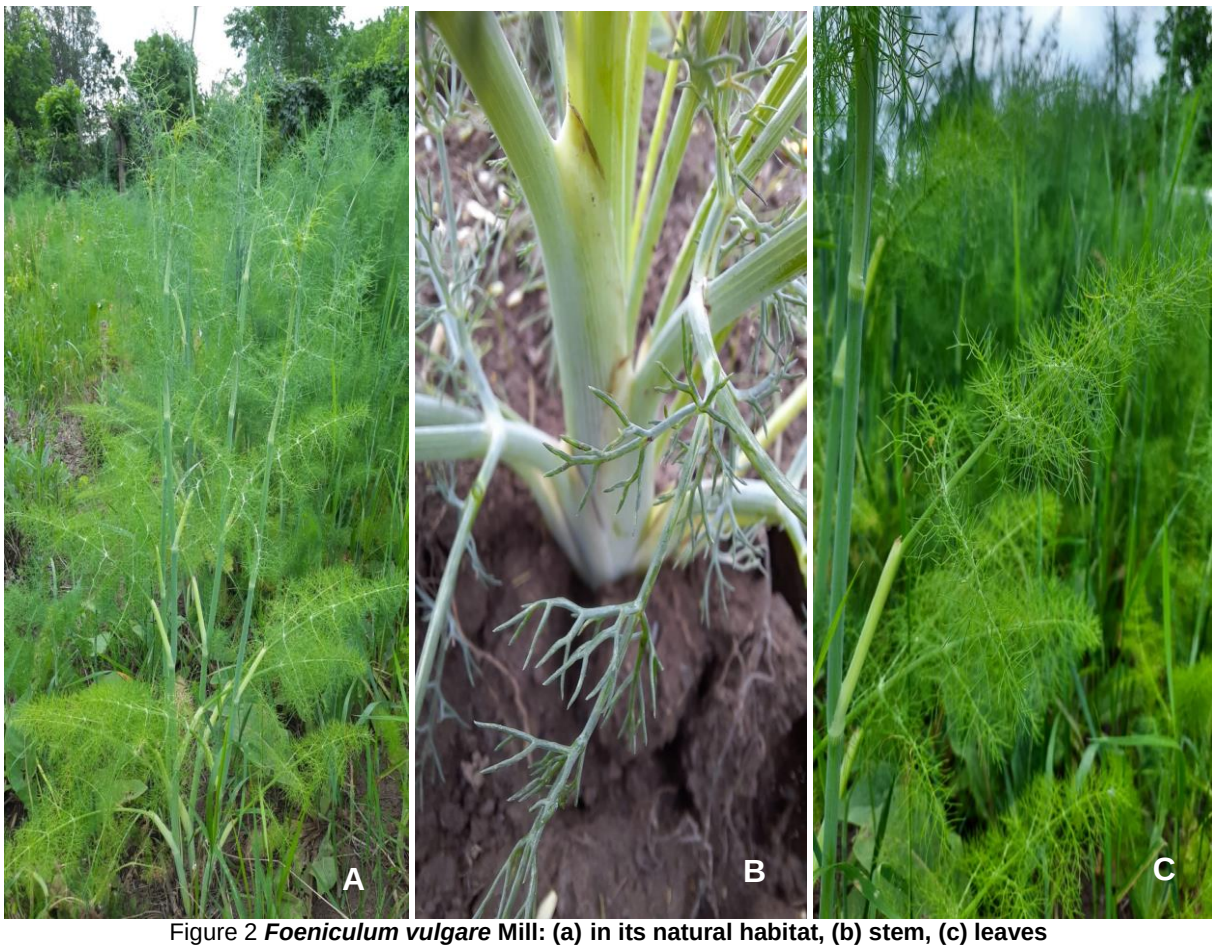

Figure 2 ***Foeniculum vulgare*** **Mill: (a) in its natural habitat, (b) stem, (c) leaves**

The main component in fennel oil is trans-anethole, which was found between 50 and 75% in var. vulgare and about 85% in var. dulce (Cucu V. *et al*, 1982).

In addition to trans-anethole, significant amounts of cis-anethole, estragole and methyl-cavicol were also detected in the essential oil (Shah C., 1970).

The chemical composition of the essential oil obtained by hydrodistillation from fennel seeds was analyzed in various studies (*table 1)* (Akgül A., Bayrak A., 1988; Damjanović *et al*, 2005; Fang L. *et al*, 2006; Singh G. *et al*, 2006; Telci I. *et al*, 2009; Zoubiri, S. *et al*, 2014).

Özcan M.M. *et al* (2006) investigated the main chemical compounds of volatile oil extracted from fennel seeds originated from Turkey: estragole (61% - 41%), fenchone (23% - 17%) and limonene (9% - 18%).

The volatile oil obtained by hydrodistillation from fennel originated from Pakistan presented in considerable amounts of trans-anethole (68%) fenchone (9.5%), estragole (4.9%) and limonene (4.5%) (Anwar F. *et al*, 2009).

The essential oil originated from Montenegro contained 62% trans-anethole, 20% fenchone, 4.9% estragole and 3% limonene (Damjanovic A.M. *et al*, 2005).

In the essential oil were found some phenylpropanoic compounds: p-methoxy phenylacetone, anisic acid, anisic ketone, dihydroxyanethol, anisic aldehyde and p-methoxy-1-phenil-1-propanol (Parejo I. *et al*, 2004; He W., Huang B., 2011; Anka Z. M. *et al*, 2019).

The fennel oil contains also some terpenic compounds: α-pinene, β-pinene, camphene, myrcene, limonene, α-phellandrene, β-phellandrene, p-cimene, linalool, terpineol and bornyl acetate (Kraus A., Hammerschmidt F.J., 1980; Shahat A.A. *et al*, 2011; Diao W.R. *et al*, 2014). The fennel fruits contain 20% fatty acids, and the specific fatty acid of the fennel fruits is petroselinic acid. The level at which this kind of acid can be found is up to 70-80% (Charvet A. S. *et al*, 1991; Reiter B. *et al*, 1998). The two varieties of *Foeniculum vulgare* Mill. var. *dulce* and var. *vulgare*, did not show differences in fatty acid composition (Coşge B. *et al*, 2008).

Table 1

Main *F. vulgare* seed essential oil components (in %) as reported in the literature

Compound	Zoubiri S. *et al*, 2014	Akgül A., Bayrak A., 1988	Telci I. *et al*, 2009	Damjanović *et al*, 2005	Singh G. *et al*, 2006	Fang L. *et al*, 2006
α-thujene	-	-	-	0.05	tr	-
α-pinene	1.22	3.18	0.12	2.81	0.2	0.42
camphene	0.19	0.93	-	0.34	tr	-
sabinene	-	-	-	0.56	tr	-
β-pinene	-	1.17	0.05	-	0.2	0.08
β-phellandrene	0.28	-	0.01	-	-	0.26
***p*-cymene**	-	1.78	-	0.28	3.1	-
limonene	6.37	2.87	2.96	3.15	3.1	6.29
1,8 -cineol	-	-	-	1.20	0.1	0.53
1,3,6 – octatriene, 3,7 –dimethyl, (E)	0.54	-	-	-	-	-
3-carene	0.17	-	-	-	-	0.11
β-ocimene	-	-	0.83	0.22	-	-
γ-terpinene	-	0.83	-	1.05	2.1	2.35
fenchone	12.93	13.85	1.19	20.30	8.6	3.28
linalool	-	-	-	-	1.2	-
camphor	0.21	-	tr	-	0.3	0.09
estragol	3.41	4.96	5.16	4.90	4.7	5.95
fenchyl acetate	0.14	-	0.13	-	0.2	0.11
***trans*-anethol**	72.86	64.71	87.85	62.00	70.1	73.2
germacrene D	-	-	-	0.18	-	-
anisketone	-	1.12	-	-	-	-
4- methoxy-benzaldehyde	-	-	-	-	-	1.99
tr: Traces (<0.05%); -: not detected						

CONCLUSIONS

The available scientific research showed that the relative content of essential oil in sweet fennel fruits is about 2.05% by weight, while in case of the bitter fennel the essential oil content is 3.37%. The oil extracted from the bitter fennel fruits is characterized by high concentrations of α-pentene and fenchone, and relatively low concentrations of trans-anethole (50%), in comparison with sweet fennel oil which contains almost 85% trans-anethole.

Regarding the botanical aspect, bitter fennel presents a stronger root in comparison with the sweet fennel, and the number of stems for the bitter fennel is 6-7 while the sweet fennel presents an individual stem.

In conclusion, this review highlights the major differences between the two fennel varieties, and as well the scientific interest on the botany and chemistry of *Foeniculum vulgare* Mill. which was internationally increased in the last decade.

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EFFECTS OF COMPLEX FERTILIZER ON YIELD COMPONENTS AND YIELD OF SOME SOYBEAN GENOTYPES

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Abstract

Fertilization is one of the main economic and health-promoting factors in crop cultivation. Field trials were carried out in 2019, in the experimental field of Soybean Breeding Laboratory from Agricultural Research and Development Station in Turda (ARDS Turda), based on a subdivided parcel design with two replications, using plots of 5 m^2. The biological material used in this study was created at ARDS Turda, 13 semi-early, early and very early soybean genotypes being evaluated: 7 varieties (Perla, Onix, Felix, Carla, Caro TD, Ada TD, Raluca TD) and 6 perspective lines (T-161, T- 295, T-165, T-6126, T-6117 and T-166). Fertilization was carried out with NPK 16:16:16 complex fertilizer applying the following doses: 150 kg/ha, 200 kg/ha, 250 kg/ha and unfertilized (Control). At the end of the growing season the genotypes were characterized by: plant height (cm), number of pods/plant, number of seeds/plant, seeds weight/plant (g), TKW (g), yield (kg/ha). The reported data is the average of 10 measurements. Statistical calculations were accomplished in Excel 2013 (Microsoft, USA) highlighting differences between studied genotypes and applied doses. The average of the seed/plant had small variations, in this year's conditions; the grain size varied between 122 g and 162 g and the maximum yield was about 3 to/ha at the dose of 200 kg/ha complex fertilizer.

Keywords: soybean, complex fertilizer, yield components, nutrient supply

Soybean *Glycine max (L.) Merrill* is apparently one of the most important cultivated crops worldwide in its agro-economic value and diverse utilities in both agriculture and industry (Choi H.K., Cook D.R., 2011). Soybean is one of the important oil grain legume crops in the world. In the international world trade market, soybean is ranked number one among the major oil crops such as rapeseed, groundnut, cotton seed, sunflower, linseed, sesame and safflower (Chung G., Singh RJ., 2008). Soybean seed composition and yield are a function of genetics, environment, and management practices, but contribution of each factor to seed composition and yield are not well understood (Yared *et al*, 2019).

Fertilization is one of the main economic and health-promoting factors in crop cultivation. High yielding soybeans require large amounts of nitrogen (N), phosphorus (P), and potassium (K) as well as a smaller amount of sulfur (S) and some micronutrients (Kahraman, 2017). Fertilization is recommended to be applied only when the soil is known to be deficient in basic nutrients (https://unctad.org/).

The aim of this study was to estimate the effects of complex fertilizer NPK 16:16:16 on quantitative traits in four different doses and the correlation between the studied traits.

MATERIAL AND METHOD

Field trials were carried out in 2019, in the experimental field of Soybean Breeding Laboratory from Agricultural Research and Development Station in Turda (ARDS Turda), based on a subdivided parcel design with two replications, using plots of 5 m^2. The biological material used in this study was created at ARDS Turda, 13 semi early, early and very early soybean genotypes being evaluated: 7 varieties (Perla, Onix, Felix, Carla TD, Caro TD, Ada TD, Raluca TD) and 6 perspective lines (T-161, T-295, T-165, T-6126, T-6117 and T-166).

Fertilization was carried out with NPK 16:16:16 complex fertilizer applying the following doses: 150 kg/ha, 200 kg/ha, 250 kg/ha, and unfertilized (Control). At the end of the growing season ten plants randomly selected from each plot were used to record data six quantitative traits: plant height (cm), number of pods/plant, number of seeds/plant, seeds weight/plant (g), TKW (g), and yield (kg/ha). The reported data, except the yield, was the average of 10 measurements. Statistical calculations were accomplished in Excel 2013

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(Microsoft, USA) highlighting differences between studied genotypes and applied doses.

Figure 1 **Study location and fertilization levels**

RESULTS AND DISCUSSIONS

Meteorological conditions have a major impact on plant growth (Popovićet *et al*., 2013a, Ikanović *et al*., 2014). Atypical climatic conditions between 1st April –30st September 2019, may be considered less favourable for soybean crop for the reference area, with consequences on yield and yield components. Temperatures and rainfall recorded a large or very large variation from one day to another and from one month to another, with large differences from the multinational average. The drought of July and September, correlated with the high temperatures of the last month of summer and the first month of autumn, forced the ripening of the genotypes taken into study (*table 1, table 2*).

Analyzing the average values of the yield and its main components, it can be observed that there are no significant differences between the three doses of fertilization and the control variant. It seems that the plant height was influenced by the applied fertilizer doses, with a small coefficient of variability in all four experimental variants. The values of the coefficients of variation calculated for the number of pods/plant respectively the number of seeds/plant indicates a small or medium variability of these characters within the analyzed biological material. Along with the number of seeds/plant, the weight of the seeds/plant and the mass of a thousand grains, they are the most important elements of yield, which contributes substantially in determining the grain production of a genotype. The coefficient of variation (CV) for the yield and 5 yield components varied from 6% to 31%, respectively. The minimum value of CV came from TKW (6%) and the greater from grain yield per plant (31%). According to Larissa Barbosa de SOUSA *et al*. (2015) the grain weight per plant had also the higher variation (CV 37.71%). The fertilizer doses impact on soybean genotypes yield in the climatic conditions of this year reveals that in average the nutritional support offered did not determine the increase of the yield.

Table 1

Temperature in Turda during 1st April 2019 – 30st September 2019

Temperature (°C)							
Month		April	May	June	July	August	September
Monthly average		11	14	22	20	22	17
Range		11.4	15.5	9.7	11.9	9.7	12.90
Range	Minimum	7	4.9	15.9	14.1	17	9.80
	Maximum	18.4	20.4	25.6	26	26.7	22.70
Monthly multiannual average (60 years)		9.9	15	17.9	19.7	19.3	15.1
Deviation from multiannual average		1.4	-1.4	3.9	0.7	2.8	1.6
Characterization of the month		warm	cool	warm	normal	warm	warm

Table 2

Rainfall in Turda during 1st April 2019 – 30 st September 2019

Rainfall (mm)							
Month		April	May	June	July	August	September
Monthly average		4.82	7.26	5.73	3.50	9.11	3.12
Range		13.8	24.2	24.8	15	24.4	14.40
Range	Minimum	0.4	0.2	0.2	0.2	1.2	0.00
	Maximum	14.2	24.4	25	15.2	25.6	14.40
Monthly multiannual average (60 years)		45.9	68.7	84.8	77.1	56.5	42.5
Deviation from multiannual average		16.7	83.7	-16	-42.1	7.2	-12.7
Characterization of the month		very rainy	excessive rainfall	slightly dry	excessive drought	slightly rainy	dry

Analyzing the average values of the yield and its main components, it can be observed that there are no significant differences between the three doses of fertilization and the control variant. It seems that the plant height was influenced by the applied fertilizer doses, with a small coefficient of variability in all four experimental variants. The values of the coefficients of variation calculated for the number of pods/plant respectively the number of seeds/plant indicates a small or medium variability of these characters within the analyzed biological material. Along with the number of seeds/plant, the weight of the seeds/plant and the mass of a thousand grains, they are the most important elements of yield, which contributes substantially in determining the grain production of a genotype. The coefficient of variation (CV) for the yield and 5 yield components varied from 6% to 31%, respectively. The minimum value of CV came from TKW (6%) and the greater from grain yield per plant (31%). According to Larissa Barbosa de SOUSA *et al*. (2015) the grain weight per plant had also the higher variation (CV 37.71%). The fertilizer doses impact on soybean genotypes yield in the climatic conditions of this year reveals that in average the nutritional support offered did not determine the increase of the yield (*table 3*, *table 4*). The correlation coeficient is a statistical estimate which measures how linear is the association between two variables (Ramalho *et al*, 2012). By analyzing the relationship between yield components and yield there can be observed some strength correlation between studied characters with positive sign.

Table 3

Data analysis for plant height (cm), number of pods/plant and number of seeds/plant (complex fertilizer NPK 16:16:16)

	Plant height (cm)				Number of pods/plant				Number of seeds/plant			
	150 kg/ha	200 kg/ha	250 kg/ha	Control	150 kg/ha	200 kg/ha	250 kg/ha	Control	150 kg/ha	200 kg/ha	250 kg/ha	Control
Mean	64	66	67	67	22	25	25	25	54	61	62	62
Standard Deviation	5.10	5.16	4.27	4.13	3.25	5.30	2.79	3.32	8.57	15.12	8.35	9.91
Range	17	19	15	13	11	19	8	10	28	51	24	32
Minimum	57	56	60	60	17	18	22	20	38	42	51	49
Maximum	74	75	76	73	28	37	30	30	66	93	76	81
CV%	8	8	6	6	15	21	11	13	16	25	13	16

Table 4

Data analysis for seeds weight/plant (g), TKW (g) and yield (kg/ha) (complex fertilizer NPK 16:16:16)

	Seeds weight/plant (g)				TKW (g)				Yield (kg/ha)			
	150 kg/ha	200 kg/ha	250 kg/ha	Control	150 kg/ha	200 kg/ha	250 kg/ha	Control	150 kg/ha	200 kg/ha	250 kg/ha	Control
Mean	7	9	9	8	140	143	141	137	2069	2277	2078	2280
Standard Deviation	1.34	2.67	1.50	1.58	9.83	12.30	12.73	10.48	256.81	400.65	365.73	148.41
Range	5	10	5	5	33	33	37	31	844	1465	1294	540
Minimum	5	5	7	6	122	129	125	122	1694	1533	1532	1924
Maximum	10	15	11	11	154	162	162	153	2538	2998	2827	2464
CV%	18	31	17	19	7	9	9	8	12	18	18	7

The sumarized data for 13 soybean genotype (*table 5, table 6)* showed that the highest values for correlation coefficient were obtained at the 200 kg/ha fertilizer doses. The positive correlations were observed for number of seeds/plant that corelates significant with: plant height (cm) (r=0.75) and number of pods/plant (r=0.98). The seeds weight/plant presented a pozitive correlation with the plant height (r=0.75), number of pods/plant (r=0.97) and number of seeds/plant (r=0.96).

Table 5

Correlation coefficients (r) for yield and yield components at 13 soybean genotypes (fertilized with NPK 16:16:16)

Quantitative traits	150 kg/ha						200 kg/ha					
	Plant height (cm)	Number of pods/ plant	Number of seeds/ plant	Seeds weight /plant (g)	TKW (g)	Yield (kg/ ha)	Plant height (cm)	Number of pods/ plant	Number of seeds/ plant	Seeds weight/ plant (g)	TKW (g)	Yield (kg/ ha)
Plant height (cm)	1						1					
Number of pods/ plant	0.12	1					0.70**	1				
Number of seeds/ plant	0.11	0.96***	1				0.75**	0.98***	1			
Seeds weight/ plant (g)	0.17	0.89***	0.87***	1			0.75**	0.97***	0.96***	1		
TKW (g)	-0.10	0.12	0.00	0.43	1		0.34	0.51	0.43	0.63*	1	
Yield (kg/ha)	0.59*	0.07	0.09	0.14	0.02	1	-0.13	-0.11	-0.15	-0.24	0.47	1

Table 6

Correlation coefficients (r) for yield and yield components at 13 soybean genotypes (fertilized with NPK 16:16:16)

Quantitative traits	250 kg/ha						0 kg/ha (Control)					
	Plant height (cm)	Number of pods/ plant	Number of seeds/ plant	Seeds weight / plant (g)	TKW (g)	Yield (kg/ha)	Plant height (cm)	Number of pods/ plant	Number of seeds/ plant	Seeds weight / plant (g)	TKW (g)	Yield (kg/ ha)
Plant height (cm)	1						1					
Number of pods/ plant	0.66*	1					0.67*	1				
Number of seeds/ plant	0.62*	0.96***	1				0.82**	0.89**	1			
Seeds weight/ plant (g)	0.39	0.80**	0.87***	1			0.65*	0.83**	0.89***	1		
TKW (g)	-0.31	-0.28	-0.20	0.20	1		-0.02	0.23	0.14	0.55	1	
Yield (kg/ha	0.30	0.01	0.06	-0.30	-0.44	1	0.56	0.17	0.28	-0.05	-0.46	1

The fertilization dose influenced the yield level differently, in the genotypes studied, the best results being recorded by Raluca TD variety and the T-166 line at the 200 kg/ha, NPK 16 16 16 complex fertilizer, with an increase of production of 534 kg/ha respectively 849 kg/ha compared to the unfertilized variant (*table 7*). It is observed that between the control and the dose of 150 kg/ha there are no significant differences between the obtained yields. The genotypes: Raluca TD, T-166 and T-6126 have achieved the maximum yields at the fertilization dose of 250 kg/ha (*figure 2*).

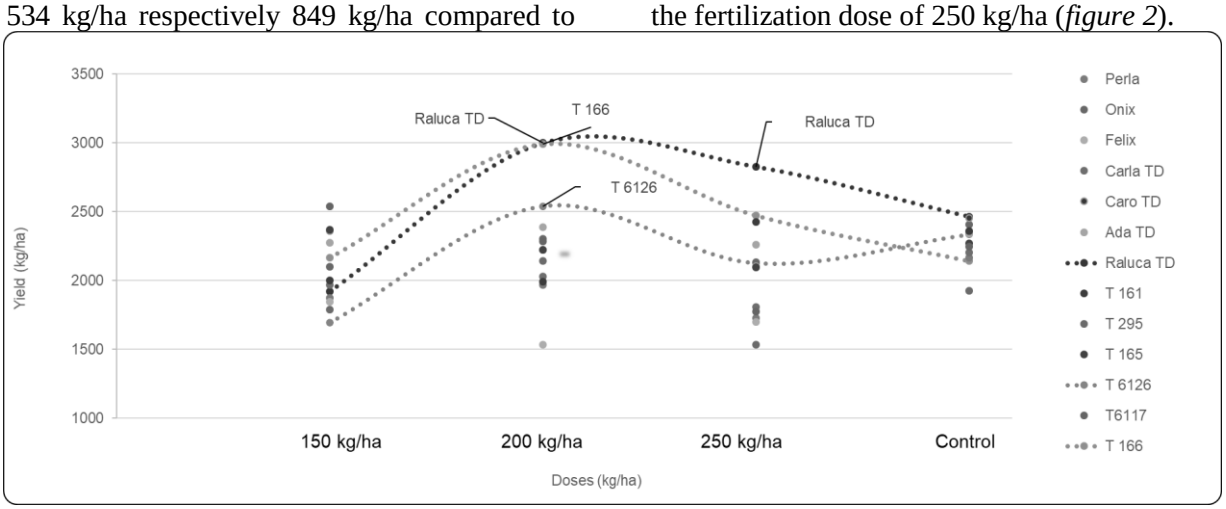

Figure 2 **Effect of complex fertilizer NPK 16:16:16 with four levels of fertilization on yield (kg/ha)**

Table 7

Effect of complex fertilizer NPK 16:16:16 with four levels of fertilization on yield (kg/ha)

Nr. Crt.	Genotype	150 kg/ha		200 kg/ha		250 kg/ha		0 kg/ha Control
		Yield (kg/ha)	Difference (kg/ha)	Yield (kg/ha)	Difference (kg/ha)	Yield (kg/ha)	Difference (kg/ha)	Yield (kg/ha)
1	Perla	1874	-290	1967	-197	1727	-436	2164
2	Onix	2102	-306	2302	-107	2132	-276	2408
3	Felix	1847	-497	1533	-811	1701	-643	2344
4	Carla TD	1966	-235	2029	-173	1805	-396	2201
5	Caro TD	2361	-92	2221	-232	2104	-349	2453
6	Ada TD	2272	-68	2386	46	2259	-81	2340
7	Raluca TD	1921	-544	2998	534	2827	362	2464
8	T 161	1998	-359	1993	-364	2426	68	2357
9	T 295	1790	-134	2143	219	1532	-392	1924
10	T 165	2371	101	2224	-45	2095	-174	2270
11	T 6126	1694	-640	2539	205	2126	-207	2334
12	T6117	2538	294	2284	39	1776	-469	2245
13	T 166	2164	24	2989	849	2471	331	2140

CONCLUSION

Given the climate change and the growing interest in soybean culture, monitoring the reaction of soybean varieties to fertilization becomes essential.

Atypical climatic conditions of the 2019 year may be considered less favorable for the soybean crop, for the reference area, with consequences on yield and yield components.

Plant height varied between 56 cm and 76 cm. Maximum number of pods/plant was 37 within the dose of 200 kg/ha complex fertilizer. Except for the dose of 150 kg/ha, in the other experimental variants, the plants had an average of 62 seeds/plant.

The average of the seed/plant had small variations, in this year's conditions; the grain size varied between 122 g and 162 g and the maximum yield was about 3 to/ha at the dose of 200 kg/ha complex fertilizer.

Genotypes that have responded positively to fertilization are Raluca TD variety and lines T166 respectively T6126.

The reaction of the genotypes to fertilization doses is different, so it is recommended to continue the experiment and the choice of genotypes and dose should be based on the results of the multiannual research.

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THE BEHAVIOR OF SOME SOYBEAN VARIETIES IN THE PEDOCLIMATIC CONDITIONS FRON THE CENTER OF MOLDAVIA

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Abstract

Soybeans is an important source of protein because the amount of protein in a hectare of soybeans is higher than in any other crop. It has a wide range of uses, and it can be used in many areas: for food production, for food and as fuel. Considering the growing interest, in recent years, for this crop, at the ARDS Secuieni a number of ten soybean varieties have been experimented, Carla TD, Larisa, Caro TD, Ilinca TD, Bia TD, Ada TD, Teo TD, Miruna TD, Felicia TD, Onix, creations of the Agricultural Research and Development Station Turda, in order to establish their adaptability to the pedoclimatic conditions of the area. On average, the factors studied greatly influenced soybean production, which varied widely, from 2687 kg/ha, to Felicia TD variety to 3409 kg/ha to Larisa variety. Regarding the correlation between soybean production and the protein production obtained, it is observed that there is a direct correlation, the correlation coefficients calculated being statistically assured and interpreted as very significant.

Key words: soybean, adaptability, production, agricultural years

Soybeans is a appreciated and demanded crop worldwide, due to its ecological plasticity (Cealac V., Budac A., 2013). In the present there is little information on the zoning of European varieties as well as their classification into maturity groups according to country and region. The classification of soybean genotypes into maturity groups is done after the vegetation period, except for China and Japan where the beginning of flowering is taken into account (Yuesheng W. *et al*, 2006). Cultivated and used for various purposes almost 5,000 years ago, is considered the miracle plant of the twentieth century, soy still focuses its attention on the importance and wide diversity for his uses (Sin G.H., 2000).

Romania is one of the few European countries that has good conditions for soybean cultivation. For the success of the soybean cultivation, in addition to beneficial climate and soil conditions, technological solutions must be found to increase the crop productivity (Walker E.R. *et al*, 2010; Bellaloui N. *et al*, 2015).

Due to the growth of the world's population, in the coming years an increase in interest in soybean cultivation is expected, is considered the main source of vegetable protein worldwide (Conner T. *et al*, 2004).

From an agronomic point of view, the species has many advantages, among which we emphasize its ability to adapt to vast growing conditions (Heiffig L.S. *et al*, 2006; Akond M. *et al*, 2013; Balbinot Junior A.A. *et al*, 2015) and his ability to fix atmospheric nitrogen.

In the present, the objectives of soybean cultivation are focused on creating varieties suitable for human consumption, with high productivity, early maturity, high tolerance to diseases and pests and good agronomic traits (Gaynor L.G. *et al*, 2011).

The soybean amelioration program at A.R.D.S. Turda has as a priority objective the creation of early, productive varieties, with a good stability of production, well adapted to the conditions of the area (Mureşanu E. *et al*, 2014).

In the present paper is presented results regarding the behavior of some Romanian soybean varieties, creations of A.R.D.S. Turda, obtained on the basis of multiannual testing in comparative crops in order to recommend in culture the best adapted soybean varieties for the area of Central Moldavia.

MATERIAL AND METHOD

The research was conducted between 2018 and 2019 at the A.R.D.S. Secuieni and aimed to establish the adaptability to the pedoclimatic conditions in Central Moldova of a number of ten Romanian soybean varieties, creations of A.R.D.S. Turda, namely: Onix (2002), Carla TD (2013), Larisa (2014), Caro TD (2015), Ilinca TD (2015),

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Bia TD (2015), Ada TD (2016), Teo TD (2017), Miruna TD (2017) and Felicia TD (2018).

The comparative culture was placed in the experimental field of the unit, on a typical faeoziom (chernozem) cambic soil, with medium texture, characterized as well supplied with phosphorus (P2O5 - 39 ppm) and mobile potassium (K2O - 161 ppm), moderately supplied with nitrogen, the soil nitrogen index being 2.1, weakly acid, with pH values (in aqueous suspension) of 6.29 and poorly fertile, with a humus content of 2.3%.

The fertilization was done with doses of 45 kg/ha a.s. of nitrogen, phosphorus and potassium, applied before the preparation of the germinativ bed. Sowing was carried out at the optimal time for this area. The prior plant had been wheat, and the sowing density was 50 germinating grains/m^2.

The cultivation technology specific to the conditions in the Central of Moldavia was respected. The data obtained were processed and interpreted statistically according to the method of analysis of variance (Ceapoiu N., 1968).

Seed quality analyzes were performed in the laboratory using the NIR DA 7250 analyzer equipped with A.R.D.S. Secuieni.

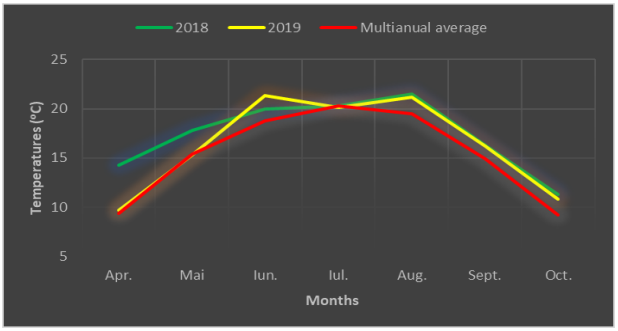

Figure 1 **Graph of temperatures recorded during soybean crop vegetation at the A.R.D.S. Secuieni**

Throughout the entire vegetation period of the soybean crop, from sowing to physiological maturity, the deviation from the multiannual average varied between 1°C (2019) and 2°C (2018). In terms of temperatures, the soybean vegetation period in the year of experimentation, compared to the multiannual average was characterized as very warm in year 2018 and warm in 2019 (*figure 1*).

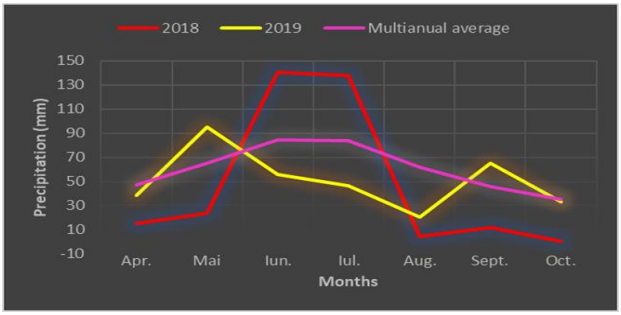

Figure 2 **Graph of precipitation recorded during vegetation at the soybean crop, at the A.R.D.S. Secuieni**

In terms of rainfall throughout the vegetation period of soybean cultivation, deviations from the multiannual average were varied, their distribution was ununiformed, and extremely uninform on the phenophase of growth and development of the plant (*figure 2*).

RESULTS AND DISCUSSIONS

The experimental results obtained at soybeans, in the analyzed period, indicate a significant difference of soybean production depending on the cultivated variety.

On average, in the two years of experimentation, the factors studied influenced the soybean production, which ranged from 2687 kg/ha (Felicia TD) to 3521 kg/ha (Bia TD). Among the studied variants, compared to the witness (Onix variety), the Larisa variety achieved a significant production increase and the Bia TD variety achieved a distinctly significant production increase, which indicates a high adaptability of the varietys to the pedoclimatic conditions of the area. Compared to the Onix variety, the Carla TD and Felicia TD varieties achieved production differences, which were statistically assured and interpreted as significantly negative (*table 1*).

Table 1

Productions recorded at soybean varieties in the pedoclimatic conditions at A.R.D.S. Secuieni

Variety	Prod kg/ha	Relative production %	Dif. kg/ha	Semnif.
Carla TD	2728	89	-329	o
Larisa	3409	112	352	*
Caro TD	3277	107	220	
Ilinca TD	3197	105	140	
Bia TD	3521	115	464	**
Ada TD	3374	110	317	
Teo TD	3056	100	1	
Miruna TD	3227	106	170	
Felicia TD	2687	88	370	o
Onix - Mt.	3057	100	-	-
DL (kg/ha)	5% 1% 0.1%	318 436 593		

Regarding the number of pods per plant, compared to the witness (Onix), one variety achieved a significant increase in production (Bia TD) and two other varieties achieved very significant production increases (Carla TD and Miruna TD). At the varieties Carla TD, Bia TD and Miruna TD, a number of pods per plant superior to the witness (Onix) were obtained, these being statistically assured and interpreted as very significant.

Regarding the weight of the grains on plant, it varied in very large limits from 10.2 gr. grains/pl. (Ada TD) up to 34.4 gr. grains/pl.

Compared to the witness (Onix), very significant increases were obtained at the varieties Carla TD, Bia TD and Miruna TD (*table 2*).

Table 2

Soybean productivity elements, average 2018-2019

Variety	Nr. pods/pl.	Nr. grain/pl.	Gr. grain/pl.
Carla TD	76.6 ***	145.9 ***	25.7***
Larisa TD	49.7	102.4 °	15.9 °°
Caro TD	32.3 °°°	70.8 °°°	10.9 °°°
Ilinca TD	43.1°°	94.3 °°°	15.2 °°°
Bia TD	60.3 *	146.8 ***	23.4 ***
Ada TD	34 °°°	71.7 °°°	10.2 °°°
Teo TD	33.4 °°°	64.1 °°°	9.9 °°°
Miruna TD	71.1 ***	184.4 ***	34.4 ***
Felicia TD	37.1 °°°	79.7 °°°	11.1 °°°
Onix	53.5 Mt.	111.4 Mt.	17.4 Mt.
DL 5% DL 1% DL 0.1%	5.7 7.8 10.6	6.9 9.5 12.9	1 1.4 1.9

The number of pods per plant was directly correlated with the weight of the grains per plant, as well as with the number of grains per plant, the correlation coefficients (r) being statistically assured and interpreted as distinctly significant (*figure 3*).

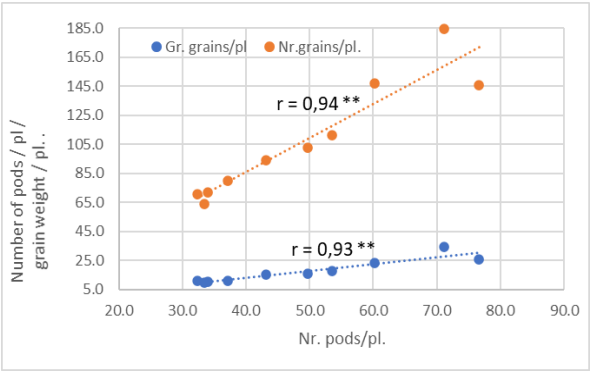

Figure 3 **Correlation between the number of pods/pl /grain weight/pl. and the number of grains/pl.**

The mass of one thousand grains in the studied varieties varied in very large limits, from 141.5 gr (Felicia TD) to 176.9 gr (Miruna TD), and the hectolitre mass varied between 75,8 kg/hl (Carla TD) and 77.5 kg/hl (Teo TD) (*figure 4*).

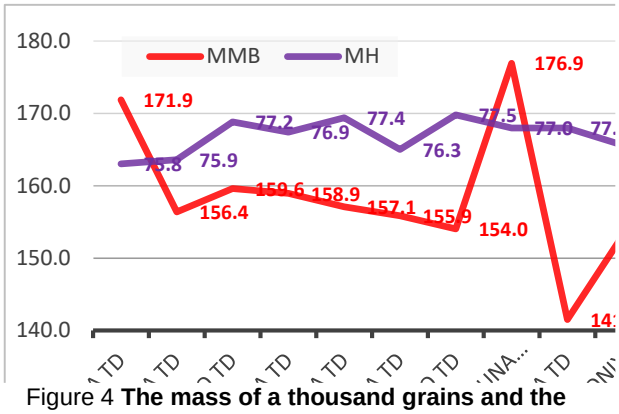

Figure 4 **The mass of a thousand grains and the hectolitre mass**

From the results obtained, it is observed that between the soybean production and the protein production obtained, there is a direct correlation, the calculated correlation coefficients were ensured statistically and interpreted as very significant.

Between the soybean production and the oil and starch production obtained, there is a direct correlation, the calculated correlation coefficients were statistically assured and interpreted as been very significant (*figure 5*).

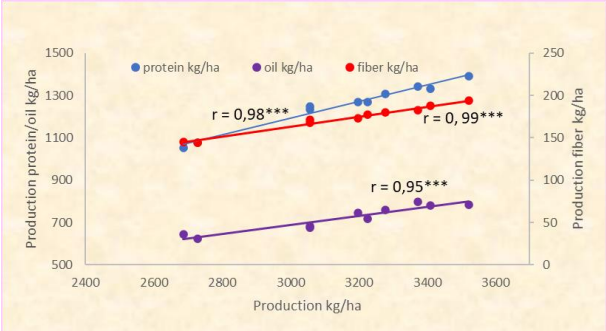

Figure 5 **Correlation between soybean seed production kg/ha and the quality of soybean production**

CONCLUSIONS

The average production of the ten soybean varieties experienced at A.R.D.S Secuieni varied in large limits, being between 2687 kg/ha at Felicia TD and 3521 kg/ha for the Bia TD variety.

Regarding the average production recorded by the ten soybean varieties studied in the period 2018-2019, the witness, the Onix variety, recorded a production of 3057 kg/ha, and the lowest productions were recorded in the case of Carla TD varieties (2728 kg/ha) and Felicia TD (2687 kg/ha), with a significant negative difference.

Higher production increases, compared to the witness (Onix), were achieved at only two varieties, Larisa TD (3409 kg/ha), which was statistically significant, and Bia TD (3521 kg/ha),

statistically assured and interpreted as distinctly significant.

The physical indices of the seed (MH and MMB) varied depending on the soybean variety, being higher in the case of MH of 77.5 Kg/hl for the Teo TD variety and respectively 176.9 g for the Miruna D variety in the case of MMB.

Soybeans is a crop that produces high yields of protein, oil and fiber, which are directly correlated with grain production.

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THE GREEN MASS AND SILAGE QUALITY OF REED CANARY GRASS, *PHALARIS ARUNDINACEA* UNDER THE CONDITIONS OF MOLDOVA

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Abstract

Reed canary grass *Phalaris arundinacea* is a cool-season, long-lived with good frost and drought tolerance, high-yielding C_3 grass species. The objective of this research was to evaluate the quality of green mass and prepared silage from reed canary grass, *Phalaris arundinacea*, cv. *Premier* grown under the conditions of the Republic of Moldova. In the third growing season, reed canary grass was characterized by high growth rate and regenerative capacity after being cut. Results revealed that harvested green mass first cut content 25.6% dry matter, but green mass second cut - 38.7% dry matter. The dry matter of the whole plant contained 109-139 g/kg CP, 74-98 g/kg ash, 368-411g/kg ADF, 616-685 g/kg NDF, 36-38 g/kg ADL, 330-375g/kg Cel and 248-274 g/kg HC. The nutritive value of natural fodder: 56.9-60.2% digestible dry matter, 11.32-11.91 MJ/kg digestible energy, 9.29-9.78 MJ/kg metabolizable energy and 5.31-5.79 MJ/kg net energy for lactation. The prepared silages were characterized by agreeable colour with pleasant smell and pH 3.98 - 4.10, it contained 30.8- 43.9 g/kg DM lactic acid, 5.8-7.2 g/kg DM acetic acid, 900-902 g/kg organic matter, 127-129 g/kg CP, 411-427 g/kg ADF, 683-704 g/kg NDF, 27-28 g/kg ADL with nutritive value: 55.6-56.9% dry matter digestibility, 11.09-11.32 MJ/kg digestible energy, 9.11-9.28 MJ/kg metabolizable energy and 5.07- 5.31 MJ/kg net energy for lactation. We found that the *Phalaris arundinacea* substrates for anaerobic digestion, have optimal C/N ratio, amount of lignin and hemicellulose. It has been established that the biomethane potential of the *Phalaris arundinacea* substrates varied from 335 to 362 l/kg ODM. Reed canary grass *Phalaris arundinacea* cv. *Premier* have good nutrient content, can be used as as natural fodder and silage for husbandry animals, also and feedstock for anaerobic digestion in biogas reactors and renewable energy production.

Key words: biochemical composition, biomethane potential, green mass, nutritive value, *Phalaris arundinacea.*

Currently, the interest in the conservation and efficient use of grassland has been restarted. Grasslands provide a variety of essential environmental benefits such as carbon storage, habitat function, limits soil erosion and improves water quality, have tremendous economic value ensuring humans food, forage for animals, and feedstock for renewable energy and biorefineries needs.

The genus *Phalaris*, family *Poaceae*, subfamily *Pooideae*, tribe *Poeae*, subtribe *Phalaridinae* contains 19-22 species, widely spread throughout the temperate and subtropical regions of the world with two centers of diversity: the Mediterranean Basin and western North America. The genus contains annual and perennial, endemic, cosmopolitan, wild, and invasive species with diploid, tetraploid and hexaploid cytotypes. In the spontaneous flora of the Republic of Moldova, there are also 2 species: *Phalaris arundinacea* L. and *Phalaris canariensis* L. (Negru A., 2007). Reed canary grass, *Phalaris arundinacea* L. (syn. *Baldingera arundinacea* (L.) Dumort; *Phalaroides arundinacea* (L.) Rauschert; *Typhoides arundinacea* (L.) (Moench) is a long-lived perennial grass, native to Europe, C_3 photosynthetic pathway. The stem is sturdy, hairless and hollow with some reddish coloring in the upper part, 60 to 200 cm tall. The leaf blades are flat with prominent ligules, usually green, flat, glabrous and taper gradually, 30-45 cm long and 0.8-1.2 cm wide. The leaves of the lower stem become light deprived as the plant grows and are replaced with new leaves higher up the stem. The inflorescence is branched panicles 7 to 40 cm long. Immature panicles are compact and resemble spikes, but open and become slightly spreading at anthesis. Spikelets are lanceolate, 5 mm long and

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pale. The fruit is a caryopsis covered by coriaceous pallets, grain 1.5-4.0 mm long, 0.7-1.5 mm wide, containing a single seed, subovoid brown with faintly striate surface, the weight of 1000 seeds averages 0.9 g. *Phalaris arundinacea* develops an extensive, rhizomatous root system. New rhizomes originate almost entirely below the soil surface from buds at the nodes of other rhizomes. A typical trait is to have quite internal airspace in roots with also very high aerenchyma amount, which facilitates both an increase of methane oxidation below ground and an increased passive methane flux to the atmosphere through the plant in wetland. Typical for this plant is its early season growth, rapid vegetative spread, high steam elongation potential, wide physiological tolerance, high architectural plasticity and longevity, adaptation to a wide range of soil types, habitats, and management systems. It is very competitive once established and will frequently develop a solid monoculture, is a valuable forage and decorative crop. The cultivation area of *Phalaris arundinacea* rapidly increases; new cultivars have reduced gramine concentrations and no tryptamine or β-carboline alkaloids. This species has been an important component of permanent and temporary grassland, it has been the subject of much agricultural research (Alway F.J., 1931; Cherney D.J.R. *et al*, 1993; Tosi H.R., Wittenberg K.M., 1993; Tokita N. *et al*, 2015; Bélanger G. *et al*, 2016). Reed canary grass has also the potential feedstock for different industrial applications, chemicals, pulp and paper production, or renewable energy (Anderson W. *et al*, 2008; Sepälä M. *et al*, 2009; Dien B.S *et al*, 2011; Kandel T.P. *et al*, 2013; Oleszek M. *et al*. 2019; Laasasenaho K. *et al*, 2020). The bulk density of reed canary grass briquettes is 746-964 kg/m^3 with calorific value 16–18 MJ/kg dry matter (Kronbergs A. *et al*, 2013; Ust'ak S. *et al*., 2019).

The objective of this research was to evaluate the quality of green mass and prepared silage from reed canary grass, *Phalaris arundinacea*, and the possibility to use green mass and silage as feed for husbandry animals and feedstock for the production of biomethane.

MATERIALS AND METHODS

The cultivar *'Premier'* of reed canary grass *Phalaris arundinacea*, created in the Research-Development Institute for Grassland Brasov, Romania and grown in monoculture on the experimental land of National Botanical Garden (Institute) Chişinău, N 46°58′25.7″ latitude and E 28°52′57.8″ longitude, served as subject of the research.

The green mass was harvested manually. The samples were collected in pre-anthesis period in third growing season. The leaves/stems ratio was determined by separating the leaves from the stem, weighing them separately and establishing the ratios for these quantities (leaves/stems). For ensiling, the green mass was shredded and compressed in well-sealed containers. After 45 days, the containers were opened, and the sensorial and chemical characteristics of prepared silages were determined in accordance with standard laboratory procedures and Moldavian standard SM 108* for forage quality analysis. Dry matter content was detected by drying samples up to constant weight at 105°C. Some assessments of the main biochemical parameters: protein, ash, acid detergent fibre (ADF), neutral detergent fibre (NDF), acid detergent lignin (ADL), have been evaluated using the near infrared spectroscopy (NIRS) technique PERTEN DA 7200 of the Research-Development Institute for Grassland Brasov, Romania. The concentration of hemicelluloses (HC) and celluloses (Cel), digestible dry matter (DDM), dry matter intake (DMI), relative feed value (RFV), digestible energy (DE), metabolizable energy (ME), net energy for lactation (NEl)) were calculated according to standard procedures.

The carbon content of the substrates was obtained from data on volatile solids, using an empirical equation reported by (Badger C.M. *et al, 1979*). The biochemical biogas potential (Yb) and methane potential (Ym) were calculated according to the equations of Dandikas V. *et al,* 2015, based on the protein (CP), acid detergent lignin (ADL) and hemicellulose (HC) values:

biogas $Yb=670+0.44CP+0.16HC-3.02ADL$

biometan $Ym=370+0.21CP+0.05HC-1.61ADL$.

RESULTS AND DISCUSSIONS

We could mention that, cultivar *'Premier'* of reed canary grass *Phalaris arundinacea* in third growing season resumed growth and development in the end March when temperatures above 5-6 C were established. The weather conditions in April-May 2019, with an optimal amount of rainfall, and lower air temperatures as compared with the previous year, helped the plants produce more shots and were favourable for their growth, development, and biomass production. We would like to mention (*table 1*), that the reed canary grass '*Premier'*, at the first cut time of harvest, end May, reached 116.1cm, but at the second cut time, middle August – 93.4 cm. The leaves content in the harvested biomass first cut the leaves content was 29.9 - 64.0%, the amount of dry matter - 25.1-37.6%. The green mass yield from first cut was 4.89 kg/m^2, but in second cut – 2.34 kg/m^2. In third growing season the dry mass productivity reached 2.11 kg/m^2.

According to results obtained in Denmark in the third year after establishment the dry mater productivity of *Phalaris arundinacea* one-cut management reached 12 t/ha, but two-cut management -16 t/ha (Kandel T.P. *et al*, 2013). In Romania the productivity of the cv. '*Premier' Phalaris arundinacea* were 65-80 t/ha green mass or 16 - 20 t/ha dry matter (Maruşca T. *et al*, 2011).

Analyzing the results of the green mass quality of the *Phalaris arundinacea* '*Premier'* in third growing season (*table 2*), we found that dry matter of the harvested green mass contained 109-139 g/kg CP, 74-98 g/kg ash, 368-411g/kg ADF, 616-685 g/kg NDF, 36-38 g/kg ADL, 330-375g/kg Cel and 248-274 g/kg HC. The natural fodder has RFV= 77-90, 11.32-11.82 MJ/kg DE, 9.29-9.70 MJ/kg ME and 5.31-5.72 MJ/kg NEl. The concentrations of crude protein and minerals were high in the natural fodder second cut. The level of structural carbohydrates, cellulose and hemicellulose decreased substantially in the fodder second cut, which had a positive effect on dry matter digestibility, relative feed value and energy content. The nutritive value of green mass: 56.9-60.2% digestible dry matter, 11.32-11.91 MJ/kg digestible energy, 9.29-9.78 MJ/kg metabolizable energy and 5.31-5.79 MJ/kg net energy for lactation.

Some authors mentioned various findings about the green mass quality of the reed canary grass, *Phalaris arundinacea*. According to results obtained in New York state US, the reed canary grass contained 13.1-17.6% CP, 48.4-55.1% NDF, 27.5-30.6% ADF, 2.37-3.49% lighin with 76.8-81.9% IVDMD (Cherney D.J.R. *et al.*, 1993). The reed canary grass grown on saline soil and harvested in heading period were characterized by 97 g/kg CP, 343/kg ADF, 597 g/kg NDF and 2.4 g/kg phosphorus (Glover D.E. *et al*, 2004).

Table 1.

Some agrobiological peculiarities of the *Phalaris arundinacea* '*Premier'* third growing season

Harvest period	Plant height, cm,	Leaf, g		Stem, g		Yield, kg/ m^2	
		green mass	dry matter	green mass	dry matter	green mass	dry matter
First cut	116.1	3.92	1.03	9.79	2.42	4.89	1.25
Second cut	93.4	2.18	0.75	0.96	0.43	2.34	0.88

The nutrients contents of reed canary-grass harvested at pre-blooming stage were: 20.1% CP, 57.0% NDF, 32.5% ADF, 2.7% ADL, 27.3% Cel and 24.5% HC (Tokita N. *et al*, 2015). In Costa Rica nutritional value of reed canary grass were 16.65-19.47% CP, 53.18-57.77% NDF, 34.60-36.86% ADF, 3.78-4.42% lignin, 18.79-20.91% hemicellulose, 31.04-32.34% cellulose, 63.38-70.55% IVDMD with estimated energy content 2.72-2.81 Mcal/kg DE, 2.10-2.18 Mcal/kg ME, 1.29-1.34 Mcal/kg NEl (Villalobos L., 2012). The *Phalaris arundinacea* plants cut in late July contained 103.4 g/kg ash, 11.2 g/kg nitrogen, 2.4 g/kg phosphorus, 619 g/kg NDF, 414 g/kg ADF, 40.0 g/kg soluble carbohydrates, 664 g/kg in-vitro true digestibility of dry matter and 459 g/kg in-vitro NDF digestibility (Bélanger G. *et al*, 2016).

Table 2

Biochemical composition and fodder value of the *Phalaris arundinacea* '*Premier' green mass*

Indices	First cut	Second cut
Crude protein, g/kg DM	109	139
Minerals, g/kg DM	74	98
Acid detergent fibre, g/kg DM	411	368
Neutral detergent fibre, g/kg DM	685	616
Acid detergent lignin, g/kg DM	36	38
Digestible dry matter,%	56.9	60.2
Dry matter intake,% BW	1.75	1.95
Relative feed value	77	91
Digestible energy, MJ/ kg DM	11.32	11.91
Metabolizable energy, MJ/ kg DM	9.29	9.78
Net energy for lactation, MJ/ kg DM	5.31	5.79

The fermented fodder - silage is the basis of most animal farm feeding systems. The production of well-preserved, high-quality silages depends mainly on the composition of the forage at ensiling and the application of appropriate silage-making practices.

When opening the glass vessels with silage made from green mass of *Phalaris arundinacea* obtained after the first and second harvests, there was no gas or juice leakage from the preserved mass. The forage materials obtained after at all the harvests resulted in silages with agreeable colour and aroma, the consistency was retained, in comparison with the initial green mass, without mould and mucus. During the sensorial assessment, it was found that the colour of the silage obtained after the first cut was dark green leaves and green-yellow stems with pleasant smell specific to pickled vegetables, but the silage made from the second cut – homogeneous olive colour with pleasant smell like pickled fruits. It has been determined that the amounts of organic acids and nutrients in the prepared silages, differed essentially depending on the cut period (*table 3*). The silages material consolidated well and the fermentation was complete with pH values 3.98 - 4.10, most organic acids in fixed form. The content of lactic acid increased from 30.8 g/kg to 43.9 g/kg DM and acetic acid - from 5.8 to 7.2 g/kg DM in the silage obtained after the second cut. The butyric acid not was detected in prepared silages. The results of the investigations (*table 3*) indicate that silages from *Phalaris arundinacea* '*Premier'*, contained 127-129 g/kg CP, 411-427 g/kg ADF, 683-704 g/kg NDF, 27-28 g/kg ADL with nutritive value: 55.6-56.9% DDM, 11.09-11.32 MJ/kg DE, 9.11-9.28 MJ/kg ME and 5.07- 5.31 MJ/kg NEl. Thus, the preparation of the silage from the second cut resulted in increase the content of crude protein and net energy for lactation.

Several literature sources describe the nutritional performance of reed canary-grass silage. The silage obtained from reed canary-grass harvested at pre-blooming stage were characterized by 14.4% DM, pH 5.7, 20.7% CP, 60.2% NDF, 34.0% ADF, 3.2% ADL, 26.8% Cel and 26.5% HC, 58.7% DDM, but the silage produced with addition of formic acid - 14.0% DM, pH 4.7, 24.3% CP, 52.3% NDF, 29.9% ADF, 2.5% ADL, 25.6% Cel and 22.4% HC, 67.2% DDM, respectively (Tokita N. *et al*, 2015). In Canada the reed canary-grass silage obtained in late July have pH 4.1, 10.4 g/kg nitrogen, 41.2 g/kg lactic acid, 4.7 g/kg acetic acid (Bélanger G. *et al*, 2016). In Poland the chemical composition of ensiled reed canary grass was: 11.7% CP, 2.6% EE, 10.2% ash, 7.7% NFC, 32.2% Cel, 26.6% HC, 8.6%ADL (Oleszek M. and Matyka M., 2017).

Table 3

The fermentation quality, biochemical composition and fodder value of the *Phalaris arundinacea* silages

Indices	First cut	Second cut
pH index	3.98	4.10
Content of organic acids, g/kg DM	36.6	51.1
Free acetic acid, g/kg DM	2.7	3.4
Free butyric acid, g/kg DM	0.0	0.0
Free lactic acid, g/kg DM	13.0	18.2
Fixed acetic acid, g/kg DM	3.1	3.8
Fixed butyric acid, g/kg DM	0.0	0.0
Fixed lactic acid, g/kg DM	17.8	25.7
Acetic acid,% of organic acids	15.85	14.09
Lactic acid,% of organic acids	84.15	85.91
Crude protein, g/kg DM	129	127
Minerals, g/kg	100	98
Acid detergent fibre, g/kg DM	427	411
Neutral detergent fibre, g/kg DM	704	683
Acid detergent lignin, g/kg DM	27	28
Digestible dry matter,%	55.6	56.9
Dry matter intake,% BW	1.70	1.76
Relative feed value	74	77
Digestible energy, MJ/ kg DM	11.09	11.32
Net energy for lactation, MJ/ kg DM	5.07	5.31

The increased interest in renewable energy production during the last decades has forced scientific research to estimate biomass energy potential. The technology of biomass conversion through anaerobic digestion and biomethane production represents the source of renewable energy with great potential, environmentally friendly and rapidly expanding in the latest years. Biogas can be used for heating, electricity and as vehicular fuel depending on its quality (Badger C.M. *et al*, 1979; Korres N.E *et al*, 2010). The concentrations of organic constituents in the biomass and their availability, the carbon nitrogen ratio (C/N) plays a crucial role in the process of biomethane production (Vintilă T. and Neo S., 2011; (Butkuté B. *et al.* 2014; Dandikas V. *et al*, 2015; Laasasenaho K. *et al*, 2020). We found that investigated substrates from *Phalaris arundinacea* '*Premier'*, according to the C/N ratio, which constituted 22.5-29.4, met the established

standards. The essential differences were observed between the content of cellulose, hemicellulose and lignin. The silage substrate contained high amount of structural carbohydrates, cellulose and hemicellulose, an acceptable content of lignin. The biochemical methane potential of investigated green mass substrates – 349-351 l/kg, but silage substrate reached 365-367 l/kg ODM (*table 4*).

Table 4

Biochemical biogas and biomethane production potential of *Phalaris arundinacea* substrates

Indices	Green mass substrate		Silage substrate	
	First cut	Second cut	First cut	Second cut
Crude protein, g/kg DM	109	139	129	127
Minerals, g/kg DM	74	98	100	98
Nitrogen, g/kg DM	17.5	22.3	20.6	20.3
Carbon, g/kg DM	514.4	501.1	500.0	501.1
Ratio carbon/nitrogen	29.4	22.5	24.3	24.7
Cellulose, g/kg DM	375	330	400	383
Hemicellulose, g/kg DM	274	248	277	272
Acid detergent lignin, g/kg DM	36	38	27	28
Bio gas potential, L/kg VS	653	656	690	685
Biomethane potential, L/kg VS	349	351	367	365

According to results obtained in Denmark, the specific methane yields of reed canary grass decreased significantly with crop maturity ranging from 384–315 and 412–283 l/kg VS for leaves and stems, respectively methane was produced by the two-cut management 5430 m^3/ha compared to the maximum methane production from the one-cut management 3735 m^3/ha (Kandel T.P. *et al*, 2013). Rancane S. *et al*, 2017, mentioned that reed canary grass first cut contained: 477.92g/kg carbon, 16.58 g/kg nitrogen and 66.3 g/kg ash, but in second cut - 466.84g/kg carbon, 17.15 g/kg nitrogen and 73.13 g/kg ash, respectively. Pocienė L., Kadžiulienė Z., 2016 remarked that reed canary grass mowing in July contained *7*3.6-9.44 g/kg ADL, 330-375g/kg Cel and 141.7-208.3 g/kg HC. Krzystek L. *et al.* 2020, indicated the biogas potential of reed canary grass silage 490 l/kg and an annual methane productivity 2558 m^3/ha. Alvinge S., 2010 mentioned that the methane yield for *Phalaris arundinacea* was 323 l/kg, but *Typha latifolia*- 300 l/kg. Sepälä M. *et al.* 2009 obtained 296 l/kg from *Phalaris arundinacea*. The reed canary grass biomass contained: 37.2-42.2% cellulose, 19.0-22.9.0% hemicellulose, 3.17-7.66% ADL, with C/H=21.9-33.1 and its biomethane potential 316-426 l/kg VS (Butkuté B. *et al.* 2014). In Czech Republic the *Phalaris arundinacea* silage substrate contained 288.0 g/kg DM, 22.36 g/kg nitrogen, 75.85 g/kg fibre, 30.37 g/kg ash, 22.20 g/kg lactic acid, 3.20 g/kg acetic acid and methane efficiencies 102.3 l /kg silage; in *Elymus elongatus* subsp. *ponticus* cv. Szarvasi-1 silage substrate there was 240.5 g/kg DM, 23.89 g/kg nitrogen, 71.40 g/kg fibre, 30.38 g/kg ash, 19.54 g/kg lactic acid, 3.84 g/kg acetic acid and methane efficiencies 94.9 l/kg silage (Bernas J. *et al.* 2019). Laasasenaho K. *et al*, (2020) have found that the element and chemical composition of *Phalaris arundinacea* herbage harvested in first cut were 15-16 g/kg nitrogen, 455 g/kg carbon, 62-63 g/kg hydrogen, 147-151 g/kg Klason-lignin and methane yields reached 348 l/kg, but from the second cut 13-14 g/kg nitrogen, 452 g/kg carbon, 61-62 g/kg hydrogen, 167-178 g/kg Klason-lignin and the methane yields 324 l/kg respectively.

CONCLUSIONS

The green mass productivity of *Phalaris arundinacea* '*Premier'*, in third growing season, reached 7.23 kg/m^2 green mass or 2.13kg/m^2 dry matter.

The dry matter of the whole plant contained 109-139 g/kg CP, 74-98 g/kg ash, 368-411g/kg ADF, 616-685 g/kg NDF, 36-38 g/kg ADL, 330-375g/kg Cel and 248-274 g/kg HC. The nutritive value of natural fodder: 56.9-60.2% digestible dry matter, 11.32-11.91 MJ/kg DE, 9.29-9.78 MJ/kg ME and 5.31-5.79 MJ/kg NEl.

The prepared silages were characterized by agreeable colour with pleasant smell of pickled vegetables and fruits, pH 3.98 - 4.10, it contained 30.8- 43.9 g/kg DM lactic acid, 5.8-7.2 g/kg DM acetic acid, 127-129 g/kg CP, 411-427 g/kg ADF, 683-704 g/kg NDF, 27-28 g/kg ADL with nutritive value: 55.6-56.9% dry matter digestibility, 11.09-11.32 MJ/kg DE, 9.11-9.28 MJ/kg ME and 5.07-5.31 MJ/kg NEl.

Phalaris arundinacea substrates for anaerobic digestion characterized by optimal C/N ratio, amount of lignin and hemicellulose, the biomethane potential of the green mass substrates

349-351 l/kg ODM, but silage substrate reached 365-367 l/kg ODM.

Under the conditions of the Republic of Moldova, the cv. *'Premier'* of *Phalaris arundinacea* produces high yields with good nutrient content, can be used as natural fodder and silage for husbandry animals, also and feedstock for anaerobic digestion in biogas reactors and renewable energy production.

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DROUGHT IN THE REPUBLIC OF MOLDOVA BECOMES MORE COMMON AND INTENSIVE

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Abstract

Droughts can be considered the most complex climatic phenomena, because they trigger several factors, namely: atmospheric precipitation, soil water reserve accessible to the plant, humidity and air temperature, evapotranspiration, wind speed, etc., these being the main climatic parameters that define the state of dry or dry weather. This article provides a brief analysis of the statistical data with the most frequent droughts on the territory of the Republic of Moldova. From this point of view, drought risk management is a set of rigorously established and organized activities, which, starting from the existing conditions and objectives of the entity, analyze risk factors in a security concept, in order to minimize risks and costs. Only the precise knowledge of the circumstances, causes of occurrence and legitimacy of manifestation of these phenomena, called in the literature natural hazards or risk phenomena, allows the adoption of appropriate measures to mitigate the negative effects and reconstruction of affected regions. Of particular importance to society is the earliest and most accurate prediction of natural disasters. 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. The evaluations show that the deficit of atmospheric precipitations is practically specific for the whole territory of the republic. The deficit of precipitations and their very uneven distribution condition frequent and intensive droughts. The probability of very strong droughts (≤ 50% of the climatic norm of precipitation) with catastrophic consequences in some months of the vegetation period on the territory of the Republic of Moldova is 11 - 41%.

Key words: affected regions, climate parameters, drought, mitigation measures, risk

Droughts can be considered the most complex climatic phenomena, because they trigger several factors, namely: atmospheric precipitation, soil water reserve accessible to the plant, humidity and air temperature, evapotranspiration, wind speed, etc., these being the main climatic parameters that define the state of dry or dry weather (Constantinov T. *et al*, 2008).

To these are added other factors that define the characteristics of the active surface (relief features, soil, water table depth, degree of vegetation cover, etc.), factors that define the physiological characteristics of the plant (such as variety and vegetation phase, degree of drought resistance), as well as factors that highlight the anthropogenic influence on the environment (the condition of the land and the agrotechnics used that can facilitate the depletion of water in the soil).

As a complex meteorological phenomenon, drought is generally characterized by the absence of precipitation, as well as by the increase of potential evapotranspiration (Corobov R. *et al*, 2007).

As the absence of precipitation can occur in all months of the year, the phenomena of drought and drought can occur in all seasons with obvious consequences on agriculture (Corobov R. 2008; Kuharuk E. *et al*, 2015).

One can thus speak of winter, spring, summer, autumn droughts with differentiated consequences, in relation to the crop development phase.

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, weak).

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

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temperature anomaly is 1.0 - 1.5 °C (Sofroni V. *et al*, 1998).

When increasing the degree of drought intensity, each component of the complex of natural or anthropic factors participates with a differentiated weight, in relation to the season, the vegetation phase, the agrotechnical works, etc.

Drought in Moldova is one of the most dangerous phenomena of nature, representing the specific feature of the regional climate, conditioned by the uneven distribution in time and space of atmospheric precipitation against the background of high air temperature values.

The evaluations show that the deficit of atmospheric precipitation is practically specific for the entire territory of the republic (Kuharuk E. *et al*, 2015).

The probability of very strong droughts (≤ 50% of the climatic norm of precipitation) with catastrophic consequences in some months of the vegetation period on the territory of the republic is 11 - 41% (Sofroni V. *et al*, 2000).

Droughts have been reported more frequently in the last two decades, and they are becoming more intense. Therefore, during the years 1990 - 2019 on the territory of the republic were registered 29 years (1990, 1992, 1994, 1996, 1999, 2000, 2001, 2003, 2007, 2011, 2015, 2017, 2019) with droughts of different intensity, which led to a decline in crop yields (Sofroni V. *et al*, 1998, 2000; www.old.meteo.md).

In the years 1990, 1992, 2003, the droughts lasted throughout the vegetation period (months IV - IX), in the rest of the years the droughts were reported in summer (www.old.meteo.md).

MATERIAL AND METHOD

In Moldova, the effects of agricultural droughts are exacerbated by low rainfall due to relatively high land slopes, which favor runoff that occurs during heavy rains.

In this paper, the relative losses of agricultural production were analyzed, depending on the intensity of droughts and their variation at the multiannual average level on the territory of Moldova. The production deficit every year was established by simulating the dynamics of the water balance, with the help of calculation programs over a series of 29 years (1990-2019), with the real course of precipitation and consumption specific to each crop.

The State Hydrometeorological Service of Moldova, based on the detailed analysis after years of the hydrothermal coefficient (CHT), established that the value CHT ≥ 1.0 characterizes a sufficient humidity, CHT ≤ 0.7 denotes a dry climate, CHT = 0.6 a mild drought, CHT ≥ 0.5 a strong and very strong drought.

Air temperature is the element that gives the most clues about what the weather will be like in a certain period of time. Temperature measurements are mainly affected by the environment, namely: the presence of buildings and other obstacles, the condition of the soil surface, vegetation, etc. The instruments for measuring the air temperature are located at a height of 2 m from the ground surface inside the meteorological shelters.

The meteorological shelter is designed to allow free air circulation around the thermometer, being located on a ground covered with vegetation, at a certain distance from buildings or other heat sources. It is important to note that air temperature is not measured in the sun.

The temperature and humidity of the air (3 stations), the intensity of precipitations (15 stations), the duration of the Sun's brightness (8 stations), the barometric trend (18 stations) are recorded with a series of stations.

RESULTS AND DISCUSSIONS

The intensification and expansion of extreme climate phenomena, decreases every year the agricultural production by at least 30-50%. According to the database of the State Hydrometeorological Service (SHS), it appears that from the amount of precipitation and temperature variation, the soils are affected, for long periods and in consecutive years, more or less by frequent droughts (www.old.meteo.md). Thus, heat, as an element of stress on agricultural plants, is a climatic hazard with a long period of installation and is characterized by lower rainfall below average, by reducing river flows and groundwater reserves, which causes a large deficit of moisture. in air and soil, with direct effects on the environment and primarily on crops. Drought leads to large losses of agricultural production. Its consequences in the past were particularly severe, especially when they were dry for two or three years in a row (*figure 1*).

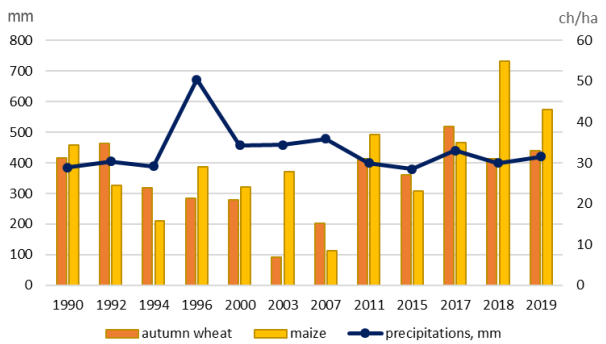

Figure 1 **Rainfall in the driest years and yield per hectare of the main cereal crops in Moldova**

The beginning of the drought is considered to be when the difference in monthly precipitation-

evapotranspiration values becomes negative, which determines the reduction of the water supply in the soil and can affect the quantity and quality of the harvest (Petcu E., 2008).

During the growing season, different crops and plant associations have different requirements for water needs, so that a period of drought does not simultaneously affect the entire cultivated or natural vegetation.

According to the intensity, there are several types of droughts (very strong, strong, moderate, weak).

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.

When increasing the degree of drought intensity, each component of the complex of natural or anthropic factors participates with a differentiated weight, in relation to the season, the vegetation phase, the agrotechnical works, etc.

The territory of the Republic of Moldova belongs to the area with insufficient humidity. The amount of precipitation decreases from northwest to southeast from 620 to 490 mm during the year.

Precipitation falls mainly during the warm year of the year in the form of short-term rain showers and only about 10% of their annual amount - in the form of snow.

The wind regime, which is formed under the influence of baric centers, is characterized by the highest repetition in the northwest (12–35% per year) and southeast (15–25%). The average wind speeds during the year oscillate on the territory from 2.5 to 4.5 m/s.

The consequences of drought are determined by the degree of intensity, duration, and the affected area. Lack of water in the soil and extremely high temperatures are the main cause of drought. According to preliminary data, the drought of this year 2020 also caused great damage to agriculture.

Droughts covering an area of up to 10% of the territory of the Republic of Moldova were assessed as local; 11-20% are considered - vast; 21-30% - very large; 31-50% - extreme, and above 50% are considered catastrophic droughts, because they cause great losses to the national economy.

The productive moisture reserves in the arable layer of the soil on the lands with autumn crops (60% of the territory) constituted 25-35 mm (75-135% of the norm), on 40% of the territory - 5-20 mm (15-65% of the norm).

On 70% of the territory in the soil layer with a thickness of 1 m the productive moisture reserves constituted 105-205 mm (85-145% of the norm), isolated (30% of the territory) - 55-90 mm (45-75% as a rule).

The productive moisture reserves in the arable layer of the soil on the plowed lands (60% of the territory) constituted 10-20 mm (45-75% of the norm), on 40% of the territory, mainly in the northern districts of the country - 25- 40 mm (90-150% of the norm), in the soil layer with a thickness of 1 m on 50% of the territory - 110-180 mm (100-140% of the norm), in the rest of the territory - 75-95 mm (60- 75% of the norm).

The productive moisture reserves in the soil layer with a thickness of 1 m in the perennial plantations on 60% of the territory constituted 60-95 mm (45-75% of the norm), on 40% of the territory - 110-155 mm (80-135% of the norm).

The reserves of productive moisture in the soil on the plantations with agricultural crops are reduced, isolated in the arable layer and in the one with a thickness of 0.5 m they are totally exhausted.

The productive moisture reserves in the soil layer with a thickness of 0.5 m on the lands with corn sowing (70% of the territory) in the background constituted 5-40 mm (10-65% of the norm), in the rest of the territory - 50- 60 mm (75-90% of the norm). In the soil layer with a thickness of 1 m on 80% of the territory the productive moisture reserves constituted 25-75 mm (25-60% of the norm), in the extreme northern and isolated districts in the southern ones - 90-130 mm (75-90% of the norm).

The catastrophic drought of 1994 on the territory of the Republic of Moldova manifested itself during the entire warm period. In the spring season 87% of the territory of the republic was affected by drought with a strong and very strong degree of intensity. In summer, the dynamics of the hydrothermal conditions contributed to the decrease of the surface occupied by the given phenomenon up to 40% of the territory, and in the autumn months the drought covered the entire territory. Approximately 70% of the republic's surface was affected by the very strong drought, the CHT values were below 0.3, which caused great damages to the national economy (over 1 billion lei).

The catastrophic drought of 2007 on the territory of the Republic of Moldova started

practically from the autumn of 2006. Thus, between 01.09.2006 - 06.08.2007, the amount of precipitation falling on the territory of the republic constituted in fact 50 - 70% of the climate norm. The situation worsened to the maximum between May and July 2007, when the amount of precipitation made up only 30% of the norm. The uninterrupted interval without precipitation in the mentioned period varied within the limits of 28-73 days, and the number of days with the relative humidity of the air ≤ 30% constituted in the territory 55-78 days, exceeding 3-4 times the climatic norm. Between May and July 2007, the average air temperature in the territory was 21 - 23 °C, being 3 - 4°C higher than the norm (record). The number of days with maximum temperatures ≥30 °C constituted in the territory 36 - 45 days, exceeding the norm 3 times, and the number of days with maximum temperatures ≥35°C, respectively 10-12 days. Thus, the deviation from the norm was exceeded 10-12 times. On July 21, the maximum record air temperature of 41.5 °C (Camenca Meteorological Station) was recorded. The high thermal regime and the insufficiency of precipitations in May-July created unfavorable conditions for the autumn crops during the formation and filling of the grains (flowering-ripening in milk), the growth, development and formation of the crop for weeds, vegetables and fruit trees. The agro-industrial sector suffered the most. The average harvest of autumn wheat per republic, in 2007, was 15.3 ch/ha, being 2 times lower than the average size of the forecasted crop and lower by 10-11 ch/ha than the average yield for the last 10 years. The harvest of the main late agricultural crops (maize, sunflower, sugar beet, tobacco, fruit trees) was largely compromised, and the enterprises of the mentioned sector were left without raw material. A very serious situation regarding feed insurance has been created in the livestock sector. The catastrophic drought of 2007 affected over 80% of the republic's territory, being the most severe drought for the entire period of instrumental measurements. According to the main agro-meteorological indices, this drought overcame even the drought of 1946, causing damages to the national economy in the amount of over 1 billion American dollars.

The catastrophic drought of 2011. During 2011 the rainfall fell very unevenly. On 60% of the country's territory (basically in the northern districts of the republic and isolated in the central and southern ones) a large deficit of precipitation was reported. Their amount was 290-415 mm (50-75% of the annual norm), which is reported in the northern districts of the country on average once in 20-30 years, and in the rest of the territory - on average once in 5-10 years. On 40% of the country the amount of precipitation fell close to the norm - 430-545 mm (80-105% of the annual norm). The average amount of precipitation on the territory of the republic was 400 mm, which places 2011 on the sixth place in the series of the driest years in the last 60 years (1951, 1953, 1986, 1990, 1994). The drought of 2011, on the territory of the Republic of Moldova, manifested itself in the second half of the warm period. Between August 1 and October 8, 2011, a high thermal regime was reported everywhere (2-2.5 °C higher than the norm) and with a significant deficit of precipitation (10-50% of the norm), which led to the onset of catastrophic drought that affected over 80% of the country's territory. Such a high thermal regime and considerable insufficiency of precipitation, in the mentioned period of 2011, was reported for the second time for the entire period of instrumental meteorological observations. The analog year is 1952.

Between August 1 and October 8, 2011 the hydrothermal coefficient (CHT), which characterizes the degree of humidity of the territory, constituted on the territory of the republic on average 0.1-0.4, which corresponds to the strong and very strong drought. Due to the large deficit of productive moisture in the soil, difficult conditions were created for weight gain and sugar accumulation in sugar beet, which negatively affected the quantity and quality of the fruit. Prolonged dry weather and very deficient soil moisture in the soil have caused critical conditions for sowing and developing autumn crops. Agricultural households began sowing cereal crops only at the beginning of the second decade of October. According to the Ministry of Agriculture and Food Industry, 77% of the land planned for autumn crops (272 thousand ha) were sown in the autumn of this year. The very dry weather continued during November. This month, the precipitation, in fact, was missing or their isolated amount was 1-3 mm, which on 75% of the country's territory is reported for the first time in the entire period of instrumental observations. Thus, the development of autumn crops took place weakly and unevenly, with a delay of 1.5 months compared to the usual deadlines, due to unfavorable agrometeorological conditions and sowing in late terms.

The interruption of the vegetation of autumn crops, which is signaled with the decrease of the average daily air temperature to + 3 °C and below, in 2011, took place on November 10 (10-15 days earlier than usual), which is reported on average once in 5-7 years. At the time of the vegetation interruption (November 10) on 60% of the territory

of the republic the autumn crops were in the phase of emergence, on 25% - in the phase of sprouting of the grains and only on some lands (15% of the territory) - in the phase the appearance of the third leaf, remaining undeveloped and weakly rooted. The agro-meteorological conditions established in August-November 2011 were unfavorable for the growth and development of autumn crops. Such a case, when the autumn crops on 1/4 of the sown lands entered in winter only in the germination phase of the grains, takes place in the Republic of Moldova for the first time in the last 60 years. In the years with partially similar agrometeorological conditions (1952-53, 1963-64) the harvest of autumn crops was only 9-14 (quintals/ha).

Many environmentalists, rightly, do not look favorably on irrigation. If technological requirements are not met, irrigation can lead to accelerated soil degradation through erosion, salinization, wilting, etc. In this case, the role of specialists in the field (hydrotechnicians, pedologists, hydrologists, others) increases considerably, but, unfortunately, we have lost them, for the most part, during the last 20 years. Now we need to get back to their better preparation.

From the point of view of the sustainable use of water resources, the emphasis must be on water from the Dniester and Prut rivers. It is dangerous to pay attention to the water sources of small rivers. Due to overexploitation, a large part of them have dried up and the process is growing.

The small amount of precipitation affected the wells and springs in the villages, in many of them the water disappeared or its quality worsened. There is talk of drying 10% of the wells, but in reality the situation is much worse. Hundreds of thousands of families are forced to bring water from long distances, to limit consumption for household purposes. The plots of land near the house could not be watered and the villagers went to the market for vegetables, thus contributing to higher prices. The only possibility for the rural population to survive in these conditions is the development of water supply and sewerage systems. The construction of aqueducts must become a national priority.

In addition, one should teach people to accumulate and use the minimum amount of water they have rationally; to build rainwater accumulators which are then used in the household, including for irrigation; to clean and deepen the wells, but not when the water runs out, but every year; to work the agricultural land properly, reducing, as much as possible, the process of evaporation of water in the atmosphere; to incorporate organic fertilizers into the soil. These measures can reduce the losses of citizens, being an effective remedy against drought. And agricultural insurance, no doubt, must be much more widespread.

Climatologists say droughts will become more frequent and severe. Our experience in combating this phenomenon is modest. I believe that we should take up the practice of managing water resources from countries in the climate zone with a permanent deficit of rainfall, such as Israel, some Arab countries and Central Asia.

Drought mitigation and control measures. As it is known, several methods are used to mitigate the risks of drought in agriculture: irrigation, cultivation of drought and drought-resistant plant species, application of advanced agrotechnical systems, use of fertilizers.

The most effective measures are irrigation. They influence the hydrological regime of the soil and the lower air layer having a double role: on the one hand, it provides the productive moisture necessary for the plants, and on the other hand, they reduce the thermal effect and diminish the evapotranspiration processes.

Depending on the technological level of the respective company, different types of irrigation can be used: based on sprinklers, based on sloping or non-sloping irrigation canals, or by drip which reduces the loss of water and energy used for supply.

Irrigation must be used, based on proper synoptic monitoring. Otherwise, the application of irrigation is not only unprofitable, but can trigger other risks and aggravate the evolution of the agricultural landscape in an undesirable way. Monitoring measures are needed to ensure the efficiency of these works to ensure a normal evolution of the agricultural landscape.

In order to increase the resistance of agricultural crops to the conditions of high thermal regime and high deficit of productive moisture in the soil, selection and improvement works of crop plants are carried out, leading to hybrids with deeper root system, which can use the reserve. of water from the deep horizons.

In order to reduce the negative effects of the mentioned phenomena, such measures are used as: ecological location of agricultural crops, planting of protection strips, use of black fields, snow retention, terms and optimal sowing norm, differentiated tillage.

CONCLUSIONS

Drought is generally a problem of meteorology, which depends on the level of precipitation, but its intensity depends to a

considerable extent on the characteristics of the soil in the affected area. Thus, the effects of drought can be intensified by the loss of part of the water from precipitation on soils with low water retention capacity, low permeability or compacted, or located on sloping land.

The intensity, duration and extent of the phenomenon of pedological drought vary from one year to another, depending on the complex interaction of agrometeorological factors, respectively particularly high maximum temperatures in the air (days of heat) and soil, associated with a low relative humidity (atmospheric drought) and a poor rainfall regime.

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AGRONOMIC AND ECONOMIC EFFICIENCY OF THE WASTE USE FROM THE PRODUCTION OF ALCOHOLIC BEVERAGES ON CAMBIC CHERNOZEM

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Abstract

Nowadays, the environment ecological status in the Republic of Moldova is deplorable in most natural and anthropogenic ecosystems. Wastes from the alcoholic beverages production is often stored chaotically presenting a major danger to the environment soil, water, air, flora and fauna. There is no waste processing and recycling company in the country. This waste contains a significant amount of biophilic elements necessary for the nutrition of agricultural plants and the increase of organic matter in the soil. About 100 thousand tons of waste is accumulated annually in the Republic of Moldova. Waste from the production of alcoholic beverages contains 28 thousand tons of organic matter, 180 tons of nitrogen, 80 tons of phosphorus and 260 tons of potassium. For this purpose, two field experiments were organized at the Technological-Experimental Station "Codru", Codru commune, Chisinau municipality, where the residues from the production of alcoholic beverages were studied: wine yeasts and vinasse (waste from wine production), distillers grains marc (waste from the production of rectified ethyl alcohol) on soil fertility and plant productivity. Research conducted in 2012-2019 showed that fertilizing the soil with cereal marc led to increased productivity of field crops. The increase in production on average is 868-1223 kg/ha of cereal units (30-42%) compared to the non-fertilized version with marc. Fertilization with waste from the production of alcoholic beverages increases on average over 9 years, the content of organic matter by 0.18-0.37% (4800-10000 kg/ha), mobile phosphorus by 0.3-1.0 mg/100 g soil (8.1-27.0 kg/ha), exchangeable potassium with 10-13 mg/100 g soil (230-300 kg/ha) for variants fertilized with waste. There was an increase in Sauvignon grape production of 0.9-2.3 t/ha (8-21%) on average for 9 years for wine waste variants. Wastes from the production of alcoholic beverages, applied to the soil as organic fertilizer have a significant economic effect, can be recovered and reintegrated into viticulture and phytotechnic sectors.

Key words: chernozem, yeasts, vinasse, grains marc, economic efficiency

Nowadays, in the case of land use in agriculture, the principle of restitution of the elements and fertility consumed for crop formation has been completely ignored. Since the agrarian reform (1990), plant production has been formed exclusively from soil reserves. These resources are depleted from year to year, and harvests become lower. It is necessary to return to the application of organic fertilizers as sources of environmental pollution. Therefore, a circle of matter and energy similar to that of nature would be established in agriculture.

According to this concept, waste from wineries (wine yeasts, vinasse) and waste from alcohol-producing sections (grain dumps) can serve as a source of organic fertilizer. 50-100 thousand m^3 of wine yeasts, 100 thousand m^3 of vinasse and about 50 thousand m^3 of grains marcs are accumulated in the country annually.

Accumulating and discharging without any legal norms, this wastes causes a serious polluting impact on the environment (Duca G. *et al*, 2006; Duca G., 2011). At the same time, the last ones contain nutrients very necessary for plants (Siuris A., 2017; Siuris A., 2018).

The main purpose of the research was to assess the fertilizing potential of the mentioned wastes, the productivity and quality of agricultural crops, the economic efficiency in order to capitalize them as fertilizers and the possibility of reintegration in viticulture and phytotechnics.

MATERIAL AND METHOD

The researches and observations were performed in two field experiments founded in 2011-2012 at the “Codru” Technological-Experimental Resort, located in Codru commune, Chisinau municipality. As objects of study served the soil, vine and field plants and wastes from the production of alcoholic beverages (wine yeasts, vinasse, cereal marcs). The soil is deep cambic chernozem very strong, clay-loamy on clayey clay.

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The scheme of experiments and the main biophilic elements incorporated into the soil with wine wastes and those from the production of rectified ethyl alcohol are presented in *tables 1 and 2.*

Table 1

The scheme of experience and the main biophilic elements incorporated in the soil with wine wastes

Fertilization variant	N	P_2O_5	K_2O
	kg/ha		
1. Unfertilized witness	-	-	-
2. Wine Yeasts, (N_{100}), 13 t/ha	100	16	300
3. Wine Yeasts, (N_{200}), 26 t/ha	200	32	600
4.Vinasse, (K450), 300 m^3/ha	21	18	450
5.Vinasse, (K900), 600 m^3/ha	42	36	900

Table 2

The scheme of experience and the main biophile elements incorporated in soil with corn marc

Fertilization variant	N	P_2O_5	K_2O
	kg/ha		
1. Unfertilized witness	0	0	0
2.Corn marc, 47 m^3/ha	120	47	38
3.Corn marc, 94 m^3/ha	240	94	76

The following methods of determination were used in the soil analysis: humus-Tiurin method; mobile phosphorus-by colorimetric dosing after Macighin; exchangeable potassium in extract after Macighin by flame photometer. The following methods were used for waste analysis: humidity - GOST 26713-85; organic substance - GOST 27980-88; pH –GOST27979-88; total nitrogen - GOST 26715-75; total potassium-GOST 26718-85. Statistical processing of the results obtained in the investigations was performed after B.A. Dospehov (1990).

RESULTS AND DISCUSSIONS

In the country annually are accumulated about 100 thousand wastes from the production of alcoholic beverages (*table 3*).

They contain 28,000 tons of organic matter, 211 tons of nitrogen, 95 tons of phosphorus and 257 tons of potassium.

Characteristic of the chemical composition of waste discharged from wineries

Solid wine yeasts. Are characterized by an acidic environment. The average pH value is 3.5 (*table 4*). The humidity varies from 42.0 to 58.9%, making up an average of 48.0%.

Table 3

The quantity and content of organic matter and main fertilizers in wastes from the production of alcoholic beverages, tonnes/year

Index	Waste				
	Liquid wine yeasts	Solid wine yeasts	Vinasse	Distillers grains marc	Total
Annual quantity	16000	2000	33000	50000	101000
Organic subst.	544	935	439	25700	27618
N	34	31	6	40	211
P	16	13	6	60	95
K	120	51	66	56	293

Table 4

The chemical composition of solid wine yeasts from wineries, reported to the mass with natural humidity (2011-2018), n = 10

Index and unit of measurement	x	min	max
pH	3.5	3.2	3.7
Humidity, %	48.0	42.0	58.9
Organic substance, g/l	46.8	38.3	50.3
Cinder, %	5.3	2.8	8.8
Carbon, %	23.4	19.2	25.5
Total azote, %	1.50	0.77	1.81
$N\text{-}NO_3$, mg/100 g	1.60	0.71	2.80
$N\text{-}NH_4$, mg/100g	32.9	26.9	51.7
Total phosphorus, %	0.70	0.60	0.79
Total potassium, %	2.5	2.3	2.7

The chemical composition demonstrates that solid yeasts are an important source of organic matter for the soil and nutrients for agricultural plants. Calculated from the table with natural humidity, the content of organic substances is on average 46.8%.

Among the primary elements, total potassium predominates, averaging 2.5%, followed by total nitrogen - 1.5% and total phosphorus - 0.70%. Compared to conventional manure, solid wine yeasts contain 2.7 times more nitrogen, 1.6 times more phosphorus, 2.4 times more potassium and 2.7 times more organic matter. On average 1 ton of solid wine yeast with natural moisture contains 47 kg NPK, with a ratio between these elements 1: 0.5: 1.7 which corresponds approximately to the nutritional needs of the main cultivated plants. So, we can see that solid wine yeasts are concentrated fertilizers that can economically justify their transportation over long distances, over 10 km from wineries (Golban A., 2016; Golban A., 2017).

Vinasse. Vinasse is the liquid left after distilling the alcohol from the wine. The amount of vinasse represents 75-85% of the volume of wines subject to distillation. Vinasse is an opalescent or slightly cloudy liquid, of a golden-reddish color, with a specific heat treatment odor and a sour taste.

Vinasse contains all the compounds, initially found in wine: organic and mineral compounds, proteins, coloring compounds, etc. As a result of the research carried out so far, it has been found that the vinasse contains such valuable compounds as: nitrogenous substances, phenolic substances, which can positively influence the biological and organoleptic qualities of alcoholic beverages or can serve alongside other compounds as a nutrient medium. sterile in the process of fermentation of molasses and production of refined ethyl alcohol. Vinasse is characterized by an acidic environment. The average pH value is 3.4 units (*table 5*).

Table 5

The chemical composition of vinasse from wineries (2011-2018), n = 10

Index and unit of measurement	x	min	max
pH	3.4	3.0	3.7
Dry residue, g/l	15.2	7.5	24.7
Fixed residue, g/l	1.9	1.2	2.9
Organic substance, g/l	13.3	6.3	21.7
Total azote, %	0.02	0.007	0.05
Total phosphorus, %	0.02	0.006	0.039
Total potassium, %	0.12	0.048	0.157
$N\text{-}NH_4$, mg/l	67	52	86
$N\text{-}NO_3$, mg/l	9.3	0.31	23.8
Ca^{+2}, mg/l	106	72	120
Mg^{+2}, mg/l	84	49	146
Na^{+}, mg/l	172	125	210
K^{+}, mg/l	579	335	1127
Cl^{+}, mg/l	90	69	122
SO_4^{-2}, mg/l	155	79	280

Distillers grains marc. Distillers grains marc is characterized by 93.4% water and 6.73 dry substances (*table 6*), the average value of pH constitute 3.7 units. From primary elements in composition of distillers grains marc dominates the azote – 0.28%, the phosphorus and pottassium constitutes on average 0.12% and 0.11% and the organic substances constitute 54.4 g/l.

Among the cations, the monovalent ones of potassium and sodium predominate (783 mg/l and 450 mg/l). The concentration of bivalent calcium and magnesium cations is on average 97 mg/l and 234 mg/l. Among the anions, the sulphate content predominates. Their concentration is from 188 mg/l to 533 mg/l with an average value of 367 mg/l.The chlorine content varies from 202 mg/l to 397 mg/l, averaging 299 mg/l

Sauvignon grape harvest obtained on levigated chernozem when applying wine wastes.

The phenomena described about the beneficial influence of waste from the production of alcoholic beverages on organic matter, phosphorus and potassium in the chernozemic soil, were also reflected on the crops of cultivated plants (*table 7*).

Table 6

Chemical composition of the distillers grains marc from the ethyl alcohol industry (2010-2018), n = 10

Index and unit of measurement	x	min	max
pH	3.7	3.4	4.2
Dry residue, g/l	66.3	40.5	72.0
Fixed residue, g/l	14.9	9.3	21.4
Organic substance, g/l	51.4	16.2	62.1
Humidity, %	93.4	92.1	97.0
Total azote, %	0.28	0.21	0.33
Total phosphorus, %	0.12	0.06	0.19
Total potassium, %	0.11	0.09	0.13
$N\text{-}NH_4$, mg/l	143	71	224
$N\text{-}NO_3$, mg/l	5.8	2.9	11.0
Ca^{+2}, mg/l	97	60	100
Mg^{+2}, mg/l	234	183	244
Na^{+}, mg/l	450	185	550
K^{+}, mg/l	783	649	850
Cl^{+}, mg/l	299	138	321
SO_4^{-2}, mg/l	357	188	533

From the measurements and calculations performed during all years of experimentation, it was established that the application of wine yeasts at a dose of 13 and 26 t/ha ensured a significant increase in grape harvest on average (2011-2019) over nine years of 1.3 and 2.3 t/ha, by 14 and 24% more compared to the unfertilized control (9.3 t/ha). Significant actions on the productivity of the vine plants were also incorporated in the vinegar in the dose of 300 and 600 m/ha annually. The average crop increase over nine years was 0.6-0.7 t/ha or 7-8% more than the control. It should be mentioned that when applying the grape in the years 2016-2019, statistically significant values of grape growth were not registered. The reason is that in recent years the vinasse has not been administered. The largest grape harvest was in the first four years of experimentation (2011-2014). Vinasse should be incorporated after every 4 years of action.

Oenological researches

Grapes from all three variants were harvested for oenological researches on the quality of wine from the experienced vine plantation. The sugar and acid content of the juice extracted annually was determined (*table 8*).

Table 7

The influence of wine wastes on the Sauvignon grape harvest obtained oncambic chernozem, t/ha, technological-experimental resort "Codru"

Experiment variant	Grape harvest over the years									Average for 9 years		
	2011	2012	2013	2014	2015	2016	2017	2018	2019	Harvest. t/ha	Harvest growth	
											t	%
1. Witness	9.8	7.6	10.6	9.8	10.8	7.4	10.4	7.0	9.9	9.3	-	-
2. Wine yeasts 13 t/ha	10.8	8.7	11.9	12.0	11.9	8.6	11.7	8.2	12.1	10. 8	1.5	16
3. Wine yeasts 26 t/ha	10.9	8.8	14.1	13.9	12.8	9.0	13.2	8.8	12.5	11.6	2.5	27
4. Vinasse 300 m^3/ha	10.8	8.7	11.2	10.5	11.4	7.6	10.0	7.2	10.0	9.7	0.4	4
5. Vinasse 600 m^3/ha	10.6	8.5	11.4	10.6	11.6	7.6	10.3	7.4	10.1	9.8	0.5	5
DL 0.5%	0.60	0.64	0.94	0.73	0.67	0.92	0.82	0.53	0.60	0.65	-	-
Sx	14.3	15.1	17.2	16.2	14.6	15.3	12.4	14.1	12.7	13.4	-	-

Table 8

Sugar content and accumulation of acids in Sauvignon grapes when applying wastes from the production of alcoholic beverages at technological-experimental resort "Codru", on average for the years 2011-2019

Variant of experiment	Sugar content, g/dm^3	Acid accumulation, g/dm^3
1. Witness	204	7.8
2. Vinasse (K_{450}), 300 m^3/ha	212	7.2
3. Vinasse (K_{900}), 600 m^3/ha	212	7.5
4. Wine Yeasts (N_{100}), 13 t/ha	203	7.0
5. Wine Yeasts (N_{200}), 26 t/ha	210	7.6

Table 9

Physico-chemical indices of Sauvignon white wines on average for the years 2012-2018

Index and unit of measurement	Fertilization variant				
	Witness	Vinasse (K_{450}), 300 m^3/ha anually	Vinasse (K_{900}), 600 m^3/ha anually	Wine Yeasts (N_{100}), 13 t/ha anually	Wine Yeasts (N_{200}), 26 t/ha anually
Alcohol, % vol	12.57	13.46	13.42	12.99	11.68
Titratable acidity, g/dm^3	5.3	5.5	4.8	5.8	5.4
Volatile acidity, g/dm^3	0.37	0.38	0.49	0.32	0.29
Sulphur dioxide, mg/dm^3	35.2	40.32	26.62	30.72	47.32
Free Sulphur dioxide, mg/dm^3	11.52	17.92	14.08	15.36	14.08
pH	3.1	3.2	3.1	3.1	3.2
Organoleptic note	7.87	7.87	7.83	7.85	7.84

Table 10

The influence of cereal marc fertilization on field crop productivity at technological-experimental resort "Codru", kg/ha

Experiment variant	Harvest of principal production								On average for 8 years		
	2012 sunflower	2013 autumn wheat	2014 sunflower	2015 corn grain	2016 autumn wheat	2017 Soy beans	2018 autumn wheat	2019 autumn wheat	harvest, kg/ha	32/5000 crop increase compared to witness	
										kg	%
1. Witness	1230	3818	1170	2515	6100	1830	3925	3950	3619	-	-
2. Marc (N_{120}), 47 m^3/ha anual	1840	5673	1790	3473	6700	2373	4813	4700	4714	1095	30
3.Marc (N_{240}), 94 m^3/ha anual	2070	6183	1980	3750	7300	2568	5300	6533	5326	1707	47
DL 0,5%	223	520	172	653	573	241	504	-	531	-	-
Sx, %	10.4	12.3	11.6	12.4	11.2	10.7	11.5	-	10.4	-	-

The analyzes performed (2012-2019) show that the sugar content of the grapes in the fertilized variants was on average 203-212 g/dm^3 with an acid accumulation of 7.0-7.6 g/dm^3. In February-March 2012-2018 in the Laboratory "Hard drinks and secondary products" were carried out physico-chemical researches on the quality of wines obtained. In the wine samples were determined the alcoholic concentration, the mass concentration of volatile acids, the mass concentration of sulfuric acid, the pH of the wines. The obtained results are presented in *table 9*. Due to the advanced content in carbohydrates, the wines have a strength of over 13% vol. The concentration of sulfur dioxide and that free is 30.7-47.3 mg/dm^3 and 14.1-17.9 mg/dm^3. The pH values are equal to 3.1-3.2 units.

Field crop productivity when applying grain marc

The phenomena described about the beneficial influence on the organic matter, phosphorus and potassium in the chernozem soil, were also reflected on the crops of cultivated plants (*table 10*).

The influence of grain marc on the qualitative indices of agricultural production

A higher protein content was also synthesized in the harvest of the variants treated with cereal marc in the dose of 47-94 m^3/ha (equivalent to N120-N240) annually (*table 11*).

Given that the application of grain marc not only increased the concentration of vital substances in the crop, but also favored the increase of its mass, it was obtained that the harvested mass of protein and fat increased considerably compared to the reference variant. The total protein increase in eight years, compared to the reference plants, was 1716-1853 kg/ha. Regarding the fat content index, a significant increase was observed. The value of the fat increase in sunflower (2012) was 248-344 kg/ha (42.6-42.7%), in 2014 all sunflower - 266-358 kg/ha (48.7%). In 2017, soybeans were grown. The value of the fat increase was 135-176 kg/ha (22.6-22.7%).

CONCLUSIONS

Wastes from wineries (wine and vinasse) and rectified ethyl alcohol production enterprises (cereal marcs), with their varied nutrient content and a significant amount of organic matter, must be included in the agricultural circuit by using them as fertilizers.

The average productions per hectare in the variants treated with wine wastes constituted 11.7-12.8 t/ha, being distinctly superior to the one obtained in the witness variant (10.8 t/ha). The increase in grape production in fertilized variants was 0.9-2.3 t/ha or 8-21%.

It was found that fertilization with wastes from wineries did not diminish the quality of the wines obtained. The physico-chemical composition agrees with the requirements for quality wines. The researched wines are distinguished by good organoleptic qualities and according to their typicality correspond to the normative acts.

The application of cereal marc led to an increase in the organic matter content in the soil by 0.12-0.22% (3000-5500 kg/ha) and mobile phosphorus by 0.24-0.47% (4.7- 10.4 kg/ha) on average for eight years. The value of the exchangeable potassium content has not changed.

The grain marc applied as fertilizer determined the obtaining of average increases of vegetable production over eight years of 1095-1707 kg/ha of cereal units or 30-47% compared to the unfertilized witness.

The grain marc used contributed to the synthesis and accumulation of crude protein in grain production. The total protein collected in eight years was 1716-1853 kg/ha.

The use of waste from the production of alcoholic beverages (wine yeasts, vinasse and cereal marc) is profitable. Expenses recover in 1-2 years.

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COMMUNITY IMPLICATIONS ON ROMANIAN AGRICULTURE IN THE CONTEXT OF THE EUROPEAN UNION'S SUSTAINABLE DEVELOPMENT STRATEGY

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Abstract

Sustainable development - a development model that seeks to ensure a balance between economic growth, quality of life and environmental conservation in the medium and long term, so as to meet the needs of the current generation without compromising the ability to meet the needs of future generations - has represented decades, the guideline that has underpinned development policies, programs and strategies. The issue of the mechanisms of financial support for Romania's agriculture is very important in our country's efforts to become competitive on the European agricultural market. However, the peculiarities of Romanian agriculture remain almost similar to the pre-accession period (fragmented agrarian structures, low technical and economic yields, outdate technical endowment, etc.), and the main question is whether community support mechanisms increase or remain Romanian farm performance, support measures to ensure their survival on the market. The paper highlights the regional development strategies of the North-East Region, solutions to improve the process of strategic implementation of development objectives, by providing viable tools for monitoring sustainable development at regional and rural level, eliminating their oversizing trends. The target indicators proposed by this paper and their rationale allow such a realistic and correct estimation of the strategic implementation and the measurement of the impact of the strategic objectives. In this context, we consider that proposed and substantiated result indicators starting from the previous trend of the region, for all strategic priorities 2014-2020, can be much better materialized in projects with major impact on sustainable development both at regional level and the rural environment, and the way of their evaluation and estimation represents a viable methodology for monitoring the regional development strategies.

Key words: sustainable, development, agriculture, objectives, strategies

Sustainable development, more than twenty years after the global campaign to promote the concept launched in Rio, remains a concept that is not fully scientifically or uniformly documented in political discourses, as it is not an observable phenomenon, integrated into scientific and standardized formulas, but constantly evolving according to new factors, changes of interests and institutional conditions. It can be seen as an aspiration to integrate through the three dimensions (economic, social, environmental) all aspects related to development, being currently disseminated through documents, conventions and political programs but with various and interpretable tools of application. However, the vision on sustainable development strategies are not unitary, in 2014, requiring the European Union to establish models of development strategies with specific indicators (ESDN) (ESDN, 2013), including the implementation of a development strategy Rural Development (Committee of the Regions) (Committee of the Regions, 2014).

It is people-centered with the aim of improving the quality of human life and is conservation-based being conditioned by the need to respect nature's ability to provide resources and services necessary for life. Thus, sustainable development means "improving the quality of human life by taking care of the capacity of ecosystems" (FAO).

“Sustainability is a relationship between dynamic human economic systems and slower ecological systems in which: (a) human life can develop indefinitely; (b) individuals can develop; (c) human culture can develop and (d) the effects of human activities remain limited so as not to destroy the diversity, complexity and functionality of ecological life support systems ", which allows" simultaneous maximization of the objectives of biological systems (genetic diversity, resilience), biological productivity), the objectives of economic systems (meeting basic needs, increasing utility goods and services) and the objectives of

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social systems (cultural diversity, social justice, participation) ”(Abrahammson K.V., 1997).

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

The term “sustainable development” is thought to have been introduced worldwide in 1980 (Kates R.W., Clark W.C., 2001) by the International Union for the Conservation of Nature and Natural Resources (IUCN) in the World Conservation Strategy (WCS), but it was assimilated with the idea of ecological sustainability (IUCN, 1980).

In 1987, the World Commission on Environment and Development, the Brundtland Report (WCED, 1987), gave the following definition: “Sustainable development is development that covers the needs of the present without compromising the ability of future generations to cover your own needs”. Based on this definition, the Commission has set the following operational objectives: launching economic growth; changing the quality of economic growth; meeting essential needs for jobs, food, energy, water and sanitation; ensuring a sustainable level of the population; conservation and improvement of basic resources; technology reorientation and risk management; integrating the environment and the economy into decision making; reorientation of international economic relations.

Since the introduction of the concept and its promotion, most authors in the literature have tried to demonstrate that sustainable development may or may not be achieved, taking into account different approaches and visions (Sharachchandra M., 1991; Barbier, 1987; Barbier E.B., 1987) - the concepts of strategies for environmental sustainability and sustainable social and cultural development (Pezzey J. C. V., 1989) approach to sustainable development from the perspective of economic growth; Daly (1990) (Daly H. E., 1990) - the goals of sustainable development; Common and Perrings (1992) (Common M., Perrings C., 1992) - the difference between economic sustainability and ecological sustainability and so on.

Since 1992, when the United Nations Conference on Environment and Development was held in Rio de Janeiro, scientific discussions have intensified on the contribution of science and technology to ensuring sustainable development, and After the 2002 World Summit on Sustainable Development in Johannesburg, a message was sent to the scientific and research community to find solutions to the problems raised by ensuring sustainable development (Clark W.C., Dickson N.M., 2003).

The need to create sustainable development strategies at national level was brought to public attention by Agenda 21 (1992) when it was stated that such a strategy must harmoniously encompass sectoral economic, social and environmental policies and plans so as to ensure economic development, socially responsible for protecting basic and environmental resources for the benefit of future generations. (UN, 1992, Agenda 21)

The implementation of these strategies requires inter-sectorial institutional participation, the creation of mechanisms involving governments, civil society and the private sector, and economic planning and decision-making needed to become more participatory so as to create an optimal framework for organization and coordination. 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.

The stages of realization and implementation of sustainable development strategies can be summarized as follows (*figure 1*):

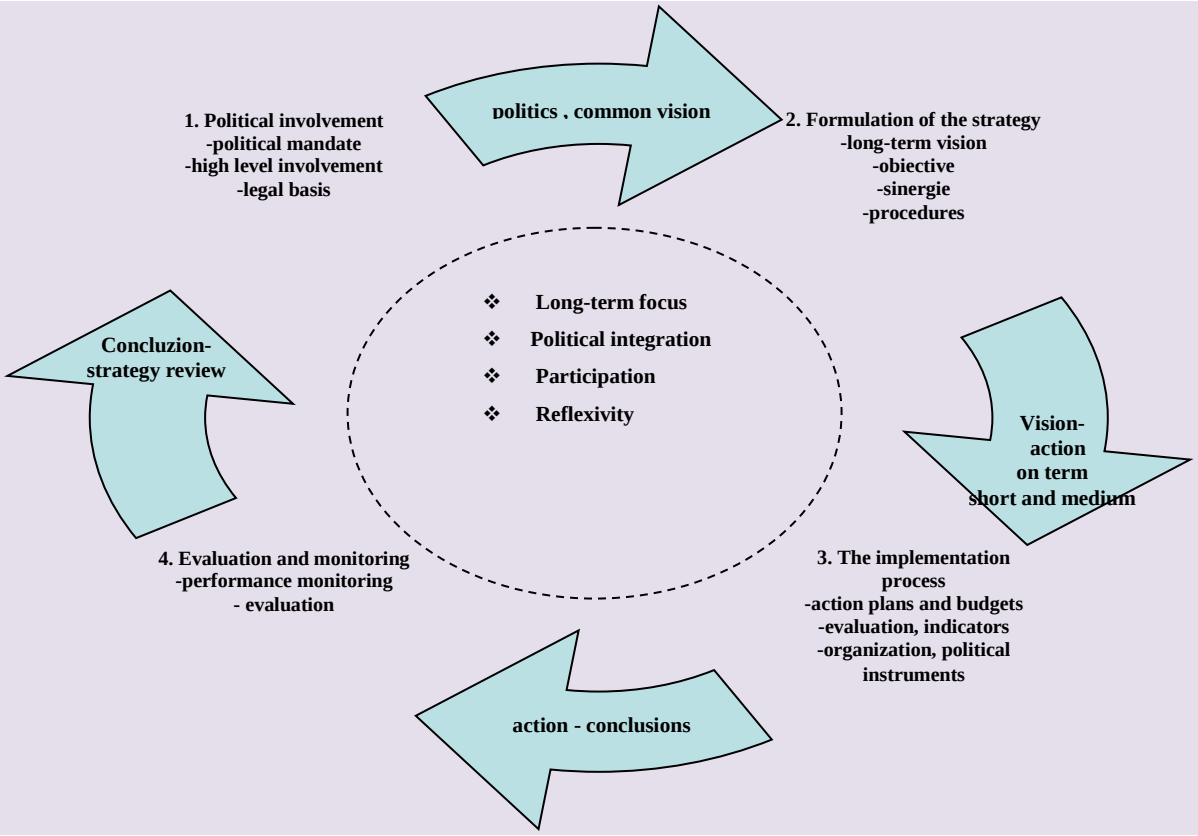

Figure 1 **Sustainable development strategy - principles and stages**
Source: ESDN (ESDN, Quarterly Report December 2007)

The relationship between EU objectives and sustainable development objectives can be summarized as follows:

• Socio-economic development: The 2020 Strategy provides for "the promotion of a prosperous, competitive and eco-efficient economy, which offers high living standards and full and high quality employment throughout the EU" (COM (2010) 2020 final); To this end, it has been set to increase research and development expenditures to 3% of GDP, increase energy efficiency by 20% and increase the employment rate (20-64 years) to 75% by 2020; these objectives are supported by initiatives 1-6 and the "Employment Package" (COM (2012) 173 final);

• Sustainable consumption and production - SDD objectives are - by addressing social and economic development in ecosystems and decoupling economic growth from environmental degradation, by improving environmental and social performance of products and processes, by increasing green public procurement and EU involvement in the global market environmental technologies and eco-innovations; supported by initiatives 4 and 5;

• Social inclusion (creating a socially inclusive society and ensuring and increasing the quality of life of the inhabitants) - SDD objectives - poverty reduction, social and territorial cohesion, reducing school dropout (less than 10%, 85% of staff under 22 to graduate high school) , restructuring social systems, increasing the participation of older people in the labour market, including women in the labour market, attracting and participating immigrants in the labour market; initiatives 6 and 7; general objective to reduce school dropout below 10%;

In the vision of the European Commission, sustainable development is fully integrated in the 2020 Strategy (smart growth, sustainable growth and inclusive growth), allowing greater coherence and integration of the three dimensions of sustainable development. European targets for 2020:

• Employment - increasing the employment rate from 68.4% in 2013 to 75% (among the population aged between 20 and 64);

• Research and development - reaching a level of 3% of EU GDP for research and development;

• Climate change and sustainable energy use - 20% reduction in carbon dioxide emissions (compared to 1990), increasing the share of renewable energy sources and energy efficiency by up to 20%;

• Education - early school leaving rate below 10%, increasing the share of graduates (population 30-34 years) to over 40%;

• Fight against poverty and social exclusion - reducing the number of people suffering / at risk

of suffering from poverty and social exclusion by 20 million people. By creating these objectives, the 2020 Strategy aims to be compatible with the long-term development objectives of the European Union's Sustainable Development Strategy (SDS). Thus, the 2020 Strategy includes SDS targets in terms of resource efficiency, levels set for climate and energy targets, poverty reduction and increasing education (*table 1*).

Table 1

Integrating SDS key objectives into the Europe 2020 Strategy

Objectives SDD	Initiatives						
	Smart growth			Sustainable growth		Inclusive growth	
	A digital agenda for Europe	An Innovation Union	Youth on the move	A resource efficient Europe	An industrial policy for the era of globalization	An agenda for new skills and new jobs	A European platform for combating poverty
	1	2	3	4	5	6	7
Climate change and energy	25-75%	25-75%		Over 75%	Peste 75%		
Sustainable transport	25-75%	25-75%		25-75%	25-75%		
Sustainable consumption and production	Under 25%	Under 25%		Over 75%	25-75%		
Conservation and management of natural resources		25-75%		Over 75%	25-75%		
Public health	25-75%	25-75%				Under 25%	25-75%
Social inclusion, demography and migration	25-75%	25-75%	25-75%			Over 75%	Over 75%
Global poverty and the challenges of sustainable development				25-75%			25-75%

Sources :2013 monitoring report of the EU sustainable development strategy, 2013 edition, Sustainable development in the European Union (EUROSTAT, 2013, Statistical books)

• Public health - SDD objective - promoting a functional health system that provides a level playing field and improves protection against threats; the European Innovation Partnership on Active and Healthy Aging (European Commission, Pilot Scheme) and Together for Health initiatives (COM (2007) 630 final);

• Climate change and energy - SDD objective - limiting climate change and the costs and negative effects on society and the environment (reduction of greenhouse gas emissions, etc.);

• Sustainable transport - SDD objective - ensuring that the transport system covers the economic, social and environmental needs of society, but also minimizing unwanted impacts on the economy, society and the environment (decoupling economic growth of transport, sustainable level of energy use, reduction greenhouse gas emissions, reduction of pollution, reduction of transport noise (at source and through mitigation measures), etc., initiatives 4, 5 and the document • Roadmap to a Single European Transport Area - Towards a competitive and resource efficient transport system (COM (2011) 144 final);

• Conservation and management of natural resources - SDD Objectives - improving the management and avoiding overexploitation of natural resources (resource efficiency, promoting eco-efficient innovations, avoiding overexploitation of renewable natural resources (fishery resources, biodiversity, water, air, soil, atmosphere), restoration degraded marine ecosystems, halting biodiversity loss, etc.); The 2020 Strategy responds to these objectives through the Common Agricultural Policy, the European Union Strategy for Biodiversity, the European Union Strategy for a “Green” Infrastructure, the Common Fisheries Policy, etc .;

• Good governance - SDD Objectives - open and democratic society, citizen involvement, political coherence, political integration, etc.; The 2020 Strategy includes the White Paper of the European Government which provides for openness, participation, responsibility, effectiveness, coherence (PNDR Annual Progress Report 2014, 2015).

SYSTEMS AND MECHANISMS FOR SUPPORTING AGRICULTURE IN THE PERIOD 2014-2020

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. 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 and rural development programs to its specific needs.

Globally, efforts to promote strategic sustainable development measures have led to: reducing the poor by 700 million people; saving approx. 3.3 million people with malaria (over 90% of children under 5); about 2.3 billion people had access to drinking water sources (it reached 89% of the population in 2012); ensuring gender equality in access to education (primary education); the number of malnourished people decreased but not at the expected rate; mortality rate in children under 5 years decreased, etc.

Table 2

Distribution of the allocation of European Funds related to EAFRD 2014-2020, at EU level

Country	EU funds in millions of EURO	% of EAFRD Total 2014-2020
Bulgaria	2 366.7	2.38%
Croatia	2 026.2	2.04%
Czech Republic	2 305.7	2.32%
Germany - Baden-Württemberg	709.6	0.71%
Germany - Berlin + Brandenburg	1 050.7	1.06%
Germany - Lower Saxony + Bremen	1 119.9	1.13%
Germany - Rhineland-Palatinate	299.8	0.30%
Germany - Saarland	33.6	0.03%
Germany - Schleswig-Holstein	419.5	0.42%
Germany - Thuringia	679.7	0.68%
Ireland	2 190.6	2.20%
Italy - National Rural Network	59.7	0.06%
Italy - Bolzano	158	0.16%
Italy - Emilia-Romagna	513	0.52%
Italy - Tuscany	414.7	0.42%
Italy - Veneto	510.7	0.51%
Romania	8 128.0	8.18%
Spain - National Program	237.8	0.24%
Spain - Aragón	467	0.47%
Spain - La Rioja	70	0.07%
Spain - Basque Country	87.1	0.09%
Sweden	1 763.6	1.78%
Great Britain - Scotland	844.7	0.85%
United Kingdom - Wales	655.8	0.66%

Source: Processing by: Rural Development 2014-2020, http://ec.europa.eu/agriculture/rural-development-2014-2020/country-files (Rural Development 2014-2020, 2015)

Performance of agricultural holdings by sector

The performance of farms in the field crops, grazing livestock crops and mixed farms was increasing during the period 2007-2014, but the net added value per hectare in the vegetal sector was highest in the horticultural sector (*table 3*). On the other hand, labour productivity reached very high values in the livestock sector (about 118 thousand euro/AWU), 243.5% more than in 2007, and in field crops (about 16 thousand euro / AWU) where the increase was 515.8%.

Table 3

Evolution of the net added value per hectare and labour productivity, per sectors, for the period 2007-2014

	2007		2014		2014/2007 (%)	
	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)

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 issue of sustainable development is a global and European priority; the implementation of national sustainable development strategies being undertaken since 2000 by over 145 countries at the initiative of the United Nations. Sustainable development involves more than the political process and requires profound changes in thinking, as well as in economic, social, consumer and production structures. Sustainable development is a model of development that seeks to ensure a balance between economic growth, quality of life and environmental conservation in the medium and long term, so as to meet the needs of the current generation without compromising the ability to meet the needs of future generations. Thus, sustainable development takes into account economic, human, ecological and social capital, in conditions of equity, long-term approach and in a systemic thinking.

In conclusion, the subventions granted based on Pillar I present the highest level of importance in obtaining the incomes and therefore influence more and directly the inequity between farms. 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.

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APPROACHING SUSTAINABLE AND RURAL DEVELOPMENT IN THE NE REGION OF ROMANIA IN A STRATEGIC CONTEXT

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Abstract

The paper aimed to identify how to approach sustainable development in regional development strategies, having as a case study the North-East Region, and to evaluate how to implement strategic objectives, at regional and rural level. The paper aims to identify new strategic proposals to ensure sustainable development of rural areas, by using a system of specific, quantifiable and representative indicators that allow, through econometric analysis, evaluation of results and projection of the evolution of sustainable development. In the conditions of intensification, increase of plant production, but also of rural development, as basic links of socio-economic progress, there is the problem of achieving and maintaining the growth of agro-zootechnical production without major damage to the environment and health of humans and other living things. of the food chain. This priority task must be addressed in the light of the concept of sustainable agricultural development. Sustainable development is conceived as a necessity of reconciliation between the economy and the environment, on a new path of development that supports human progress, not only in a few places and for a few years, but everywhere and for a long future. This is in fact the only long-term alternative to the environmental crisis generated by human society. In the 2014-2020 strategy, the EU intended to spend almost € 100 billion on rural development policy through the European Agricultural Fund for Rural Development (EAFRD). One of the objectives of the EU's strategic framework for 2014-2020 was to place greater emphasis on delivering results. However, efforts in this area have been faced with the eternal problem of planning a new programming period before relevant data on expenditure and results from the previous period are available.

Key words: approach, sustainable development, strategies, regional, European

The national financial aids for agriculture support were reduced and directed towards the prices control for the basic products and for supporting the consumption, or towards subventions granted for inputs purchase. The use of some inadequate mechanisms of agricultural policy, lacking the performance objectives, determined the maintenance of the agriculture's subsistence character and has not allowed the formation of the sector of the middle commercial farms. In such conditions, it was aggravated the dual character of the Romanian agriculture, being developed a subsistence agriculture and large agricultural enterprises, which could not compete on the European market, and this leaded to the increase of self-consumption and to calling the food imports (Ungureanu G. *et al*, 2013).

In other respects, the paper aims to highlight a number of such impact assessment tools in the form of a set of indicators able to provide an overview of the direct and indirect measures stemming from the integration process on agriculture, as well as on the influence of CAP mechanisms on agricultural performance at regional level. Impact assessment at the regional level is all the more important because, on the one hand, the agricultural policy measures implemented in our country are related to the level of the whole agriculture, without taking into account the regional particularities and, on the other hand, to be applied decentralized requires essential information to substantiate them.

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

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reference to the fiscal administration and the current problems in the public finances

RESULTS AND DISCUSSIONS

Thus, Romania adhered to the European Union, with profound structural issues at the level of the agricultural sector. In our country, the number of subsistent and semi-subsistent farms is very high, predominating the agricultural exploitations leaded by the elder farmers, and the food industry is insufficiently developed in order to assure an outlet market for the basic agricultural products.

The integration into the European Union was one of the key priorities of Romania's foreign policies. As a substantial part of this strategy, Romania had to adopt, step by step, an agricultural policy and an institutional framework fully compatible with the communitarian agricultural policy (Cap) of the European Union. The two pillars of the Community Agricultural Policy of the European Union are to support the market and incomes and the rural development, and their funding shall be performed through EFAG, respectively EAFRD.

Estimating the GDP / Per capita disparity index: Based on the trend of the 2000-2019 data series, we are seeing a 32.2% potential increase in the indicator; based on the trend of the 2015-2019 data series, a growth potential of 12.7%. In fact, we can say that although economic growth is projected for the North-East Region, it does not contribute substantially to changing the region's contribution to national gross domestic product. Thus, at the level of the North-East Region, the potential variation of the GDP / inhabitant disparity compared to the national average is between (42.7% - 50.1%).

Supporting the development of micro-enterprises and SMEs is an important objective of sustainable development as it allows the economic revitalization and economic involvement of resource regions. From this point of view, it is noticed that the business environment (formed by almost 90% of the micro-enterprises) was affected by the economic crisis, especially during 2017-2019.

The number of enterprises has started to increase since 2020, but their number has been under the 2000-2015 growth trends. During the implementation of the strategy (2015-2019) there is a reduction of approx. 20% of firms in industry and commerce, and especially growth in construction, agriculture and other sectors (*Table 1*), contrary to the strategic objectives of developing the processing industry in the region. However, trade firms remain predominant (about 39%), while those in agriculture account for only 4.2% in 2020 (an increase of only about 790 firms). 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 euro's, 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 2015 (*Table 1*).

Table 1

Evolution of enterprises active in sectors of activity during the period 2015-2020

Specification	2015	2016	2017	2018	2019	2020	2020/ 2015
Total	57168	60898	59051	53165	48591	50298	94.7
Agriculture, forestry and fishing	1863	1839	2056	2022	2004	2099	122.0
%	3.3	3.0	3.5	3.8	4.1	4.2	
Industry	7681	7555	7267	6525	5976	6088	80.9
%	13.4	12.4	12.3	12.3	12.3	12.1	
construction	4706	6047	6164	5075	4534	4642	135.8
%	8.2	9.9	10.4	9.5	9.3	9.2	
Trade	25733	26063	23580	21431	19340	19672	78.1
%	45.0	42.8	39.9	40.3	39.8	39.1	
Hotels and restaurants	2589	2813	3266	2948	2605	2755	116.1
%	4.5	4.6	5.5	5.5	5.4	5.5	
Other sectors	14596	16581	16718	15164	14132	15042	116.3
%	25.5	27.2	28.3	28.5	29.1	29.9	

Sources: INS

It is recommended that Romania support the elaboration by the European Commission, in close partnership with the Member States, of a Common Strategic Framework (CSF) for the European Regional Development Fund, the European Social Fund, the Cohesion Fund, the European Agricultural Fund for Rural Development and the European Fisheries Fund, to establish an integrated

and coherent set of guidelines for the implementation of these instruments of the Community budget. The CCS must bring a higher level of coherence and complementarity in the planning and implementation of co-financed investments from the five structural funds, both at Community level and at national, regional and local level (Ungureanu G. *et al*, 2013).

However, this should not affect the algorithm on which the financial allocation is made on the three policies concerned (cohesion policy, the common agricultural policy and the fisheries and maritime affairs policy) nor the specificity and added value of the interventions of each fund. From the point of view of strategic programming at European level, the CSF must be closely, but not exclusively, linked to the Europe 2020 Strategy and the Integrated Guidelines. The proposed thematic priorities will have to meet the EU's major development objectives, while retaining some flexibility in relation to the level of development, needs and challenges specific to each Member State (Henke R., 2014).

If we correlate the previous analysis with the share of subsidies, it is observed that in 2015 in small farms the most important were direct payments, while in large farms there were other subsidies (those for disasters) and subsidies for intermediate consumption (*table 2*). In 2020, direct payments became the most important, representing over 60% of the structure of subsidies regardless of the size of the holdings (*table 2*).

Table 2

Subsidies structure, per standard value categories, in 2015 and 2020

Specification	Plant production subsidies	Animal production subsidies	Rural development	Intermediate consumption subsidies	Decoupled payments	Other subsidies
Total-2015	1.2	38.1	0.0	10.6	21.0	29.1
Total-2020	0.8	7.6	1.8	5.2	61.9	22.6
2015						
(1) 2 000 - < 8 000 EUR	0.0	14.9	0.0	1.2	42.6	41.1
(2) 8 000 - < 25 000 EUR	0.0	72.5	0.0	0.7	18.8	8.1
(5) 100 000 - < 500 000 EUR	0.9	36.6	0.0	13.3	15.9	33.2
(6) >= 500 000 EUR	3.3	14.2	0.0	24.0	20.4	38.1
2020						
(1) 2 000 - < 8 000 EUR	0.0	6.0	0.0	0.7	61.6	31.9
(2) 8 000 - < 25 000 EUR	0.0	8.5	2.8	3.9	61.7	23.2
(3) 25 000 - < 50 000 EUR	2.6	5.2	0.0	4.7	62.8	24.7
(4) 50 000 - < 100 000 EUR	0.0	2.0	0.1	5.5	68.5	23.8
(5) 100 000 - < 500 000 EUR	0.5	0.5	5.0	7.8	66.5	19.7
(6) >= 500 000 EUR	2.0	19.0	0.7	6.9	55.1	16.4
2015						
Field crops	2.0	0.2	0.0	22.1	27.9	47.8
Other permanent crops	2.9	0.0	0.0	6.1	72.5	18.8
Other animals	0.0	99.9	0.0	0.0	0.1	0.1
mixed	0.0	8.0	0.0	0.2	42.5	49.3
2020						
Field crops	0.4	0.0	2.5	6.7	69.5	20.8
Horticulture	0.0	0.0	0.0	0.4	76.8	22.8
Wine	0.0	0.0	0.0	33.4	64.8	1.8
Other permanent crops	0.0	0.0	0.0	0.0	97.2	2.8
Milk	0.0	0.0	3.9	0.7	34.7	60.7
Other grazing livestock	0.0	16.4	0.0	0.4	48.6	34.6
Other animals	7.6	74.8	0.0	3.0	11.2	3.4
mixed	0.0	10.4	0.0	0.5	62.4	26.7

Source: FADN (RICA)

It is imperative that the particular situation of the less developed regions of the Union be duly taken into account. A suggestive example in this respect is the level of development and the quality of infrastructure in key areas (transport, environment, energy, health, education, social assistance, broadband, etc.). These regions continue to have significant gaps in this respect compared to the rest of the Union.

As can be seen, the Regional Development Strategy 2020-2020 does not cover all the aspects necessary for adequate monitoring of the sustainable development of the region and the rural environment, and in many cases the proposed result indicators are oversized compared to the real

evolution of the region over the last 14 years. This oversizing of results, such as reducing the disparity to 25% or the risk and exclusion rate to 3.5%, is in fact a negative aspect of the way strategies are implemented in our country.

The evaluation of the Regional Development Strategy 2015-2019 highlighted the following:

- it does not address all aspects of sustainable development pursued at national level, not taking into account a series of indicators neither in the socio-economic analysis, nor in the strategic planning;
- does not propose measurable measures and especially quantifiable indicators for the proposed measures, this being based on a series of statistical indicators evaluated in the socio-economic analysis for the pre-accession period, which identifies the evolutionary trend of the period;
- separates rural priorities from other regional priorities, focusing on infrastructure development, the rural economy and human resources;
- the objectives for rural development are not detailed, being passed centrally which gives a confusing picture of the measures that were actually pursued for the development of rural areas, etc. (*table 3*).

Table 3

Sustainable Development Objective Indicator Priorities Target 2022 General Recommendations

Sustainable Development	Objective	Indicators	Target 2022	General Recommendations
Structural transformations and macroeconomic balances	Improving human capital Developing a modern infrastructure Supporting a competitive economy and local development Optimizing use and protecting natural resources	Gross domestic product per capita	Minimum 26857.7 RON/loc	Ensuring an average annual growth rate of 29.2%
		GDP / disparity index vs. national average	Maximum 42.7% (or maintaining the level of the year 2019)	Ensure an average annual growth rate of 8.6% or maintain disparity in 2019 (37.9%) We believe that the 25% strategy's disparity index proposed by the strategy is not feasible in the context of regional development over the last decade.
	Supporting a competitive economy and local development.	Number of active enterprises	Minimum 82207.7 companies	Ensuring an average annual growth rate of over 16.0% (supporting the establishment of over 30000 companies)
		Întreprinderi active la 1000 locuitori	Minim 22 companies to 1000 habitants	Ensuring an average annual growth rate of over 16.4% The strategy proposes only 20 companies per 1000 inhabitants, but the potential is higher.
	Developing a modern infrastructure Supporting a competitive economy and local development	Existing tourist accommodation capacity	Minimum 33662.4 places	Ensuring an average annual growth rate of over 15.0%; over 8000 accommodation places (eg equivalent to about 300-400 tourist boarding houses)

The evaluation of the Regional Development Strategy 2020-2020 highlighted the following:

- integrates the objectives for the rural environment within all regional priorities, focusing on: infrastructure development, rural economy, human resources, telecommunications and innovation;
- rural development is integrated and separated under priority 3 as a separate strategic objective with three components: local infrastructure, diversification of the local economy and SME development (entrepreneurship);
- the objectives are detailed and accompanied by result indicators for the established measures and implementation projects;
- proposes concrete and measurable measures (projects, time, funds, etc.), quantifiable result indicators; and so on.

Target indicators must be based on a realistic and concrete estimate in order to be monitored and thus allow the impact of strategic objectives to be measured. In this context, we consider that the proposed and substantiated result indicators starting from the previous trend of the region, for all strategic priorities 2020-2020, can

be much better materialized in projects with major impact on sustainable development both at regional and international level. rural environment. (*Table 4*).

Table 4

Evaluation of the results of the implementation of the 2015-2019 strategic objectives

Priority	Sustainable develoment	Rezultats	Impact
Business environment Human resources and social services Rural development	Gross Domestic Product per capita	Real GDP growth per inhabitant by 24.9%	+
		Increase of the disparity index compared to the national average of GDP / place cu 4,2% (o pondere de 62,1% din media naţională, ultimul loc)	-
		The slight increase of GDP / place in Botosani county, disparity (-18.6%)	+
		The slight decrease of GDP / place in Suceava County, disparity (-3.7%)	-
		The strong decline in GDP / place in Vaslui County, disparity (-32.7%) (last place at regional level)	-
Business environment	Increase in the number of active enterprises	Decrease in the number of active enterprises by 5.3%	-
		Discount approx. 20% of companies in industry and commerce, and especially growth in construction, agriculture and other sectors Reducing the number of enterprises in the processing industry (considered a priority sector)	-
		Growth by 19.9% of the number of enterprises per one thousand inhabitants	+
		The growth rate of new businesses has fallen by almost 30% (88% of the national average)	-
		The number of newly created businesses in rural areas was about 30% Increasing the share of companies in agriculture, commerce and other sectors in predominantly rural regions	+

The different methodology for implementing the two strategies determined us to identify quantifiable outcome indicators in order to evaluate the implementation of these strategic measures at the regional level and especially for the evaluation of sustainable development at regional and rural level.

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.

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The European model was often compared with the agriculture supporting system from other countries, being emphasized the weaknesses and the advantages of such an organization model. United States of America were often considered the benchmark, the profound reforms from this country allowing a reduced number of farmers to ensure sufficient production at equitable prices.

The design of the evolution of the selected strategic indicators, for the period 2014-2022, based on the trend of the periods 2000-2014, allowed us to compare the results obtained with the result indicators proposed within the Regional Development Strategy of the North-East Region.

The conclusions drawn from this analysis allowed us to observe that for the period 2014-

2020, the sustainable development objectives are partially pursued in implementation, through selective result indicators, which led us to develop new performance indicators or to change the values proposed in the current strategy. Our approach led to the redefinition of the general objective, to the reshaping of the results for 9 specific strategic objectives, the modification of the target values of 11 achievement indicators and the introduction of 23 new indicators for monitoring the strategic objectives of farms concerning the discomposure on income sources showed us that the value of the agricultural production leads to 68.8% of inequity, the remaining ones being under the influence of subventions. Among these, the most important contribution was of the free payments (20,8%) and the subventions for the intermediary consumes. The assessment of the effect generated by the modification of the income sources on the total income:

- incomes from the agricultural production, other subventions and subventions for breeding, lead to the increase of the inequity between the specialized farms; the increase with 1% of the incomes from the agricultural production leads to the increase of inequity with 6,85%;

- the subventions generally lead to the decrease of the inequity between them, especially in regard to the subventions for breeding (decrease of 4,1%) and direct payments (with 3,04%).

In conclusion, the subventions granted based on Pillar I present the highest level of importance in obtaining the incomes and therefore influence more and directly the inequity between farms. 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.

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FINANCIAL CRIME: HOW FINANCIAL INSTITUTIONS CAN MITIGATE MONEY LAUNDERING RISK ASSOCIATED WITH POLITICALLY EXPOSED PERSONS AND IMPROVE THEIR COMPLIANCE PROGRAM

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Abstract

The customer acceptance policy of financial institutions stipulates that the Bank shall enter in business relationship and offer banking products and services to customers based on risk appetite correlated to the reputational risk. According to Financial Action Task Force (FATF), a politically exposed person (PEP) is "an individual who is or has been entrusted with a prominent public function: Heads of State or of government, senior politicians, senior government, judicial or military officials, senior executives of state owned corporations, important political party officials, etc." The business relationship involving politically exposed persons (PEPs) is classified according to Know Your Customer and Anti Money Laundering Principles with high risk, because PEPs have the position to influence some decisions at state level, being involved in corruption, bribery schemes; they have access to significant state funds which can be laundered through companies owned by PEPs, their relatives or close associates by abusing of PEPs high position. The purpose of this scientific research is to highlight the money laundering risk indicators connected to PEPs and to propose mitigation measures to be applied by financial institutions, while strengthening their controls, as a part of an effective compliance program. .

Key words: Anti-Money Laundering, Politically Exposed Person (PEP), Sanctions, Compliance Program.

The economic activities performed in many developing countries favors initiation and after that the development of an impressive number of illegal activities, named as financial crimes.

Each modern society contains also a shadow economy, based on own rules where illegal activities take place and dirty money are obtained.

In many cases the authorities perform investigation activities when it is too late; the wrong things are visible and cannot be contested, when there are unbalances in society.

Each new governance, has the major objective to demonstrate how corrupt was the previous governance and based on this the dimension of financial crimes is increasing as a result of the intensification of the organized crime.

In this sense, the organized crime is using the corruption of politicians, judicial and financial bodies, customs authorities, etc.

For financial institutions is very important to apply the principles of Know Your Customer (KYC), in relation to PEP, which are classified from Anti Money Laundering (AML) point of view with high risk because of: *bribery, money laundering, terrorist financing* activities they may be involved in and for which must be applied by the financial institution enhance due diligence measures, which include but are not limited:

- prior approval of the initiation/continuation of the business relationship with a PEP client by the senior executive (executives or employees that have sufficient knowledge of the institution's exposure to money laundering and financing of terrorism and have a senior position to make decisions regarding that exposure and who are not necessarily members of the Board of Directors)
- collecting additional information about the source of funds and the source of wealth related to the business relationship or transactions and their verification (e.g. supporting documents);
- paying close attention to the client-related personal information from third parties (e.g. the press, requests for information from authorities, etc.);
- the high value transactions of clients assigned to the PEP category have to be approved in advance by the senior executive;

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- enhanced, continuous monitoring of the business relationship and transactions performed through accounts.

The purpose of this scientific paper is to highlight the importance of applying the KYC principles regarding the PEP clients, to highlight PEP specific regulatory trends, define risks connected to PEPs and to describe how to apply best practices to mitigate risks associated with PEPs while strengthening the existing controls.

MATERIAL AND METHOD

This scientific investigation was realised after the analysis of the following legal regulations:

- Law on Preventing and Combating Money Laundering and Terrorist Financing no. 308 of 22.12.2017
- Directive (EU) 2015/849 of the European Parliament and Council of 20/05/2015 (the "IV Directive") on prevention of use of the financial system for the purpose of money laundering or terrorist financing, which amends (EU) regulation no. 648/2012 of the European Parliament and Council, and which revokes directive 2005/60/EC of the European Parliament and Council and directive 2006/70/EC of the Commission;
- Order no. 15 of 08.06.2018 regarding the approval of the Guidelines on the Identification and Reporting of Activities or Transactions Suspected of Money Laundering;
- Order no. 17 of 08.06.2018 regarding the approval of the Guidelines on the Identification and Monitoring of Politically Exposed Persons
- Regulation No. 200 of 09 August, 2018 on requirements for prevention and combating money laundering and terrorist financing in the activity of banks;
- Wolfsberg Guidance on Politically Exposed Persons (PEPs) (released 2003, revised 2008, updated 2017)
- FATF Guidance on Politically Exposed Persons (2013)

The research methods which were used at elaboration this scientific research are: analysis and synthesis, induction, deduction.

RESULTS AND DISCUSSIONS

Politically Exposed Persons are subject of various investigations by international organizations, being defined as:

- Individuals who have or have had positions of public trust such as government officials, senior executives of government corporations, politicians, important political party officials, etc. and their families and close associates. (Wolfsberg Group, 2017).
- Natural persons who are or have been entrusted with prominent public functions and immediate family members, or persons known to be close associates, of such persons (EU Money Laundering Directive (4th 2015),
- An individual who is or has been entrusted with a prominent public function: Heads of State or of government, senior politicians, senior government, judicial or military officials, senior executives of state owned corporations, important political party officials, etc. (FATF, 2013; FATF, 2019),
- Natural persons that exercise or exercised during the last year prominent public functions at national and/or international level as well as members of the governing authorities of political parties (Law 308/2017 on Preventing and Combating Money Laundering and Terrorist Financing).

PEPs clients generate for financial institutions the following risks: *compliance risk, reputational risk, legal risk.*

In this sense, financial institutions use various methods to identify the Politically Exposed Persons:

- Through self-declaration – when a customer declares in the process of initiation/continuation of the business relationship with the financial institution that he/she is a PEP and the financial institution is performing all the necessary diligences
- Using screening tools – when the financial institution's employer from Front Office is introducing the name/surname of the customer in the IT system of the financial institution and the data of the customer is screened against local and international PEP lists. When coincidences of customers with PEP lists are registered the employer from Front Office performs the necessary diligences regarding the approval of this customer according to the AML Policy of the financial institution.

Among the most famous providers of PEP lists are LexisNexis Solutions, Refinitiv World Check One, Fircosoft, etc.

In some cases, the are situations when in the lists offered by some providers doesn't exist local PEPs related to some functions from state, this creating deficiencies in identification local PEPs. In this case, it is recommended for the financial institution to create the local PEPs list, based on the provisions of the local legislation in force of the specific country.

It is very important to perform screening of customers against PEP lists because this process gives possibility to the financial institutions to identify the PEPs and to mark them with high risk, applying enhanced due diligence measures.

In the same time, PEPs are very careful and trying to shield their identity using different ways (FATF, 2013):

- Use of corporate vehicles (legal entities and legal arrangements) to obscure the beneficial owner.
- Use of corporate vehicles without valid business reason.
- Use of intermediaries when this does not match with normal business practices or when this seems to be used to shield identity of PEP.
- Use of family members or close associates as legal owner.

Therefore, as a part of enhanced measures applicable in business relations with the politically exposed persons, their family members or PEP related persons, the financial institutions must apply a process of analysis and verification by using special factors, such as (Cox D., 2014; Sullivan K., 2015):

- the person owns or controls, in whole or in part, directly or indirectly, a financial institution and/or a professional participant on the non-banking market;

- the person owns or controls, in whole or in part, directly or indirectly, a financial institution and/or a professional participant on the non-banking market that is a partner or correspondent in a transaction with the Bank;

- personal property or lifestyle is not in accordance with the legitimate sources of income or the known property of the person, as well as the transactions performed;

- there are reasonable suspicions that the person has attempted to hide the nature of his/her income;

- the person is responsible or able to influence significant public procurement processes;

- the person is responsible for the issue of licenses, permits, approvals, limited governmental permissions in sectors considered to have high risk of corruption, such as construction, mineral extraction, health care, etc.;

- the person has preferential access to the privatization of former state assets;

- PEP at the international level, who is a citizen or resident, or has business interest in a country with a high risk of illicit trafficking in drugs and psychotropic substances, a country with a political system based on an autocratic and authoritarian regime or a country that has been identified as having strategic deficiencies including high levels of corruption; Other criteria depending on the risk identified in relation to the client, business relationship, conducted transactions, etc.

According to FATF, the financial institutions must be very careful at specific behavior of PEP, which may raise *reasons of suspicion/red flags* (FATF, 2013):

- The PEP is very interested about the AML policy or PEP policy of the financial institution
- The PEP doesn't want or feels uncomfortable to provide the financial institution the information about the source of funds or source of wealth
- After checking the information provided by PEPs about the source of funds source of wealth was identified that the information is not corresponding to the information officially available about salaries, asset declarations
- The PEP cannot provide justification about doing business in one or another high risk country
- The rapid movement of funds repeatedly by PEPs to and from countries with which PEP doesn't seem to have any business relationship
- At a company registered in high-risk jurisdictions, from the documents submitted or from other sources, the bank understands that the beneficial owner is a politically exposed person or persons associated with a PEP;
- Performing banking operations without any economic sense with involvement of politically exposed persons or transactions that do not reveal from their content the need to carry out such operations;
- The natural or legal person makes payments for the benefit of the politically exposed person or his family members for different types of services, but such transactions are not relevant to the specific activity for these natural or legal persons.

For monitoring purposes of PEPs it is very important to continuously monitor the Transparency International's Corruption Perception Index (CPI), which aggregates data from a number of different sources that provide perceptions by business-people and country experts of the level of corruption in the public sector (Transparency International, 2020; Golban A., 2019).

Analyzing the *figure 1*, we can reveal that the lowest level of CPI in 2019 was registered in: Denmark, New Zealand, Finland, Singapore, Sweden, Switzerland, Norway, Netherlands, Germany, Luxembourg and the highest level of CPI, was registered in: Somalia, South Sudan, Syria, Yemen, Venezuela, Sudan, Equatorial Guineea, Afghanistan, North Korea.

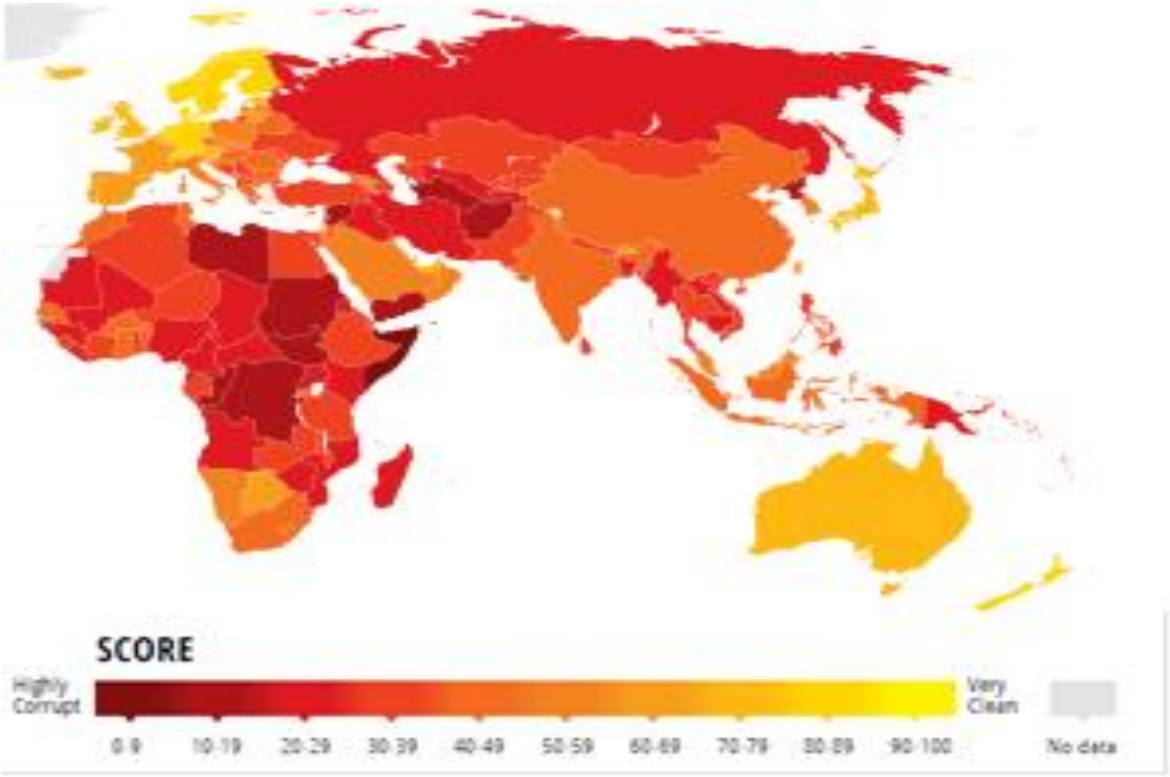

Figure 1 **The Corruption Perception Index in 2019**

Republic of Moldova was placed according to CPI in 2019 on the 120 place, between Sierra Leone (119) and Niger (120), Pakistan (120), Bolivia (123). Compared to Romania, the CPI for the Republic of Moldova is much higher than for Romania by 50 positions, which was placed on 70 place.

According to Corruption Perception Index Report (2019), the countries from Eastern Europe face:

- ✓ limited separation of powers,
- ✓ abuse of state resources for electoral purposes,
- ✓ opaque political party financing and conflict of interest.

In order to address effectively corruption, the political leaders from Eastern Europe have to prioritise public interests and set an example for transparency (Transparency International, 2020).

For financial institutions is very important to identify PEPs clients, to understand the purpose and nature of the business relationship and to apply enhanced due diligence measures (McCusker, R., 2006).

In case when financial institutions doesn't identify correctly the PEPs clients or do not apply enhanced due diligence measures regarding PEPs or do not report to local authorities the suspicious behavior of PEPs regarding money laundering and terrorist financing, the financial institutions risk fines/penalties from authorities.

In 2020, financial institutions received fines for breaches in the AML/KYC area as follows:

- ✓ The Financial and Capital Market Commission fined *Signet Bank of Latvia* (906 610 EURO) - for violating anti-money laundering and anti-terrorism financing (AML) regulatory requirements.
- ✓ New York Regulator - The New York State Department of Financial Services fined *Deutsche Bank AG* ($ 216.1 million) - for AML compliance failures, correspondent banking relationships with Danske Bank Estonia and FBME Bank.
- ✓ Chinese Central Bank fined *BNP Paribas Chinese Unit* (2.7 million yuan - $378.200) – for failures in KYC processes and in reporting significant and suspicious transactions
- ✓ FCA, fined the *Commerzbank London branch* (£ 37.8 million) - for violations of AML controls.
- ✓ 5 banks from Kenia - *KCB Group KCB.NR, Equity EQTY.NR, Co-op Bank Kenya COOP.NR, StanChart Kenya SCBK.NR and Diamond Trust DTK.NR* faced AML fines ($ 3.75 million) – for AML violations

Analyzing the figure 2 we can reveal that the dynamics of AML penalties have an increasing trend, registering in 2018 by approximately 2 times more penalties compared to 2018, being equal to $ 8 billion. In the first semester of 2020, were registered 6 billion dollars penalties. The majority of the AML fines were related to the breaches

regarding the KYC procedures, reporting suspicious transactions, lack of AML controls, Customer Due Diligence.

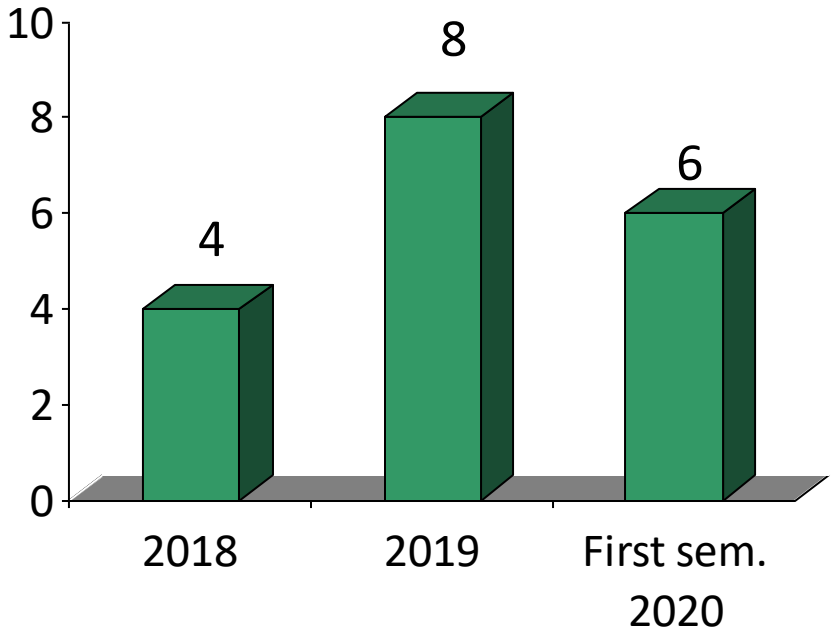

Figure 2 **The dynamics of AML penalties during 2018-first semester of 2020, billion dollars**

Therefore, from the investigations performed above, applying with good faith the principles of Know Your Customer, Enhanced Due Diligence Measures, Continuous monitoring and Reporting Suspicious transactions in case when there are reasons of suspicion/red flags regarding Politically Exposed Persons represent the necessary measures to be performed by Compliance/AML Officers which will protect the Bank against sanctions from authorities and will ensure a good reputation of the financial institution.

CONCLUSIONS

As a result of the performed investigations, we can highlight the following conclusions:

Financial institutions treat PEPs as high risk customers from AML point of view because of bribery, corruption, terrorist financing they may be involved in.

Identification of PEPs is performed using self-declaration of PEPs and automated screening tools;

PEPs care very much about their identity, in this sense using various methods to hide that they are the ultimate beneficial owner of assets, funds (corporate vehicles, family members, close associates).

For monitoring purposes, Transparency International's Corruption Perception Index gives possibility to create an image about the level of corruption in the public sector all over the World.

The fines for noncompliance with AML rules increased by 2 times in 2019 compared to 2018, being equal to $ 8 billion and to $ 6 billion in first half of 2020, revealing the importance of respecting by financial institutions the AML/KYC rules, as follows: identification the source and destination of funds, identification the purpose and nature of the business relationship with the customer, documentation of transactions performed by the customers.

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PROMOTING THE GREEN BUSINESS - A PILLAR OF THE SUSTAINABLE DEVELOPMENT

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Abstract

The evolutionary trends of the economic and social environment are increasingly associated with new forms of the economic growth and development, focused on the attention given to the relation with the environment and the impact on this. This orientation is also supported by the sustainable development strategies, which are increasingly active for the national business practices. By this paper, we aim to bring together, in a common vision, the approaches that support a balanced economic growth, in accordance with the requirements of the environmental protection and the natural resources conservation. Through a qualitative empirical research, we identify the green businesses as a pillar of the sustainable development that supports the evolution of the business environment in a consolidated and balanced pace. The analysis, descriptive-exploratory, is based on synthesis and exemplification and follows the evolution of green business in the last 10 years, at European and national level, starting from the European experiences in the countries that have supported and promoted the mechanisms to strengthen the green business. The results of the study are materialized in a synoptic presentation of the national business environment oriented towards the green business, arguing the need to connect the strategic requirements of the sustainable development, Horizon 2030, with the specific objectives of any form of business: profitability and stability. Thus, we present a general dashboard that groups the most relevant areas in which green businesses in Romania have demonstrated their sustainability, considering both economic and social objectives, as well as the ecological ones. Although the means of promoting such businesses are not very visible, sufficiently transparent or strongly supported, we draw some conclusions which support the hypothesis that the future of a solid and sustainable business environment requires the reconsideration of the economy-environment relationship and promoting the symbiotic perspective on which the green business it is based.

Key words: eco-economy, green business, waste recovery, sustainability

Concepts such as eco-economy, sustainable economy, circular economy are relatively new and modern and they refer to a new type of economy that is developing without excessive environmental damage.

In the practical approach of these concepts, growth and development have different meanings, which allows finding of solutions to develop and maintain a solid and yet friendly economy.

Since the discussions regarding a definitive definition of the sustainable development are still open, the authors launch a question considered a starting point of the present paper research: how can we establish whether a project, an action, a company or a business determines and produces results quantified and considered as sustainable?

The economic environment, being in a large process of reorientation, requires a major reconsideration, since in almost all countries in the world it is acknowledged and aware of the severe deterioration of the environment with direct effects on the social environment and life quality. Since the 1990s, the problem of greening the economy has been raised, purely theoretical at a first glance, but meant to find effective solutions to the global world problems.

The world economy has undergone, in a relative short time, through complex transformations, firmly felt both in terms of social welfare and the condition of the environment. We consider, in this context, that eco-economic support through green business is a reliable solution to both economic development and environmental protection. In order to transform the economy characterized, in some sectors as being “destructive”, into a new, “environmentally – friendly” economy, a major change in the mentality and the way of managing businesses are required, as a recognition of the fact that economic systems are dependent on environmental factors, especially through the resources used in the economic activities.

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In this context, the sustainable development specific issue can be materialized towards the green business sector, which is at an early stage in the companies on the national market. The authors start on the premise that environmental problems, more and more numerous and emphasized in recent years, have given rise to new markets and new opportunities for business enterprises located in the business environment positioned towards sustainable development. Essentially, the problems triggered by the economy-environment relationship are becoming opportunities for new businesses. Fundamentally, notions such as efficiency, productivity or profitability call for new challenges that current economic systems should manage.

MATERIAL AND METHOD

The interrelated approach to the concepts of economic efficiency, profitability and sustainable development starts from a set of errors that have occurred as a result of unbalanced economic growth, to which many successful businesses around the world have contributed. These errors refer to: lack of constant follow-up of the company's mission, predominant short-term orientation towards profits, evaluation of economic benefits based only on annual financial results, frequent change of management, orientation of the company as a whole only on numerical and quantitative aspects, etc. (Lafratta, 2004). In addition, the world's population uses natural resources faster than they can be regenerated, and waste production is faster than the environment is able to assimilate.

The purpose of this paper is to identify and analyze the ways in which new types of environmentally friendly businesses can be developed, adapted to the problems currently facing both society and the environment, as well as economic systems.

One of the simplest, but comprehensive definitions of sustainable development, formulated with the establishment of S.E.A. (System of Environment Administration) as a methodology for assessing the impact of socio-economic activities on the environment is: ”a firm and determined management of natural resources and the conservation of the balance of various ecosystems”. The debates on ecological issues were correlated with those on economic reconstruction. Unanimous views subscribed to the European Commissioner for the Environment's idea that ”economic development in accordance with ecological principles will underpin many business models, being a priority on the agenda of many governments.” (Dimas, 2009) Since we live on a finite planet, which has a limited amount of natural resources and a limited capacity to absorb waste, it is not possible for the economy to grow indefinitely. As early as February 2009, the head of the European Central Bank, Jean-Claude Trichet, stated: ”We live in a non-linear world in which classical economic models and theories cannot be applied, so future development cannot be fully foreseen.” (Seager, 2009). It is absolutely necessary to identify the impact, respectively the eco-economic directions of the green businesses.

New types of business, based on ecological principles, generically called green businesses are considered alternatives and solutions for the transition from an economy based on an unbalanced growth to the eco-economy. Compatibility between wealth production and environmental pressure reduction has already become a general requirement which can be achieved, provided that specific rules of socio-economic conduct are followed. ”Building the eco-economy is the biggest investment opportunity in history. Companies that have a new economic vision and include environmental aspects in business planning, will be winners” (Brown, 2002). At the O.N.U. Conference (1992), on the environment and development it was concluded that “the main cause of global environmental degradation lies in unsustainable patterns of production and consumption, especially in industrialized countries”. Specialists from different areas of interest have reached a consensus and believe that an economy will be sustainable only if it respects the principles of ecology. Moreover, others believe that non-compliance with ecological principles in the economy inevitably leads to collapse.

The research documentation for this paper follows a set of basic elements that we correlate: the issue of sustainable development in a practical approach that we identify as reflected in the trend towards the ecological or green business environment. The research for this paper is based on chronological foray, data highlighting and interpretation. Information is used from reports on business environments with ecological potential, especially the business environment that highlights added value in terms of sustainable development, specifically those results that can be quantified economically and socially through sustainable development indicators. The research methods used are incursion, selection and synthesis, filled by highlighting the results related to the development of the business environment with ecological potential. The paper has rather a descriptive character, through the synthetic presentation of the impact results of green business in the socio-economic environment in Romania.

RESULTS AND DISCUSSIONS

Starting from the question *of what green businesses are and how they can be evaluated from the perspective of sustainable development*, we

have documented the sources of ideas that can turn a traditional business into an eco-business.

The most relevant results indicated the following sources of inspiration for the development of the green business environment: ecological services, clothing and furniture from waste and recycled materials, repairs and reconditioning, catering with organic products, waste collection and processing, food waste composting, encouraging local and traditional production, manufacturing based on environmentally friendly materials, using plastic waste as a raw material for the fashion industry (H&M, Nike, Patagonia brands), establishment of ecological green spaces (synthetic turf, drought-resistant plants, use of permaculture principles), cleaning services of ventilation systems, handmade organic production (cosmetics and cleaning products), consultancy for sustainable development and waste management, agri-food production and trade ecological principles, composting of food waste for use in the agricultural industry, selective collection and recycling of reusable materials (paper, glass, aluminum cans, batteries, etc.), central heating with renewable energy, spaces and shopping centers based on eco-friendly technologies and eco-design (Park Lake Bucharest), ecological houses and dwellings, thermo-fleece insulation systems made of sheep wool or other raw materials coming from the zootechnical sector, etc.

The model countries with the most sustained eco-economic concerns and which, following their own experiences, have demonstrated the economic, social and ecological viability of eco-business, are: USA, Holland, England, Italy, France, Germany, Austria.

As early as 2006, the Romanian Ministry of Environment has considered the orientation towards waste management, appreciated as a great opportunity and particularly profitable, for which investments of over 8 billion euros have been estimated.

In 2004, the “National Waste Management Strategy” was developed based on the consideration of integrated waste management systems. According to the Romanian legislation, the manufacturing companies have the obligation to recycle 20% and to capitalize 30% of the quantity of packaging resulting from the production activity.

Thus, environmental protection has become a source of inspiration for one of the most promising areas of business: green business. Although the profitability of these businesses is recognized, the profit, which can be 5-10%, is gathered over time, a specific aspect of any environment investment. However, at national level, a problem still facing the focus on the green business sector is the lack of investors associated with distrust in the profitability of such businesses. According to the European Commissioner for the Environment, Maritime Affairs and Fishery: ”Companies competing for environmental awards are the real drivers of change and transition to a circular economy, proving that innovation, economic viability and environmental protection can work together. Green solutions can be incorporated into business models, regardless of size or stage of development, economic sector or country” (Vella, 2016). The most suggestive green business models in Romania were promoted by economic agents such as: Eco Rom Ambalaje S.A., Scandia Romania, Bio Energy (part of the ABBC group, with an investment of about 90 million euros in the cogeneration plant from Suceava) Recolamp, Argeșana, Bioflex and other companies.

Regarding the quantification of green business results, one of the most important methods of quantifying the ecological performance of an economy is given by the Environmental Performance Index (EPI) which allows the numerical quantification of environmental performance benchmarks and environmental policies of a country. This index was developed from the pilot environmental performance index stage, first published in 2002, to two other variants developed later EPI 2006 and EPI 2008.

Another tool for measuring green business performance is the Dow Jones Sustainability Index (DJSI). According to S&P Global, ”the Dow Jones Sustainability World Index comprises global sustainability leaders as identified by Sustainable Asset Management (SAM). It represents the top 10% of the largest 2,500 companies in the S&P Global Broad Market Index based on long-term economic, environmental and social criteria. The Dow Jones Sustainability Indices (DJSI) are a family of best-in-class benchmarks for investors who have recognized that sustainable business practices are critical to generating long-term shareholder value and who wish to reflect their sustainability convictions in their investment portfolios”. For Romania, for now the most representative and complex tool for analyzing the performance of green business is the Green Business Index (GBI), a real barometer of environmental responsibility of Romanian companies and which monitors green initiatives in the Romanian business sector. The core of the instrument is the statistical indicators of sustainable development, in accordance with the proposals of the European and the National Institute of Statistics. The standardized reference

frameworks of this instrument are internationally applicable: ISO 14031, ISO 26000, ISO 16001. Another significant reference framework for measuring the eco-performance of green business is that of the OECD which has developed a system of indicators called green growth indicators, defining green growth as follows: “Green growth is about fostering economic growth and development while ensuring that the natural assets continue to provide the resources and environmental services on which our well-being relies. To do this it must catalyze investment and innovation which will underpin sustained growth and give rise to new economic opportunities.”

According to studies conducted by management consulting firms on the economic and financial results of companies profiled on green or ecological business, it turned out that "green companies" recorded superior results compared to similar firms that did not adopt eco-friendly systems, management or compared to its own activity in the period when it did not base its activity on ecological principles.

CONCLUSIONS

In the business environment, the concept of "green" means, first of all, efficiency and low consumption of resources, but also integrated community support in economic activities. Thus, companies are invited to review their sustainable practices, because a solid sustainability strategy is much more effective than measures to improve the image of companies, such as greenwashing. Thus, one dimension of the direction to follow is that of the accelerated development of the green economy, defined as an economic system that preserves and restores ecosystems and social welfare. Currently, Romania is one of the countries with extremely high potential in terms of business opportunities with ecological profile.

Sustainable development and green business are in a symbiotic relationship supported by one of the newest forms of economy: the circular economy which, although it is not yet of major interest in Romania, is increasingly visible in practice, some of the new businesses being oriented towards the reuse of waste as a raw material for the new round of production or towards the eco-economic reconsideration of existing businesses. The approach in this paper called for studies and research that argue that the economy can be "reinvented" by capitalizing on opportunities to build green businesses, which are best incubated in the new circular economy - another fundamental pillar of sustainable development.

In conclusion, we believe that economies could benefit from a new relaunch by disseminating best eco-economic practices, stimulating innovation, developing new methods of efficient organization and management, investing in social and human capital, pursuing the protection and conservation of environmental factors, environment - all these being certain directions of sustainable development.

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**** Towards Green Growth: Monitoring Progress, 2011,* http://www.oecd.org/greengrowth/green-growth-indicators/

SECONDARY IRRIGATION INFRASTRUCTURE IN ROMANIA: INFLUENCE OF THE WATER USER`S ASSOCIATIONS MODERNIZATION ON THE PERFORMANCE OF THEIR MEMBER FARMS

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Abstract

In this paper the authors undertook an analysis of the Water User's Associations influence on the performance of their members and on the agricultural sector. The existing crop irrigation infrastructure was built during the communist period, before 1989. It was divided, since it's been built, into primary and secondary infrastructure. After 1989, the secondary infrastructure, usually built and located in key spots, in the proximity of water sources and farms, was assigned to these units for maintenance and modernization. Water User's Associations are non-profit economic units that can be established by a minimum of ten members, agricultural units, and can benefit for receiving such an infrastructure located in their proximity. Since Romania joined the E.U., some financial incentives have been developed with the purpose of modernization of the primary and secondary irrigation infrastructure. Thus, the secondary infrastructure can benefit from up to 1,000,000 Euro, with an intensity of 100% non-reimbursable for the modernization of its entire serving area. In this paper the authors analyze the effectiveness of such an investment, a specific investment amounting to 999,933 Euro. It will be shown how by carrying out the investment and modernizing the infrastructure, an annual saving of 6,621,000 cubic meters of water will be achieved, as well as an annual saving of at least 463,200 lei. As will be shown, the largest impact consists in the sufficient irrigation of the crops that leads to yields up to 4 times higher per ha. The authors determined numerous indicators from the studies that are presented in the paper.

Key words: irrigation, crops, European incentives

Romania is in the top of the European Union countries in terms of the number of farms, about one million farmers developing this activity, unfortunately most of them working in the inefficient system of subsistence agriculture (National Rural Development Programme 2014-2020).

Through the Common Agricultural Policy, Romania benefits from two types of financial support: direct payments granted under the 1st Pillar and non-reimbursable financial aid granted on the basis of investments made by farmers, through the 2nd Pillar (NRDP 2014-2020).

The EAFRD is complementary to direct area payments to farmers, respectively natural and / or legal persons engaged in agricultural production. While the Agency for Payments and Intervention in Agriculture (APIA) manages these direct payments, the Agency for Rural Investment Financing (AFIR) manages European non-reimbursable funds for the modernization of the agricultural sector (Robu A.D. *et al*, 2016).

Each of the two pillars provides support through two different European funds. Thus, direct payments through Pillar have as their source EAGF (European Agricultural Guarantee Fund), while Pillar II payments have as source EAFRD (European Agricultural Fund for Rural Development). The latter, whose tools have benefited the unit analyzed in the present paper, is carried out in Romania through the National Rural Development Program (NRDP 2014 – 2020).

Starting from the initiative of the European Council on support for rural development through the European Agricultural Fund for Rural Development (EAFRD), the National Strategic Plan for Romania, which is the instrument for the implementation of the National Rural Development Program for the period 2007 – 2013, was developed. Finally, NRDP is the instrument for accessing the European Agricultural Fund for Rural Development (EAFRD) and has been developed for the 2007 – 2013 and 2014 – 2020 intervals (AFIR, 2018).

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One of the main sectors that benefit from EAFRD funds in recent years is the irrigation sector. Specifically, both the primary infrastructure (managed by the National Agency of Land Improvement under the Ministry of Agriculture) and the secondary infrastructure owned by the Water User's Associations are aimed at modernization.

The allocated funds for the secondary infrastructure were not significant in the recent years but it is expected that this allocation will rise given the increasingly dry years that are recorded throughout Romania.

The authors undertook an analysis of the Water User's Associations influence on the performance of their members and on the agricultural sector. The existing crop irrigation infrastructure was built during the communist period, before 1989. It was divided, since it's been built, into primary and secondary infrastructure.

After 1989, the secondary infrastructure, usually built-in key spots, in the proximity of water sources and farms, was assigned to these units for maintenance and modernization.

Water User`s Associations are non-profit economic units that can be established by a minimum of ten members, agricultural units, and can benefit for receiving such an infrastructure located in their proximity.

Since Romania joined the E.U., some financial incentives have been developed with the purpose of modernization of the primary and secondary irrigation infrastructure (Brezuleanu S., 2009).

Thus, the secondary infrastructure can benefit from up to 1,000,000 Euro, with an intensity of 100% non-reimbursable for the modernization of its entire serving area. The studied unit invested 999,933 Euro by which covered three sectors: modernization of the irrigation of waterpipes for 6.4 km, modernization of the main pumping station and the acquisition of six irrigation equipment.

By this investment, after its commissioning, It will be shown how by carrying out the investment and modernizing the infrastructure, an annual saving of 6,621,000 cubic meters of water will be achieved, as well as an annual saving of at least 729,951 lei. The largest impact consists in the sufficient irrigation of the crops that leads to yields up to 4 times higher per ha. The authors determined numerous indicators from the studies that are presented in the paper.

MATERIAL AND METHOD

The necessary studies and approaches for development of this paper have been carried out during 2020. The primary data was the main source of information. The authors have gained access to the Water User's Organization financing project, financial statements and accounting statements. For studying these documents, a series of visits were carried out at the unit's headquarters. Since the Organization has 13 members, these member's financial and accounting documents were studied. The documents of the 13 units regarding the evolution of the areas used for crops in the agricultural year 2019 – 2020, the financial accounting documents regarding the evolution of the economic indicators, the evolution of the technical capacity through the irrigation investments made and other aspects were analyzed.

On the other hand, data from secondary sources, respectively the specific literature in Romania and abroad was used, including the official reports of the Agency of Financing of Rural Investments.

Both the data obtained in the analysis of the documents of the agricultural units as well as those of the specialized literature were processed and interpreted in order to highlight the advantages of the 1,000,000 Euro investment that this Water User's Organization made during the last two years.

RESULTS AND DISCUSSIONS

Two main factors are currently involved in sector irrigation in Romania: the Ministry of Agriculture and Rural Development - including through subordinate agencies - and farmers, who have formed Irrigation Water User's Associations. The general lines of activity of these two factors were drawn by Law 138/2004 - the Law on Land Improvements.

Since Romania's accession to the EU, on 1st January, 2007, it benefits from grants for the modernization of the existing secondary irrigation infrastructure. This infrastructure comes from the regime prior to 1989 and is located in the proximity of large and constant water sources: Prut, Siret, Olt rivers, Danube stream etc.

In order to take possession of this infrastructure located in their vicinity, farmers have to establish Water User's Associations, according to the requirements designed and published by the Ministry of Agriculture and Rural Development.

Owning such an organization, they become eligible to benefit from 1,000,000 Euros from the E.U., 100% non-refundable, to modernize their irrigation system.

These systems generally consist of irrigation pumping stations, canals, pipes and antennas. All these together contribute to the water pumping from the primary infrastructure (main pumping

stations which sucke water from the source) to the crop irrigation final equipment (pivots, drums etc).

The specific investments of the project consist in modernizing the secondary irrigation infrastructure by modernizing and rehabilitating the SPP pressure station and the network of buried pipes which the Association owns. The investment is of public utility and serves all its member and landowners. The modernization and rehabilitation works, with the acquisition of irrigation equipment were the object of the investment.

The total area of the Association taken for study has 2,761 ha. This area is cultivated by the 13 member farmers, on the territory of three communes from Iași County. The modernization will generate, after its commissioning, a water saving of 20.17%. This investment was proposed taking into account the required quantity of water for each crop. *Table 1* centralizes the quantity of water required by each crop of the farms in the Association.

The investment was required especially due to the appreciable age (about 36 years old), the existing facilities and equipment are physically and morally worn, damaged, so they operate with very low energy yields, high electricity consumption for water pumping and particularly high maintenance and repair costs.

As it can be seen, the expenses for all the irrigation systems used for the 2,761 ha is double in the scenario of maintaining the current structure without the grant modernization (*table 2*)

Besides the important financial economies that the Water User's Organization benefits, another significant benefit for the farmers is the much better production of their crops. In 2020, the most significant differences were recorded on maize and sunflower crops. Given that all the above costs of the infrastructure usage and staff salaries are supported by all the 13 members, the expenses for each member is extremely low compared with the benefits of optimally and sufficiently irrigating the crops. Moreover, given the state-of-the-art technologies used when building these systems by European financing, the needed staff for operating the whole system is minimum. One of the main assets of the system is the SCADA technology which allows the system to be controlled by any mobile phone or computer.

Table 1

Irrigation norms used within the studied farm

Nr. crt	Crop	Area ha	Percent	Irrigantion norm (mc / ha)	Norm distribution by month – ha					
					April	May	June	July	August	September
1	Wheat	359	13	1,840	359	359	0	0	0	-
2	Maize	1,105	40	2,470	0	1,105	1,105	1,105	1,105	-
3	Sunflower	138	5	2,000	0	138	138	138	-	-
4	Sugar beet	221	8	3,060	0	221	221	221	221	221
5	Soy	138	5	2,530	0	138	138	138	138	-
6	Lucern	414	15	3,470	0	414	414	414	414	-
7	Forage plants	248	9	3,670	0	248	248	248	248	248
8	Vegetables	138	5	3,030	138	138	138	138	138	-
TOTAL		2,761	100	-	497	2,761	2,402	2,402	2,264	469

For the cost – effectiveness analysis of the project the following data was used; it revealed a cost / effectiveness ratio of 0.46 lei / 1 cubic meter of saved water. This is due to the many positive features of the system after its commissioning, automatizations, higher efficiency etc.

Table 2

Figures on the system modernization benefits – lei

Description	By modernizing	Without modernizing	Odds
Pumped water volume from the water source, cubic meters	6,621	8,372	1,751
Repairs and maintenance costs, lei	65,000	300,000	235,000
Staff salary	110,000	360,000	250,000
Supplies	30,000	30,000	0
Cost of pumping electricity	572,130	815,330	243,200
TOTAL	**783,751**	**1,513,702**	**729,951**

It can be seen that there is a difference of 729,951 lei in terms of financial savings because of the modernization by the financing project. This means that the whole investment will pay off in as short as six and a half years.

Table 3

Calculation of irrigation water cost

Nr. crt	Specification	Unit	By modernizing	Without modernizing
1	Necessary water volume	Thousand cubic meters	1,730	1,730
2	Total water costs	Lei / year	969	969
2.1	Delivered water quantity	Thousand cubic meters	2,167	3,308
2.2	National Land Improvement Agency fee	Lei / year	969	969
3	Total exploitation costs, of which	Lei / year	600,460	286,492
3.1	Electricity	Lei / year	205,460	149,492
3.2	Wage	Lei / year	180,000	72,000
3.3	Consumables	Lei / year	15,000	15,000
3.4	Repair and maintenance costs, machine spare parts	Lei / year	200,000	50,000
4	Unit price of water required for irrigation	Lei / 1,000 mc	347,65	165,60
5	Water price reduction / increase [(2+3)/1]	%		-52,37

The main differences in costs consist, as can be seen in Table 3, in the amount of water delivered, electricity consumed, wages and maintenance costs.

The significant difference in the quantity of water delivered is explained by the significant losses recorded through the defective pipes before the investment.

As we can see from the same Table 3, the reduction if the water cost for irrigation in the investment scenario is 52.37% lower compared to the scenario where no investment is established.

A very important aspect is that the difference of 52.37% will be felt in the accounting and profitability of all farms served by this investment.

CONCLUSIONS

1. The authors of this paper took into study a Water User's Association which applied and won an European Grant of 995,100 Euros, finishing the project implementation in 2020;
2. The whole irrigation infrastructure of the Association taken into study is one of the largest in Romania, serving a total netto area of 2,761 ha and a number of 13 different vegetable farms;
3. The authors made an analysis on both the Association financial statements and individual statements on some of the members;
4. The expenditure of each member was minimum for implementing the project and for the usage of the infrastructure the whole yearly expenditure is 783,751 lei for year 2020; the cost – effectiveness analysis revealed a ratio of 0,46 lei for each one cubic meter of saved water;
5. The most important contribution of the system is that it provides enough water for all the crops of the members raising all the crop productions

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TAXATION: IS FLAT RATE BETTER THAN PROGRESSIVE RATE?

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Abstract

Our research aims to analyze the evolution in time and space of taxation rates and the impact of legislative changes on the microeconomic and macroeconomic environments, as well as the impact of legislative changes, the analysis of different models of tax systems based on the flat tax rate, used in Romania, or progressive tax rates, preferred in countries like France, Belgium and Luxembourg. Attempts at comparing personal income taxes are relatively rare and difficult to achieve precisely because of the tax legislation that is significantly different from one country to another in terms of tax base, tax rates or method of calculation of the various taxes and fees. Identifying the best taxation approach is the main goal of our paper. Our research is aimed at identifying the best taxation system, at determining the correlation between tax burden and tax income, thus analyzing the distributive effects of flat rates or progressive rates, and the effects of preferring one to the other, in other words determining whether they encouraged the formation of a middle class or on the contrary, they have deepened the inequity among the population, the effects that these systems have had on the social, economic and political environments in Romania and in the French-speaking countries included in our research: France, Belgium and Luxembourg.

Key words: taxation, best taxation rate, flat rate, progressive rates

Economics researchers have developed the principle of equity, which they consider one of the pillars of an optimal tax system. In his famous book entitled the *'Principles of Political Economy'*, John Stuart Mill (Mill, 1885) argued that equality should be at the core of any tax system, just like it should be at the core of all government policies. Henry Sidgwick (Sidgwick, 1907) defined the general principle of equity as follows: *'An action which a person considers fair for themselves is implicitly considered fair for all similar circumstances'.* However, research on fiscal policies in terms of equity relies on Stacy J. Adams' *theory of social equity* (Adams, 1965). He claims that every individual expects a comparable level of effort and benefits, and is tempted to change their behavior if they perceive any treatment differences.

From a fiscal point of view, theories claim that taxation should take into account the taxpayer's financial power and resort to progressive taxation, which should be a tool for redistributing and equalizing wealth within society. Two important taxation principles are linked to the idea of the ability to pay: *the principle of horizontal equity and the principle of vertical equity*.

- The principle of vertical equity states that wealth should be directed from the high-income socio-professional categories to lower-income categories; according to this principle, individuals in similar circumstances should be treated equally by the tax system.
- The principle of horizontal equity require higher-income individuals to pay more taxes, as they have a greater ability to pay; according to this principle, some of the wealth that they produce is reallocated, thus pursuing other objectives than that of reducing the gap between income levels by granting child allowances, overtaxing the unmarried, etc. The principle of horizontal equity is considered the most important principle in the theory of taxation analyzed by Elkins (Elkins E., 2006), which states that the rule of horizontal tax equity requires equal tax treatment for taxpayers who are in similar situations or circumstances. The principle of horizontal fiscal equity does not seek to define the manner in which taxes are charged, but requires government bodies to justify non-uniform fiscal policies (Repetti J.R., 2012).

In the light of the theories described above, in our opinion, the income levels of both individuals and business entities is the most

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relevant basis for comparison in determining the requirements of the horizontal tax equity principle.

Literature review has revealed that all theories on taxes and fees strive to substantiate their necessity for both taxpayers (individuals or business entities) and for the state budget. However, these theories actually conceal the truth, namely the fact that they are more favorable to the state than to taxpayers.

Theories are developed to justify tax burden and taxation level, in order to demonstrate a certain fiscal fairness, the increase or introduction of new taxes and duties, which are tools used to regulate the economy that must keep inflation within certain limits, hence the need to redistribute income and wealth from taxpayers to the state. Based on the various theories on the necessity and fairness of income distribution in society described above, and taking into account the economic and political backgrounds, modern states redistribute income and wealth at levels varying from one country to another and from one time to another.

Therefore, public authorities use taxation, either progressive or flat rate taxation, to cover public expenditure needs for allowances, subsidies, provision of collective goods and services.

According to the level of the tax rate (Bistriceanu E., 1995), there are:

- ***proportional rates***: regardless of the size of the tax base, the same tax rate applies, which means that the same proportion is kept between the taxable base and the amount of the tax actually levied;
- ***progressive rates***: is characterized by the increase of the tax rate as the tax base increases. It is a tax calculation method that best meets the principle of tax equity.
  - *simple progressive tax* (or global taxation) involves the use of increasing rates, as the tax base increases (the transition from one scale to another is disadvantageous for those whose earned income level is at the bottom of the scale, compared to those at the top of the previous scale),
  - *compound progressive tax* (on tranches), when the income to be taxed is divided into tranches on which increasing tax rates are levied. The amount of the tax levy results from the sum of the partial amounts calculated for each income tranche.
- ***regressive rates***, which decrease as the tax base increases,
- ***degressive rates***, which increase at different rates up to a certain value of the taxable base, and after reaching a preset level of the amount of tax, they decrease constantly in relation to the total income.

Progressive taxation is dwelt on by M. Slade Kendrick in his work *The Ability-to-Pay Theory of Taxation* (Kendrick M.S., 1939), which is explained in terms of sacrifice. According to him, sacrifice is the basic principle that underlies tax collection. Therefore, one's ability to pay taxes must be analyzed based on their wealth and on the ease with which they acquired that wealth. A classic criterion for the distribution of taxes is that everyone should equally sacrifice the loss of utility. This tax distribution method is continuous and has the following four properties: the way in which taxpayers distribute a given tax total depends only on their own taxable income; a tax increase means that everyone pays more; each tax increase is made according to the taxpayers' current income; the ranking of taxpayers according to pre-tax income and after-tax income is the same, there is a function of relative utility to which all taxpayers sacrifice equally. Relying on this concept of sacrifice, Kendrick developed three theories of *progressive taxation* in his book (Kendrick M.S., 1939):

- *Theory of equal sacrifice*, according to which taxes should be set so that the taxpayer's sacrifice in paying taxes is the same;
- *Theory of proportional equality*, according to which taxation should be made based on the income earned, therefore equality is to be found in proportion and not in the extent of sacrifice;
- *Theory of minimum sacrifice*, which is construed in the sense of a group, the goal being the least sacrifice for the group, so taxes should first be set according to the income of the very rich. Moderate-income individuals would be taxed only after the income of the very rich and of the rich has dropped to the level of average income. This theory virtually requires the gradual elimination of high income through taxation.

The issue of tax progressiveness has generated some of the oldest and most controversial debates in the field of fiscal policy, in terms of achieving fiscal fairness. Most opinions refer to the progressiveness of income tax, but there are specialists who claim that progressiveness should affect the whole set of taxes borne by taxpayers. As stated in the Laffer curve (*'trop d'impôt tue l'impôt'*), tax progressiveness must be approached not only from the viewpoint of fiscal fairness, but also from the viewpoint of efficiency, as too much tax destroys the tax base.

However, flat rate taxation, also called capitation, does not abide by the principle of social equity, as it does not take into account the taxpayers' amount of income or wealth or their personal situation. Flat rate taxation is currently used in developing countries (Romania, Hungary),

when calculating direct taxes such as corporate income tax and indirect taxes: VAT, customs duties.

Arthur B. Laffer is the one who provided the most convincing explanation for the relationship between the tax rate enforced by the government and the income on which tax is levied. The 'Laffer Curve' (Laffer A.B., 1765) graphically shows the trade-off between tax rates and tax revenues, and explains how a non-progressive tax can help increase tax revenues. The Laffer analysis explains how the government can earn the same amount of income in two different ways: by collecting a high tax from a small part of the population (a high tax on a narrow tax base), which is the equivalent of progressive taxation, or by levying a low tax on a wide taxable base, i.e. a single rate of tax.

MATERIAL AND METHOD

The methodology used to achieve this goal consisted of data collection methods, statistical and economic analysis of data on the main categories of taxes that have significant shares in national tax systems, namely: income tax, profit tax, social contributions, VAT. As concerns the research methods employed, in our paper, the most common method is the comparative method, as it allows to determine the differences and similarities between the analyzed tax systems, comparisons that have been synthesized in tables or charts. The research techniques and procedures used are documentary analysis, analysis of important legislation, collection and processing of information, creation of tables, figures and charts to synthesize and highlight the research results.

According to Richard's opinion (Richard J., 1995), *'the entire accounting legislation in Romania is based on French financial accounting with all the characteristics of static accounting, macroeconomic and fiscal objectives'*. Starting from this idea, we set out to identify and compare the wage levels, tax bases and tax calculation methods used in Romania and in the French-speaking countries included in our research: France, Belgium and Luxembourg.

Among the European Union Member States, we only chose the French-speaking countries with the highest effective tax rates and drew comparisons between the minimum reference wage and average gross wage also taking into account other indicators such as: unemployment rate, labor productivity and consumer price index.

The tax systems of the European Union Member States were analyzed in terms of income tax of individuals and legal entities, indicators of progressivity, income inequality, tax rates, tax and contribution withholding method, with an emphasis on the tax systems of French-speaking countries: France, Belgium and Luxembourg and a comparative study on wage income tax calculation.

In order to highlight the wage differences between Romania and the French-speaking countries (France, Belgium and Luxembourg), and between the flat tax rate specific to Romania and the progressive tax rate system existing in the abovementioned French-speaking countries, we made wage calculations according to the legislation of each country, starting from the minimum wage and average gross wage.

RESULTS AND DISCUSSIONS

The trend in developed countries is still to tax in progressive rates to the detriment of flat rates, as authorities consider this method of collection to be more equitable.

The minimum wage in Romania is among the lowest in Europe. In 2020, the minimum wage amounts to 2,230 LEI (approximately 470 EUR) per month, i.e. a net wage of 1,346 LEI (approximately 280 EUR) per month. Skilled workers (i.e. holders of a higher education degree) earn a minimum gross wage of 2,350 lei (approximately EUR 467) per month, i.e. a net wage of 1,413 LEI (approximately EUR 296) per month. Workers in the constructions industry earn a minimum gross wage of 3,000 lei (approximately 628 EUR) or a minimum net wage of 2,362 LEI (approximately 494 EUR) per month due to the tax and social security contribution exemptions applying to employees in this industry. The minimum wage in Romanian has continued to rise in recent years: for instance, the minimum gross wage has increased by 125% between 2014 and 2019, from 200 to 450 EUR per month. Part of this increase is, however, purely artificial and employees did not benefit from it, since in January 2018 the government announced a massive increase in the minimum gross wage, which went from 1,450 RON per month to 1,900 RON per month (i.e. approximately EUR 415 per month), yet at the same time transferred the employers' obligations to pay wage taxes and social security contributions to their employees, which neutralized the effect of this increase. Employees did not benefit from this spectacular 30% increase of the minimum gross wage, as this increase was accompanied by the full transfer of employers' obligations to pay wage taxes to their employees. In Romania, the average gross wage in 2020 is 5,429 lei, approximately EUR 1,136 (wages in Romania were calculated using the exchange rate of 31.12.2019, 1 euro = 4.7793).

In France, on the 1st of January 2019, the gross monthly amount of the minimum interprofessional growth wage (SMIC) was 1,521.22 euros for a number of 151.67 work hours/month, with an increase of 1.5% between

January 2018 and January 2019. In ten years, the minimum gross hourly wage increased by 13.7%, going from 8.82 euros in July 2009 to 10.03 euros in 2019, while prices, except for tobacco, increased by 9.8%. (https://www.insee.fr/en/recherche/recherche-statistiques?q=salaire+moyen).

According to the National Institute of Statistics and Economic Studies (INSSE), the average gross wage in France is 37,000 EUR per year, 3,083.33 euros/month, while the average net wage is 2,300 euros per month.

In Luxembourg, the wage is freely negotiated between the employer and the employee, taking into account the work performed. In Luxembourg, there is a minimum social wage (SMIC) that any employer must observe. This minimum wage is differentiated according to the employee's skills in unskilled and skilled minimum wage. As of the 1st of January 2020, the *minimum unskilled social wage* amounts to 12.3815 euros per hour, which is equivalent to 2,141.99 euros gross per month for a full-time job of 40 hours per week. The minimum wage of skilled workers amounts to 2,570.39 euros gross per month. The qualification must be proven by a formal certification or a minimum number of years of work experience. The average wage in Luxembourg is 3,591.58 euros. In Luxembourg, wages are also indexed to the cost of living. When the price index has increased by + 2.5% over the last 6 months, all wages must be increased accordingly.

In Belgium, on the 1st of January 2019, the minimum guaranteed average monthly income (RMMMG) is 1,593.81 euros for a 38-hour work week, with a maximum of 9 work hours per day and 45 work hours per week. Exceptions are possible up to 11 work hours a day and 50 work hours a week, yet they are subject to strict regulations and mutual consent. The average gross wage in Belgium in 2020 is 2,008.9 euros. Belgium is one of the European countries where the evolution of wages between 2010 and 2019 was the least favorable for workers.

According to a study conducted by the European Trade Union Confederation (ETUC), the average wage was almost frozen in Belgium during this period, with an increase of 1.5%. The sharpest decline in average wages was in Greece, where income dropped by about 15%. The evolution of the average wage in the European Union Member States between 2010 and 2019 is shown in *figure 1*.

According to data in Figure 1, in addition to Greece (-15%), five other countries have seen declining average wages in the last ten years: Cyprus (-7%), Croatia (-5%), Spain (-4%), Portugal (-4%) and Italy (-2%). The average wage was almost frozen in three countries, with increases close to zero: Finland (+ 0.1%), Belgium (+ 1.5%) and the Netherlands (+ 1.5%).

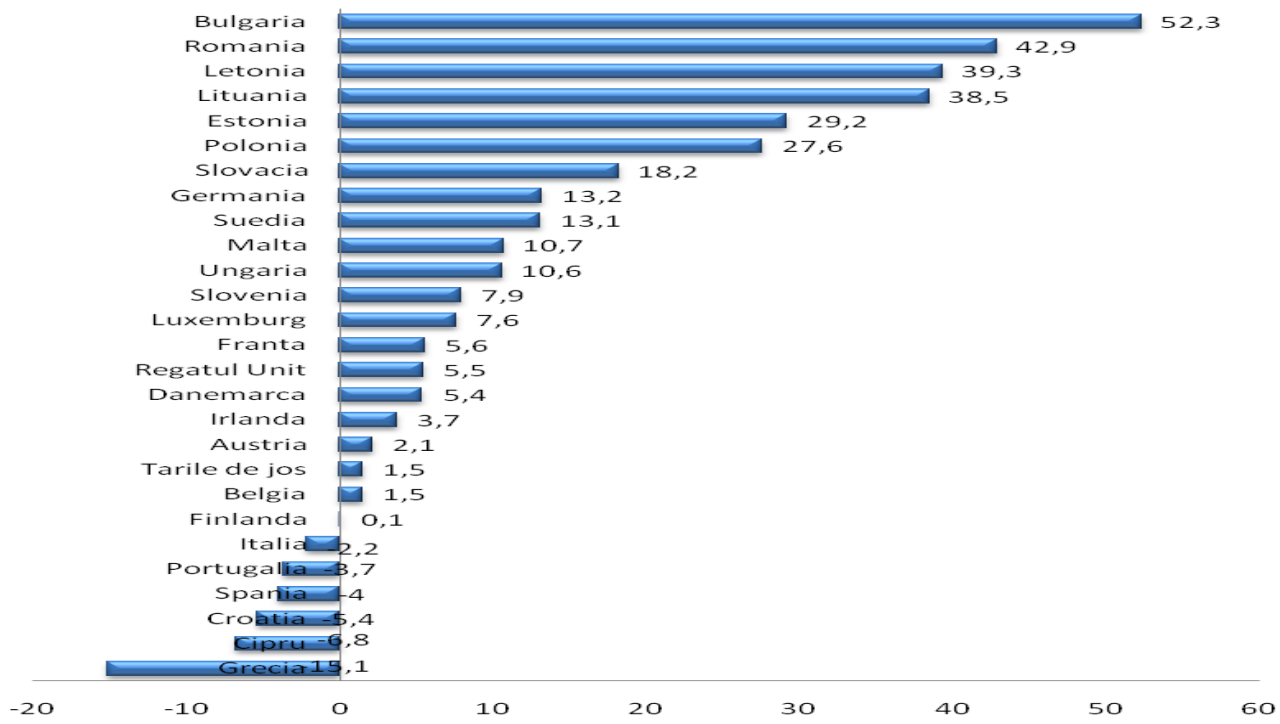

Figure 1 **Evolution of the average wage in the EU Member States between 2010 and 2019**
Source: personal processing of data taken from https://www.lalibre.be/economie/conjoncture/les-salaires-belges-ont-stagne-ces-dix-dernieres-annees-5e399cfa9978e234870aa827 accessed on 25.05.2020

Table 1

Comparative study of minimum, average wages and statistical indicators

Indicator	Romania	France	Luxembourg	Belgium
Minimum reference wage	466.60	1,521.22	2,141.99	1,593.81
Average gross wage	1,135.94	3,083.33	3,591.58	2,008.9
MinWage/AverWage*100 ratio	41.08%	49.34%	59.64%	79.34%
Unemployment rate in 2019	3.9	8.4	5.6	5.4
Labor productivity $ in 2019	58.003	96.446	199.367	103.779
Consumer price indices (CPI) in 2019	3.8%	1.1%	1.7%	1.4%
Purchasing power in 2018	15,377€	25,358€	33,332€	25,911€

Source:personal processing of data taken from the Ilostat database accessed on 13.05.2020 https://ilostat.ilo.org/fr/topics/unemployment-and-labour-underutilization/ accessed on 22.05.2020

CONCLUSIONS

When looking at the table above, one notices that the highest minimum monthly wage is earned by people working in Luxembourg, i.e. 2,141.99 euros, while the lowest is in Romania, i.e. merely 466.60 euros. Belgium and Luxembourg have very close minimum wages. The same cannot be said about the average gross wage, which is significantly higher in Romania than in the other analyzed countries and reveals the existing wage inequalities and the high number of individuals working for the minimum wage, on the verge of poverty. The mechanism suggested in the European Social Charter is that the ratio between the gross national minimum wage and the gross national average wage should be at least 60%, which is the case in Luxembourg and Belgium. The *unemployment rate* reflects the inability of an economy to create jobs for people willing to work, but who are unemployed, although they are available and are actively looking for a job. Therefore, it is considered to be an indicator of the efficiency and effectiveness of an economy in absorbing workforce and labor market performance. A country's unemployment rate is a key indicator used to monitor economic cycles. When the unemployment rate is high, the country is not able to provide enough jobs for available workers, and this could be a sign of economic recession. Therefore, the government's goal is to implement policies and measures to bring unemployment incidence to a more acceptable level. Paradoxically, low unemployment rates may well hide significant poverty, as is the case in Romania, while high unemployment rates may occur in highly developed countries with low poverty incidence. In countries where is no safety net for unemployment and social benefits, many people, despite the strong solidarity of their families, simply cannot afford to be unemployed. Rather, they have to make a living as often as they can, in the informal economy or in informal working conditions. In countries with well-developed social welfare systems or where savings or other supports are available, workers can better afford to make time to find better jobs. Therefore, in many developing countries the problem is not so much unemployment as the lack of decent and productive work, which leads to various forms of underutilization of the workforce (i.e. work not legally declared, low income and low productivity).

Consumer price indices (CPI) measure the evolution over time of the price level of goods and services consumed. In many countries, they were initially introduced to measure changes in the cost of living of workers, so that wage increases may be linked to changes in price levels. Consumer price index is a macroeconomic indicator of inflation, a key statistical datum for governments and central banks to target inflation and monitor price stability.

The *purchasing power* of a given amount of money actually depends on the cost of living, i.e. the general level of prices, and measures how much money we need to buy goods and services. This indicator is used to compare the wage levels of the analyzed countries according to the prices of goods and services that differ from one country to another. Luxembourg has the highest minimum wage, the highest purchasing power and the highest labor productivity, followed by Belgium, France and, far behind, Romania. The indicators in the table above allow us to conclude that although in French-speaking countries taxation is levied in very high progressive rates compared to Romania, labor productivity and the consumer price index are very high.

According to the analysis conducted, although Romania has the lowest tax rate in terms of wage income tax, i.e. 10%, the average tax rate for the minimum and average wage is much higher than in French-speaking countries. The situation changes considerably, with an increase in wage income. Belgium has the highest effective tax rate,

i.e. 50.21%, while France and Luxembourg still have lower effective tax rates than Romania.

Efficient tax reform can be achieved in two different ways. On the one hand, if the current tax rate is higher than the optimal rate in the Lauffer curve, then reducing the tax rate would increase revenue by increasing the tax base. On the other hand, if the tax rate is lower than the optimal rate, then the increase in the tax rate would increase the income, despite the decrease in the tax base.

Supporters of the fixed annual tax system are convinced that the existing progressive tax system prevents overtime, reinvestment or saving. They believe that taxes are higher than the optimal tax rate described by the Laffer analysis and that a moderately low single tax rate would increase tax revenues. They argue that if taxes were lower, people would have a greater incentive to work and invest, which would stimulate the whole economy.

The comparison between Romania and the French-speaking countries that we carried out in terms of wage income taxation revealed that not the level of tax rates is essential for the welfare of the economy, but actions should be taken to improve living standards by investing in education and healthcare, by granting tax relief to key development industries (research, medicine, information technology), by attracting foreign investors, and by reducing and using more efficiently public spending.

In the modern world, there are no perfect inequity-free tax systems, but improving them in that direction is a priority for any country.

Although, no magical cure has been discovered so far to solve the problem of taxation, in a framework of absolute equity and effectiveness, my intention is to contribute, through this paper, to the diagnosis and improvement of these systems.

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DIGITAL NATIVES AND IMMIGRANTS. FINDING THE GAP

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Abstract

The presented paper investigates the needs of digital immigrants (generally those born before the year 1985 (those before the Millennial generation are considered to be digital immigrants and those born after 1985 are digital natives, having grown up only in a world defined by the internet and smart devices, Prensky, 2001). Digital immigrants should integrate and use the ICT argued for the introduction of Information and Communication Technologies (hereinafter ICT) in public policies in education. However, there is consensus on four basic arguments (OECD, 2001): are a basic skill, such as reading, writing, and math, they represent an opportunity for economic development and a requirement for employment, they are a tool for school management, they are a tool that improves the teaching and learning process.
The first two arguments are linked to the potential socioeconomic benefits attributed to the use and appropriation of ICTs. These have an impact on human development, both that one of the development goals for the millennium postulates that it is necessary to "ensure that can take advantage of the benefits of new technologies, in particular those of information and communications" (ONU, 2013). In relation to the potential economic benefits, it is reasonable to assume that, with the use of ICT, the inhabitants of developed countries acquire skills and competencies that complement their possibilities to function successfully in society. However, these arguments should be considered with more caution in developing countries, since in these people do not necessarily have the basic skills necessary to effectively take advantage of the potential of ICT.

Key words: digital natives, digital immigrants, educational gap

In the 1960s, the concept of "functional literacy" emerged, defined as "learning that enables people to function in various roles (citizens, fathers and mothers, workers, members of a community) with a view to improving productivity" (Martínez R., Fernández A., 2010). However, this definition creates tensions and debates when considering that the functionality it cannot be an end in itself. The International Literacy Symposium (1975) defines the literacy "not only as learning to read, write and calculate, but as a contribution to the liberation of the person and their full development" (Infante Y. Letelier P., 2013). Few years later, in 1978, it is specified that a functional alphabet is a person who "can undertake those activities in which literacy is necessary for effective performance in your group and community" (UNESCO, 1978).

According to Itzcovich (2013), in the debates around the new definitions of the notion of literacy, certain transformations of society can be read, which imply that new competencies are necessary to achieve full social integration and, at the same time, that these competencies are changing in a vertiginous way, which originates a great paradox: by when reduce the incidence of illiteracy, being literate means something else. Therefore in the current context of the digital age, one wonders what does it mean to be literate in the 21st century? For Fourez (1997), in general, it is a metaphor that alludes to the importance that literacy has had since the end of the last century.

This expression would designate a type of knowledge, of capacities or competencies that, in our current scientific-technological world, it would be a simile to the relevance that literacy had in the last century. In this sense, it arises the term "digital literacy" to refer to the learning of the knowledge typical of an era where communication is essential, establishing a general consensus that the ICT universalization must be part of literacy processes (Itzcovich, 2013).

Currently, without adequate literacy, both traditional and virtual, people they are at constant risk of exclusion. According to Jabonero and Rivero (2008), it is relevant develop initiatives aimed at scientific and technological literacy and the computational domain of popular sectors, since the prevailing digital divide accentuates the levels of inequity in the countries of the region.

In relation to the above, in this path of

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evolution towards the information society is generating the so-called "digital divide", which may have different connotations, but which taken to the educational, citizen and social sphere, it translates into:

• Access gap, referring to problems in accessing technology, generally conditioned by family income.

• Gap of appropriation and cultural capital, related to the effective use of ICT.

In this sense, it is not enough to be surrounded by technology to be a fully integrated digital citizen; training in digital skills is essential.

MATERIAL AND METHOD

A systematic review of scientific articles was carried out in two phases. The first one explored the Pub Med and Google Scholar databases in a general way, to investigate the feasibility of addressing the subject, based on the following questions that guided this study: How to identify the characteristics of natives and immigrants? How to specify the gap between natives and immigrants? And how to overcome the existing gap in the educational field? A second search was carried out in the EBSCO, Redalyc, Science direct and Scopus databases. The descriptors digital immigrants, digital natives and generation gap were used.

RESULTS AND DISCUSSIONS

Prensky M. (2001) raises the term digital natives as the first generation that has grown up with digital technologies, natives of the language of computers, video games, the Internet and computer experts (Aesaert K., 2015). In the words of Herther K. (2009), are those who they were born approximately from the year 1980, they grew up hand in hand with technology, which they prefer to use to carry out their daily tasks, for which they share, create, communicate, coordinate and learn differently.

They have a distinctive set of characteristics that they have apparently developed through immersion in digital technology during childhood and adolescence when neural plasticity is high (Fajardo, 2016). These traits are evidenced because they function best when networked, have significant visuospatial abilities and the ability to to integrate the virtual with the physical world (Parkes, 2015). They choose the graphic instead of the text; the image is the way they communicate and think. They also enjoy doing several things at the same time, which is why they are considered multitasking; They then move easily from one task to another and pay attention to several things at once.

They prefer random access and receive information quickly through parallel processing with a strong need for instant response. They know what they want and increase their creative capacity due to the skills they have acquired over time (Naves F.A., 2015). This is how they become empowered by the use of all the tools mediated by the internet, with a high risk of being carried away by entertainment and game; for this reason, they spend more time on these activities than on serious work.

For this reason, digital natives have turned the network into a very important place of socialization through blogs and social networks where they can express themselves and participate by giving and receiving information (Lai K.W., 2015) In addition, they obtain a large knowledge base through the Internet and from electronic resources, which allows them to be independent and with the ability to interrogate and validate the data they obtain. In general, they are characterized by adopting changes in the way of communicating, informing and learning in accordance with the current technological revolution.

However, not all subjects born on the dates that coincide with this generation possess the traits that define it. To be a digital native, a global culture must be shared, so it cannot be generalized when the age factor is taken as a reference (Lai K.W., 2015) or when the same opportunities to access and use technology are lacking. Thus, after young people who have less experience in the use of ICT, who belong to a socioeconomic context that does not allow them access and have had little impact on their lives, can be called "non-digital-digital natives" (Hernandez D., 2014).

Digital immigrants are older people born in the predigital era, before the 90's, they communicate correctly and according to spelling rules, and they follow instructions before carrying out a task (Furini M., 2014). Their mental traits are directed to processes of inductive-deductive analysis, step by step, and their learning is based on pre-acquired knowledge (Gallardo, 2015).

Unlike natives, they adapt to the digital world when they are adults and learn a different language, a new culture and a different way of communicating. Prensky (2001) identifies them as the old or non-native generation, because they make use of technology in the frames and forms that reveal its non-digital roots.

In their daily experiences they edit a document on paper, print a message, ask others to see a page from the computer instead of sending them the link, call and confirm if a message has been received after having sent it, solve a problem at the same time, they act based on deductive

analysis, and knowledge is based on previously acquired knowledge (Herther, 2009).

Native concepts and digital immigrants can stigmatize the difference; hence, at times, natives are considered young people who only use technology for entertainment, so it seems that they are distracted and far from reality. Since they can read a text, listen to the teacher and send a text message at the same time without losing concentration, it is assumed that they are not paying attention and are classified as rude (Fajardo, 2016).

From this perspective, immigrants are described as obsolete, since it is difficult for them to learn digital language; so that they do not understand the natives because they do not share the same language. In either case, the conceptions of digital natives and immigrants are taken to extremes without allowing middle points that include those natives who cannot have access to ICT for different reasons and those immigrants who are entering the digital world to somehow getting closer to the language of digital natives.

At the university level, professors can be designated as digital immigrants and students as digital natives, since each one has characteristics that allow them to be identified according to the access and use of technology (Prensky, 2001). The differences between digital natives and immigrants are evident in what they do in their daily, academic and professional life. For this reason, a gap arises between teachers and students, who differ in the way they think, act, communicate and process information, since they have their own learning styles and preferences (Berio-Zapata C., Rojas H., 2014). So, the digital gap in education can be considered a new expression of inequality in terms of social, cognitive and generational inequities, At the social level, it generates the exclusion and discrimination of students who cannot enter the network because they do not have the possibility of have internet connectivity (Larghi, 2015). The expectations of the students have definitely changed. They are totally different from those maintained by their teachers, especially in relation to the type of technologies available, the frequency of use, communication skills, the degree of personalization of learning and the schemes of digital quality, interactivity or multimedia resources.

Today's students are no longer the same people for whom the higher education system was designed, so it is important to take into account the probability of redesigning education systems and teaching processes. Therefore, students get tired and impatient when they receive keynote lectures that do not motivate them or arouse interest, which does not allow real and meaningful learning (Calva, 2015).

Prensky and Anderson (2009) state that students think and process information in a very diverse way, since they use a different digital language than their teachers, who were not born in this environment and have had to adapt, which implies that the educational system designed for the training of natives is not the most adequate.

So far, two types of content that should be taught are recognized: inherited, which implies the traditional and includes reading, writing, arithmetic, logical thinking, understanding texts and ideas from the past; and the content of the future, which corresponds to the digital and technological; the two necessary to generate the profiles of the professionals that society needs (Espinosa, 2017).

Thus, education for digital natives should not be directed to a linear-temporal logic, but in a procedural way, in which the concepts are explained in parallel to how they are conceived in the real world. Likewise, immigrants have to promote a participatory culture where the student is the protagonist of their destiny, and begins to make decisions and actions directly related to their context and professional training (Prensky M., Anderson M., 2009). However, it must be considered at an educational level that natives, due to their multitasking ability they have lost their productivity level, the ability to concentrate and their long attention spans, as they want to quickly switch from one topic to another, so, on many occasions, the information they obtain is superfluous due to the fact of opening the largest number of communication channels or online jobs without achieving a high depth of knowledge (Kirk C. *et al*, 2015).

In accordance with world trends in education and current problems, immigrants need to know the characteristics of their students, understand their needs and learning methods, in order to choose a suitable environment to consolidate and evaluate knowledge and know-how by allowing them to be protagonists of their learning.

In the same way, they should stimulate self-regulated learning that allows the student to be proactive, be self-motivated and use the strategies that allow them to achieve the desired academic results. For immigrants in education for learning to teach with ICT and improve their role in the training of professionals they need the acquisition and appropriation of informational competences to know, learn and apply these technologies, in order to design the objectives of the course, define the learning contents, the didactic strategies and the

evaluation of the acquired knowledge, all mediated by technological tools.

CONCLUSIONS

The differences between the teacher and his students are evident; That is why there must be a common language and style between them that allows more fluid communication for an optimal teaching-learning process. For this reason, the immigrant has the challenge of recognizing from the beginning the characteristics of their students to provide them with didactic strategies and educational models that favor greater academic success. Likewise, in education, both digital natives and immigrants need to acquire informational skills that allow an adequate use of ICT, which implies ensuring an appropriate implementation of these in the curricular content and, therefore, the improvement of teaching practice every day when planning appropriate digital tools for the construction of meaningful learning. Efforts need to be invested in the design of non-traditional pedagogical models and innovative teaching materials that support teaching and learning. Therefore, it is necessary to delve deeper into a procedural logic, in which the concepts are explained in parallel to how they are conceived in the real world. On the other hand, it is crucial to teach both the inherited knowledge that implies the traditional and includes reading, writing, arithmetic, logical thinking, understanding the texts and ideas of the past as well as the future content, which corresponds to the digital and the technological. Both are necessary to generate the profiles of the professionals that society needs to train.

It is important to develop future research that contributes to solving questions about how to use play in the classroom to encourage the participation of digital natives, and how to articulate study programs that allow the student's direct relationship with the text. Also, ensure that both natives and digital immigrants develop informational competencies with an emphasis on the development of communication skills and critical and reflective thinking of information. Finally, the ability to multitask in digital natives should be studied in depth in order to allow continuous improvement in their learning.

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STRATEGIES FOR SUSTAINABLE RURAL DEVELOPMENT OF THE NORTH-EAST REGION OF ROMANIA

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Abstract

The paper aims to identify how to approach sustainable development in regional development strategies, having as a case study the North-East Region, and to evaluate how to implement strategic objectives, at regional and rural level. The document aims to identify new strategic proposals to ensure the sustainable development of rural areas, using a system of specific, quantifiable and representative indicators that allow, through econometric analysis, the evaluation of results and the projection of sustainable development developments. The approach of sustainable development and rural development in a strategic context had above all a theoretical character, the analysis being oriented towards: the delimitation of the different conceptual aspects regarding the sustainable development and the strategies of sustainable development; addressing rural development from sustainable development; regulations on sustainable development at global, European and national level, etc. The paper thus highlights, starting from the analysis of regional development strategies of the Northeast Region, solutions to improve the process of strategic implementation of development objectives, by providing viable tools for monitoring development, sustainable development at regional and rural level, eliminating their trends disproportionate. The target indicators proposed by this document and their justification allow such a realistic and accurate estimation of the strategic implementation and the measurement of the impact of the strategic objectives. At European level, concerns about incorporating the principles of sustainable development into Member States' development strategies emerged with Agenda 21, but the approach was fragmented and policy implementation was inconsistent in trade, investment, technology and sustainable development.

Key words: strategies, agricultural structures, development, sustainable

The aim of the paper is to identify how to approach sustainable development in regional development strategies, studying North East study and assessing how to implement strategic objectives at regional and rural level. The paper aims at identifying new strategic proposals for ensuring a sustainable development of rural areas by using a specific, measurable and representative system of indicators, allowing the econometric analysis to evaluate the results and the prognosis of the evolution of the sustainable development phenomenon.

The purpose of the paper is focus on highlighting the logic of strategic intervention by capturing priorities, strategic objectives, results and impacts. The analysis allows identifying the interconnection of the strategic objectives with the national sustainable development objectives and to identify the result indicators related to the strategic objectives needed to monitor the implementation of the strategies, all based on the different methodologies for the implementation of the two evaluation strategies.

MATERIAL AND METHOD

In the research has used to traditional research methods and techniques: analysis of scientific literature, statistical data analysis, database use, surveys, polls, measurement techniques used in marketing research (semantic differential, Likert's scale, correlation method ranks, and so on). Data processing methods were used for statistical analysis and graphics.

RESULTS AND DISCUSSIONS

The Regional Development Strategy for 2014-2020 period does not cover all aspects necessary for adequate monitoring of the sustainable development of the region and the rural environment, and in many cases the proposed output indicators are oversized compared to the real evolution of the region over the last 14 years. This overstimulation of results, such as reducing the 25% disparity or the risk and exclusion rate to

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3.5%, is in fact a negative aspect of how strategies are being implemented in our country.

Sustainable development strategies aim to mobilize and focus society's efforts to achieve sustainable development, providing a framework for formulating a vision for a sustainable future, as well as a framework for the processes of negotiation, mediation, consensus and institutional capacity building. The need to create sustainable development strategies at national level was brought to public attention by Agenda 21 (1992) when it was stated that such a strategy must harmoniously encompass sectoral economic, social and environmental policies and plans so as to ensure economic development, socially responsible for protecting basic and environmental resources for the benefit of future generations.

Sustainable development strategies at European level

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 euro's, 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

Sustainable development strategies at European level

Indicators	2013	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: Dona *et.al*, 2014

The Commission's Multiannual Financial

Designing sustainable development indicators related to strategic measures for the period 2014-2022.

We will project the evolution of the selected strategic indicators for the period 2014-2022 based on the trend of the periods 2000-2013 and 2007-2013 and we will compare the results obtained with the result indicators proposed in the Regional Development Strategy of the North-East Region. In this context, we will focus in this analysis on the sustainable and additional development indicators for which we have a comparison basis for the 2020 horizon and we will base our proposals including indicators for which the strategy does not propose monitoring indicators. If we look at the world, however, the issue is much more complex, because a multitude of negative trends have been identified: economic disparities between regions and deepening poverty in developing countries (while most countries in the world have experienced economic growth, there are many more countries that have suffered economic declines and declining incomes per capita, disparities between people within the same nation, between rich and poor nations or between the incomes of multinational companies and gross domestic product in the countries in which they operate continues to and politics lead to violent conflicts affecting entire regions and nations); poverty; malnutrition; the development of diseases with a major impact on national economies (eg malaria); overconsumption of resources in industrialized countries; increasing energy consumption (by over 70% in the last 30-40 years); major climate change; deterioration of environmental conditions and damage to habitats and biodiversity, etc. 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 euro's, 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 2*).

Table 2

Sustainable development strategies at European level

Country	The year of the first strategy	Updated versions	Other revisions	Other revisionsNo. Establishment /	Predominant size (economic, social, environmental)	Other dimensions
Austria	2002	2011	-	159 (5/23/131)	Equal	International
Belgium	1999	2010	2000,2004	230 (6/31/193)	Social	
Bulgaria	2007 (draft)	-	-	-	-	-
Croatia	2009	-	-	-	-	-
Czech Republic	2004	2010	-	167 (6/17/144)	Equal	International Education Research
Danemark	2002	2009	-	200 (21/87/92)	Equal	International households
Estonia	2005	-	-	32 (4/12/16)	Equal	Culture
Finland	1998	2006	-	186 (6/26/154)	Equal	International Education Research Comunity
France	2003	2010	-	75 (9/50/16)**	Equal	International Education Research

The Commission's Multiannual Financial Framework confirms that the structure with two 2020, the CAP budget will account for 35% of EU spending, 5% less than in 2014 (*table 3*).

Table 3

Sustainable development strategies at European level

Country	The year of the first strategy	Updated versions	Other revisions	Other revisionsNo. Establishment /	Predominant size (economic, social, environmental)	Other dimensions
Austria	2002	2011	-	159 (5/23/131)	Equal	International
Belgium	1999	2010	2000,2004	230 (6/31/193)	Social	
Bulgaria	2007 (draft)	-	-	-	-	-
Croatia	2009	-	-	-	-	-
Czech Republic	2004	2010	-	167 (6/17/144)	Equal	International Education Research
Danemark	2002	2009	-	200 (21/87/92)	Equal	International households
Estonia	2005	-	-	32 (4/12/16)	Equal	Culture
Finland	1998	2006	-	186 (6/26/154)	Equal	International Education Research Comunity
France	2003	2010	-	75 (9/50/16)**	Equal	International Education Research

For the Rural Development Funds - Pillar II of the CAP, the amount of payments made amounted to 1973 million Euros in the year 2015, representing an absorption rate of almost 19% of the allocation for the whole program. If we report payments made at the indicative amounts for 2007-2015 and EUR 5569.62 million respectively, the absorption rate is better, about 34%. From the total amount paid, the area payments related to the Axis 2 measures "Improving the environment and the rural area" and the measure 611 "Direct complementary payments" carried out by the Paying and Intervention Agency for Agriculture amounted to 948 million Euros.

If we sum up the funds paid for agri-environment measures with less favored areas (LFA) and those for complementary direct payments (CNDP), it results that for the period 2007-2015, the expenditures made for some implemented projects are quite low. This is a serious cause for concern as it is essential to implement as many projects as possible for the development of rural areas in Romania and the reduction of the gaps towards the developed EU Member States.

Since we are in the sixth year of application of the rural development program it can be said that the absorption rate is low. Romania is ranked among the EU member states (along with Bulgaria) from this point of view. It should be noted that in the first three years since the accession, Romania has been able to use the European funds allocated to rural development to top up the payments. Specifically, this means that out of the 30% that can be used to supplement direct payments from the EU budget, 20 percentage points have been allocated from rural development funds.

The Paying and Intervention Agency for Agriculture also made payments under the National Rural Development Program for less-favored areas and agri-environment measures, respectively those for top-ups (plus the payments made from the national budget for complementary national payments).

Table 4

Estimated level of European budget allocated to Romania for agriculture and rural development in 2014-2020

EXPLANATIONS / YEARS	2014 (-80%)	2015 (-90%)	2016 (-100%)	2017	2018	2019	2020	Total 2014-2020 (mil. Euro)
Direct payment (Euro / ha)	162.2	182.5	202.8	202.8	202.8	202.8	202.8	
Annual total amount of direct payments (million euro)	1.576	1.774	1.971	1.971	1.971	1.971	1.971	13.205
Market measures (million Euros)	100	100	100	100	100	100	100	700
Rural Development (million Euros)	1.160	1.160	1.160	1.160	1.160	1.160	1.160	8.120
Total funding of the Common Agricultural Policy 2014-2020. (million Euros)	2836	3034	3231	3231	3231	3231	3231	20.025

Source: Processing based on APIA data

We can conclude that for the first pillar, € 3.28 billion allocated by the EU for the period 2007-2015 has so far been spent € 2.444 billion, so a 74.5% absorption rate. Taking into account the penalties of about 128 million euros, which must be reimbursed and borne from the national budget, the rate of absorption of direct payments in Romania for the years 2007-2014 is reduced to about 70%. However, it can be said that in comparison to other EU funding, the absorption in agriculture is a very good one.

CONCLUSIONS

The work has resulted in farmers' decision analysis as a result of the CAP policy, the effects of payment schemes on farms in Romania and performance optimization to increase their economic efficiency.

Producers will find valuable information in the paper regarding the importance of optimal sizing of farms according to the profile and its need to seek rational and production chain, the optimal structure of crops, crop rotation and identifying the main sources of financing FEADR (EAFRD) funds.

This study must be extended by performing an analysis on a sample of a representative sample of the Romanian agricultural exploitations. Building such a database is not a goal. The traditional means to that is called in other scientific approaches, such as example the RICA base, are in present in Romania only in an early stage of development.

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ANALYSIS OF MYCOTOXINS FROM CEREALS AND CEREAL PRODUCTS AT IASI COUNTY

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Abstract

Cereals and cereal products are of unique importance because they are consumed by millions of people and are considered, from a nutritional point of view, the main source of carbohydrates for humans and animals. Thus, the microbiological and mycotoxicological safety of cereals is considered very important both for food and for animal feed. The paper presents the results of research on the level of mycotoxin contamination of cereals and cereal products in Iasi County in the 2015-2019 study interval. The aim was to study the incidence of mycotoxins that have a negative influence on the safety of agri-food products, with subsequent negative impact on human and animal health. The obtained results were within the maximum allowed limits provided by the specific legislation in force (EC Reg. 1881/2006).

Key words: mycotoxins, cereals, cereal products, ELISA

Cereal grains, due to their high content of toxins, represent the ideal nutrient medium for the multiplication of micromycetes and the elaboration of their mycotoxins. Mycotoxins produced by fungi are extremely toxic and cause acute or chronic mycotoxicosis in animals and humans consuming feed / food contaminated with such compounds (Pfohl-Leszkowicz *et al*, 2007). It was found that cereals and fodder can be contaminated with mycotoxins from the field, but also after harvest, especially during their conservation period, when storage conditions are favorable for germination of resistance forms of fungi and their multiplication. The extremely heterogeneous distribution of mycotoxins within a batch of agri-food product is demonstrated by the fact that the products contain variable amounts of mycotoxins, which are dependent on the nature of the substrate, storage conditions, but also on the place and manner of sampling to be analyzed. Therefore, sampling must be a reference step in the mycotoxin analysis of agri-food products. The samples taken must be representative of the analyzed batch and ensure fidelity and reproducibility for it (Coman I. *et al*, 2012).

Mycotoxins have toxic effects on both human and animal health, and the level of toxicity of various mycotoxins depends on the amount of toxins, age and time of exposure (Chhonker T. *et al*, 2018). Mycotoxin contamination in animal feed and the potential transfer to animal products for human consumption remains a major problem that alerts the world. Mycotoxins have been found in animal products (eggs, milk and dairy products) obtained from animals which have been fed contaminated feed (Meucci V. *et al*, 2010). It is well established that not all molds are toxic and not all secondary metabolites in molds are toxic. Currently, over 300 mycotoxins have been identified; however, only a few regularly contaminate food and feed. These are: aflatoxins, ochratoxins, zearalenone, fumonisins and trichothechenes (Alshannaq A., Yu J., 2017).

Aflatoxins are mycotoxins produced by the fungal species *Aspergillus sp*., the most toxicogenic being *Aspergillus flavus* and *Aspergillus parasiticus*. They are normally present in the soil and in various organic materials (Liu Y. Wu F., 2010). While *Aspergillus flavus* strains produce only aflatoxins B1 (AFB1) and B2 (AFB2), *Aspergillus parasiticus* strains can produce AFB1, AFB2, G1 (AFG1) and G2 (AFG2) (Bennett J., Klich M., 2003). In fact, AFB1 is considered to be the most potent hepatocarcinogen in mammals and listed as a carcinogen I by the IARC. Aflatoxins are probably the best known and most researched mycotoxins in the world, but they present the highest toxicological risk (the strongest natural carcinogens known). They have been associated with various diseases, such as aflatoxicosis in pets and humans. They received more attention than any other mycotoxin due to

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their strong carcinogenic effect demonstrated in laboratory animals and their acute toxicological effects in humans (Mila et al., 2015). Practically, the only species of non-toxic *Aspergillus* are *Aspergillus niger* and *Aspergillus oryzae*, the latter being the most used in industrial biotechnologies. Ochratoxins were first isolated from *Aspergillus ochraceus* in 1965 in South Africa after corn infected with these fungi was found to cause the death of experimental animals (Luís C. *et al*, 2016). These are secondary, low molecular weight fungal metabolites that are mainly produced by molds belonging to several species of the genera *Aspergillus* and *Penicillium*, especially *A. ochraceus* and *P. verrucosum* (Freire *et al*, 2017). Ochratoxin has been shown to be a nephrotoxic, immunosuppressive, teratogenic and carcinogenic agent (Richard *et al*, 2007). Several types of ochratoxins occur naturally, namely ochratoxin A, ochratoxin B (dechlorinated OTA) and ochratoxin C (ethylated OTA) and are often co-produced.

Ocratoxin A is the most common toxin and is classified by the IARC as a potential human carcinogen of group 2B. It is one of the most relevant ochratoxins, with great public and agroeconomic significance, due to the confirmed nephrotoxic, genotoxic, neurotoxic, immunotoxic, embryotoxic and teratogenic effects and suspected carcinogenicity (Milićević D. *et al*, 2016). Practically, the lack of exposure to ochratoxin is impossible, given that it is constantly found in cereals and cereal products, which are also the major source of contamination of animals or humans. The carcinogenic effect of ochratoxin is manifested by the induction of tumors in the kidneys, liver and urinary tract. Regarding genotoxicity, ochratoxin has been found to break the nucleotide chains of DNA, in vitro, and in vivo disrupt DNA synthesis, causing genetic mutations in cells. People are frequently exposed to OTA due to its ubiquitous presence in a wide variety of foods, including grains (barley, oats, rye, corn and wheat), beans, dried fruit, tea, coffee, cocoa, wine, beer, herbs, poultry, fish, pork, eggs, cheese and milk. OTA as a causative agent of endemic human nephropathy has been highlighted worldwide. Recently, induction of apoptosis in neuronal cells has been reported to be a contributing factor in the pathogenesis of neurodegenerative diseases such as Alzheimer's disease and Parkinson's disease (Milićević D. *et al*, 2016).

Zearalenone is a mycotoxin with hyperestrogenic effects produced mainly by fungi: *Fusarium graminearum*, *Fusarium culmorum* and *Fusarium sporotrichoides*. Maize, wheat, oats, barley and rye are largely infected with zearalenone-producing molds. It is a non-steroidal estrogen and its main metabolites (alpha zearalenol and beta zearalenol) cause significant estrogenic activity in humans and animals (hepatic, uterine, mammary and hypothalamic estrogens). In humans, toxicity is mainly chronic, while the acute form is quite rare. Zearalenone and its metabolites can effectively stimulate the growth of mammary gland cells. Thus, it has been suggested that it may be involved in the onset of breast cancer. Some cases of early puberty have been reported in adolescents exposed to this mycotoxin. Zearalenone is included in the category of non-carcinogens for humans, group 3, according to IARC. However, it has a strong embryonic toxicity and induces apoptosis and oxidative stress in human embryonic stem cells (Cao H. *et al*, 2019).

Fumonisins are mycotoxins that frequently contaminate cereals, mostly corn. Fumonisins disrupt lipid synthesis in nerve cells, causing damage to the nervous system, liver and lung damage. Consumers of large amounts of corn are frequently exposed to esophageal cancer. Fumonisins cause damage to plants, attacking cell membranes and reducing chlorophyll synthesis.

Trichothecenes are secondary fungal metabolites that are harmful to human and animal health, causing a number of acute and chronic symptoms. They are produced by different species of *Fusarium*, such as: *Fusarium culmorum, Fusarium sporotrichioides, Fusarium tricinctum, Fusarium roseum Fusarium graminearum, Fusarium nivale* and *Fusarium sambucinum*.

Trichothecenes have the same basic structure, all these substances containing an epoxy function placed at C12-C13, which is responsible for their toxic activity; they are classified into two major groups: macrocyclic and non-macrocyclic. Their synthesis takes place with great efficiency at a temperature between 6-24 °C and in extremely humid environment.

Macrocyclic trichothecenes are subdivided into types C and D, and *non-macrocyclic trichothecenes* are subdivided into types A and B, where type A appears to be more toxic than type B. Type A includes: toxin T-2, toxin HT-2, and type B includes deoxynivalenol, as important representatives of these groups.

T-2 toxin causes intoxication, which is manifested by nausea, dizziness, vomiting, necrotic lesions in the mouth and throat, diarrhea and bleeding in various organs. It is also an immunosuppressant, irreversibly attacking the bone marrow and causing a reduction in the number of leukocytes. It has an effect on serum proteins, causes lymphocyte depletion and subsequently stomach necrosis.

Deoxynivalenol (vomitoxin) is formed in plants before harvest, and its presence is highly dependent on temperature and other climatic conditions. This mycotoxin causes general weakening of organisms, necrosis (gangrene) in various tissues (gastrointestinal wall, bone marrow, lymphatic tissue), changes blood parameters and attacks the immune system (Radiana M. *et al*, 2017).

These fungi are found worldwide and are adapted for colonization and growth on a wide range of substrates, with preferences for moisture and nutrient content (Susan *et al*, 2011).

Most mycotoxins have chemical stability, being resistant to temperature (including baking, storage or other food-related biotechnological procedures). The danger of the appearance and increase of the amount of mycotoxins occurs, however, in the improper storage of agri-food products. The toxic effects of mycotoxins depend largely on their chemical structure, but also on the amount accumulated in the body. In Europe, most of the amount of ochratoxin, for example, is taken up by ingesting cereals. Molds that can appear on cereals and cereal products must be carefully monitored, as their toxins act strongly on higher organisms, through synergism, even in small quantities. For this reason, the European Community has regulated maximum permitted limits for mycotoxins in food and feed. The mycotoxin monitoring program for food and feed is mandatory for the following sectors of activity: vegetable farms, grain reception bases, concentrated feed mills, livestock farms, food manufacturing units. In all these types of units, the level of contaminants must be kept as low as possible, by using good hygiene practices (GHP) and production (GMP).

MATERIAL AND METHOD

The determinations were performed in the period 2015-2019, from samples of cereals (wheat, corn, rye) and cereal products (white flour, wheat gluten, semolina, corn, wheat bran), which were taken at random, after an objective sampling strategy, both from grain storage units and from their processing units (mills) in Iasi county.

Sampling was performed based on a pre-established working procedure, in accordance with Annex no. 1 of the EC Regulation no. 401/2006 which establishes the sampling modalities and the analysis methods for the official control of the mycotoxin content in food.

Elemental samples are taken from different points distributed throughout the batch or sublot. Mycotoxins are unevenly distributed in a batch, therefore all necessary measures are taken to ensure that the sample taken is representative of the batch. Therefore, it is necessary to take a large number of elementary samples from various places in the lot, according to the legislation (random sampling = several elementary samples which by joining, form the aggregate sample).

The global sample is obtained by summing the elementary samples. Each aggregate sample shall be placed in a clean container of inert material, which provides adequate protection against the risk of contamination and against damage which may occur during transport. All necessary precautions shall be taken to avoid any change in the composition of the sample which might occur during transport or storage. Each sample shall be sealed at the place of sampling and identified by labeling with the following information: nature of the sample, date and place of sampling, and any other additional information. It must reach the laboratory as soon as possible.

The sampling method is done depending on the size of the batches of cereals and cereal products (*Tables 1 and 2*).

Table 1

Dividing the lots into sublots according to the product and the weight of the lot

Product	Batch weight (tons)	Weight or no. of sublots	No. of elementary samples	Overall sample weight (kg)
Cereals and cereals products	≥ 1 500	500 tons	100	10
	> 300 și < 1 500	3 sublots	100	10
	≥ 50 și ≤ 300	100 tons	100	10
	< 50	-	3-100	1-10

Table 2

The number of elementary samples taken depending on the weight of the lot

Batch weight (tons)	The number of elementary samples	Overall sample weight (kg)
≤ 0,05	3	1
> 0,05-≤ 0,5	5	1
> 0,5-≤ 1	10	1
> 1-≤ 3	20	2
> 3-≤ 10	40	4
> 10-≤ 20	60	6
> 20-≤ 50	100	10

In the case of samples taken in the storage-marketing stage, these being prepackaged in packaging ready for sale, the global sample must be a minimum of 1 kg, and the product is not removed from the original packaging until it is to be analyzed in the laboratory.

The samples that arrive at the laboratory for analysis are each divided into three distinct

samples: the test sample, the additional opinion sample and the reference sample. All these are obtained only in the laboratory, being separated from the previously homogenized laboratory samples.

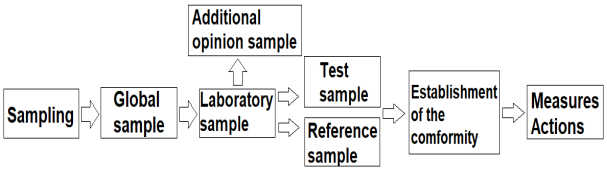

Figure 1 **Sampling and analysis of samples**

The sample for additional opinion can be kept in the laboratory or at the operator. If the sample for additional opinion is kept in the laboratory, the storage time is:

-until the issuance of the analysis bulletin, in case of compliant products;

-1 year when the evidence is non-compliant.

The reference sample is kept in the laboratory for the following period:

-until the release of BA in the case of compliant products;

-1 year when the evidence is non-compliant.

The establishment of the conformity of the samples is made based on the results obtained following the laboratory analysis, to which the correction for recovery and the degree of uncertainty of the measurement are applied, in accordance with the provisions of Reg. CE 401/2006.

Acceptance of lots:

-The lot is considered "accepted" when the sample is compliant, i.e. the value obtained after performing the laboratory analysis is less than or equal to the maximum allowed limit (AML) provided in EC Regulation no. 1881/2006 with the subsequent completions and modifications.

-The lot is considered "rejected" when the sample is non-compliant, i.e. the value obtained from performing the laboratory analysis is higher than the AML provided in EC Regulation no. 1881/2006 establishing the maximum levels for certain contaminants in foodstuffs.

During the study period (2015-2019) a total number of 261 samples consisting of cereals and cereal products were taken and analyzed, as follows: 57 samples of white flour, 7 samples of wheat gluten, 94 samples of wheat grains, 2 samples of wheat semolina, 17 samples of corn, 77 samples of corn grains, 6 samples of rye and 1 sample of wheat bran.

Samples of products taken for the quantitative determination of mycotoxin content were analyzed based on RIDASCREEN determination kits specific to each mycotoxin (aflatoxin B1, total aflatoxins, ochratoxin A, zearalenone, fumonisins and trichotecenes), and for the interpretation of the results was used microELISA photometer.

Sample preparation of cereals and cereal products - grinding, extraction, filtration, dilution

Detection limit: for cereals and cereal products - 1 - 2.5μg / kg.

Reproducibility: 80-100%.

Principle of the test: the test is based on the antigen-antibody reaction. The plaque wells are labeled with specific anti-mycotoxin antibodies. Add standards or samples, enzyme conjugate and anti-mycotoxin antibodies. Free mycotoxin and the enzyme conjugate compete for antibody binding sites (competitive enzyme-linked immunosorbent assay). At the same time, mycotoxin antibodies are bound to immobilized antibodies. The unbound enzyme conjugate is removed by the washing step. Add the substrate-chromogen mixture to the wells and leave to incubate; the bound enzymatic conjugate will convert the colorless chromogen into a blue substance. Adding the stop reagent will cause the color to change from blue to yellow. The measurement is made spectrophotometric at a wavelength of 450 nm. The absorbance is inversely proportional to the mycotoxin concentration in the sample.

Equipment used: microELISA photometer (450nm), mill, shaker, centrifuge, mechanical stirrer, graduated cylinder: 100ml, 1l, funnel and Whatman filter paper no. 1, graduated pipettes, micropipettes: 50μL, 100μL, 1000μL.

Reagents: methanol, dilution buffer, wash buffer, distilled water, etc.

Sample preparation:

Samples should be kept in a cool place, protected from light. The representative sample must be ground and thoroughly homogenized before starting the extraction procedure.

Way of working:

-weigh 5g of ground sample and transfer to a container with a lid over which the specific amount of reagents is added (methanol / distilled water 70/30). The sample size can be increased if necessary, but the volume of distilled water must be adapted accordingly (for example: 25 g of sample in 125 ml of distilled water or 50 g of sample in 250 ml of distilled water):

- shake vigorously for a few minutes (manually or with a stirrer)

-filter the extract using Whatman filter paper no.1

-to dilute the extract

-50l of extract per well is used, in the test.

Protocol:

- Before starting work, bring all reagents to room temperature.

-Insert a required number of wells for standards and test samples into the holder.

-Add 50 μL of standard sample.

-Add 50 μL of enzyme conjugate to each well.

-Add 50 μL of antibody solution to each well.

-Mix manually by rotating the plate and incubate approx. 30 min at room temperature (20-25 ° C).

-Pour the liquid and beat it vigorously face down on an absorbent paper to remove traces of liquid.

-Add 250 μL wash buffer and remove the liquid again. Repeat the washing step 2 times.

-Add 100 μL (2 drops) of substrate / chromogen in each well. Mix by hand, rotating the plate and incubate for 15 minutes. at room temperature (20-25°C).

-Add 100 μL (2 drops) of stop solution in each well.

Mix gently, shaking the plate nicely and measure the absorbance at 450 nm. The reading is done at 10 min. after adding the stop solution.

The average value of the absorbents obtained for standards and samples are divided by the absorbance value of the first standard and multiplied by 100. The zero standard is equal to 100% and the absorbent values are expressed as a percentage:

$$\frac{abs.\ standard}{absorbanta} \times 100 = \%\ abs.\ zero\ standard$$

The values calculated for the standards are entered in a coordinate system on semilogarithmic millimeter paper with respect to the mycotoxin concentration expressed in μg / kg.

The mycotoxin concentration corresponding to the absorbance of each sample can be read using the calibration curve. To obtain the mycotoxin concentration in the sample in μg / kg, the concentration read from the calibration curve must be multiplied by the corresponding dilution factor.

RESULTS AND DISCUSSIONS

Due to the enormous impact of mycotoxins on public health and the economy, it is extremely important to prevent and continuously monitor the incidence of mold infections and associated mycotoxin production (Mia E. *et al*, 2013).

EC Regulation no. 1881/2006 establishes the maximum allowed levels for some contaminants in food products. According to this Regulation, the maximum permitted level of mycotoxins in cereals and cereal products is:

-2 μg / kg for aflatoxin B1;
-4 μg / kg for total aflatoxin;
-750-1750 μg / kg for deoxynivalenol (depending on the product category);
- 75-100 μg / kg for zearalenone;
- 5-10 μg / kg for ochratoxin A;
- 4000 μg / kg for fumonisins.

T2 and HT2 toxins are subject to a monitoring period, before establishing maximum legal limits allowed by the competent authority in the field (EFSA- European Food Safety Authority).

In *table 3* are presented the analytical results of the analyzed samples, which recorded *positive values*, obtained in the study interval 2015-2019, for the characterization of mycotoxins from cereals and cereal products.

Table 3

Analytical results of the analyzed samples

Nr. crt.	Name of mycotoxin	Cereals and cereals products					
		Total number of samples analyzed	Number of negative samples	Number of positive samples	Nature of the sample	Value of the analyzed positive sample (μg/kg)	LMA (μg/kg) according Reg. CE 1881/2006
1.	Aflatoxin B1	40	38	sample no. 1	wheat	1.49	**2**
				sample no. 2	wheat	1.55	
2.	Aflatoxins	44	40	sample no. 1	wheat	1.5	**4**
				sample no. 2	wheat	1.61	
				sample no. 3	wheat	1.97	
				sample no. 4	maize	2.65	
3.	Deoxynivalenol	54	36	sample no. 1	white flour	21.0	**750**
				sample no. 2	white flour	22.0	
				sample no. 3	white flour	23.0	
				sample no. 4	white flour	82	
				sample no. 5	white flour	82	
				sample no. 6	white flour	136	
				sample no. 7	white flour	242.322	
				sample no. 8	white flour	347.353	
				sample no. 9	white flour	491	
				sample no. 10	wheat	636	**1250**

				Sample no. 11	maize	41	**1750**
				sample no. 12	maize	69	
				sample no.13	maize	114	
				sample no. 14	maize	157.916	
				sample no. 15	maize	170.489	
				sample no.16	maize	252.267	
				sample no. 17	maize	324.2	
				sample no. 18	maize	446.956	
4.	Zearalenone	35	31	sample no. 1	maize	2.68	**100**
				sample no. 2	maize	2.68	
				sample no. 3	wheat	3.984	
				sample no. 4	white flour	5.597	**75**
5.	Ochratoxin A	47	41	sample no. 1	rye	1.56	**5**
				sample no. 2	wheat	1.56	
				sample no. 3	wheat	1.56	
				sample no. 4	wheat	1.56	
				sample no. 5	wheat gluten	3.5	**10**
				sample no. 6	wheat gluten	4.556	
6.	Fumonisins	17	9	sample no. 1	maize	45.36	**4000**
				sample no. 2	maize	56	
				sample no. 3	maize	82.233	
				sample no. 4	maize	212.87	
				sample no. 5	maize	299	
				sample no. 6	maize	431	
				sample no. 7	maize	757	
				sample no. 8	maize	854	
7.	Toxin T2/HT2	24	24	-	-	-	**monitoring**
Total number of samples		**261**	**219**	**42**			

CONCLUSIONS

In the studied period (2015-2019) a total number of 261 samples was analyzed, of which, for 219 samples representing a percentage of 83.9%, no mycotoxin values were registered, these being below the detection limit. A number of 42 samples, representing approx. 16.1% of the total studied were positive for mycotoxins, which is a relatively low percentage. None of the samples registered with a positive value for the content of mycotoxins, registered as exceeding the maximum allowed limit provided by the legislation in force (EC Reg. 1881/2006).

Of the total samples found to be positive, the highest frequency of contamination was recorded by deoxynivalenol, with a percentage of about 42.8%, the other mycotoxins having the following incidence: 19% fumonisin, 14.3% ochratoxin A, 9.5% zearalenone, 9.5% total aflatoxin and 4.8% aflatoxin B1.

The maximum levels for mycotoxins, permitted by the legislation in force, shall be set at a level which considers human exposure in relation to the tolerable dose of the toxin in question and which can reasonably be attained for the production, storage and processing of cereals and cereal products. This approach ensures that agri-food operators apply all possible measures to prevent and limit, as far as possible, mycotoxin contamination in order to protect public health.

In general, mycotoxins are unpredictable and unavoidable natural contaminants in agri-food products, posing a permanent serious risk to health for both humans and animals, while contributing to considerable economic losses for agriculture. Particular attention should be paid mainly to prevention measures against mycotoxin contamination of cereals, as it is impossible for other technologies to ensure their complete decontamination. Experts in the food field believe that the most effective way to avoid the effects of mycotoxicosis is to prevent fungal infestation of agricultural crops, by respecting the agrotechnical conditions of cultivation and harvesting, as well as storage conditions, as the processing of contaminated raw materials cannot lead to the removal of mycotoxins.

In order to ensure effective protection of public health, products containing mycotoxins exceeding the maximum permitted levels should not be placed on the market as such or mixed with

other foodstuffs and not will be used as ingredients in other processed products.

The general conclusion is that, based on the results of the analyzes performed for Iasi county in the period 2015-2019, for the selected products, taken "from the base of the food chain", the degree of mycotoxin contamination can be considered acceptable. The general situation is characterized by low contamination, which leads to risks to human health related only to chronic exposure. At the same time, the cumulative toxic effect of mycotoxins encountered simultaneously, especially in cereals, must be considered. Cereals should be ranked first on a hypothetical "warning list" due to their national dietary importance, natural synergism and all possible combinations of major mycotoxins, and the frequent level of contamination.

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STUDIES ON THE EVOLUTION OF THE AGRICULTURAL SECTOR IN THE CONTEXT OF CAP 2014-2020

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Abstract

The Community Agricultural Policy (CAP) assumed by the six founding members by the Rome treaty in 1958 was characterized by a strong intervention of the state, according to the sectors climate and location characteristics, subject of imbalances between demand and supply, and with a high volatility of prices and incomes. In 2003, a series of principles and methods considerably modified the CAP policy, introducing new principles and mechanisms, and terms like unique exploitation payment, cross-compliance, financial discipline. Finally, in 2007, a unique common organizing of the markets (unique COM) was instituted as part of its reform, aiming agricultural productivity growth by promoting technical progress and optimization of the production factors, fair life standards for the agricultural population, stabilization of the markets, supply safety and reasonable prices for consumers. The present analysis aims to highlight the structural and dynamic evolutions of the main indicators in the food sector in the North-East of Romania.

Key words: production factors, strategies, financial

Through the rural and agricultural policies that reformed the Common Agricultural Policy (CAP), the main issues involved aspects such as an improvement on farm orientation to the market needs, creating a balance between unique payments and quality criteria, an alignment to the standards of the World Commerce Organization and a financial discipline that involved freezing the first pylon budget and imposing compulsory annual sums. Among these, the CAP highlighted a series of specific objectives such as agricultural productivity growth, by promoting technical progress and facilitating production means and labor force, assuring a fair life standard for the population working in this field, stabilization of the markets and fair prices.

Today, agriculture only represents a small part from the economy of developed countries in the EU, and public intervention was consolidated lately by a series of rural-agricultural policies such as sustainable development, climate change tackling, improvement of the territories and landscapes, diversity and rural economy revitalization, bioenergy and biomass production as a main target, and most important, food production.

In Romania, a member state of the EU, and implicit beneficiary of the CAP 2014-2020, the agricultural sector remained a rather constant contributor to the gross domestic product, with considerable contribution in the third and fourth trimesters of the year, when corn, sunflower and other late harvested crops are accounted.

MATERIAL AND METHOD

The scientific and methodological support in this study was based on a series of direct and indirect documentation, including observation, comparison and analysis of the economic and phenomena processes studied.

Data from secondary sources, such as Romanian and foreign specialized literature was used, available and applicable at a national level.

Both data from the specific literature and from the analysis of official documents and statistics have been processed and interpreted in order to identify the development of the N-E area of the country, in the 2014-2020 CAP context.

RESULTS AND DISCUSSIONS

The proposals of the Commission regarding the EU budget for 2014-2020 limit the expenses at the level of 2013, according to the data below (*table 1*).

Our country contribution to the gross domestic product in 2019 was lower than the ones in 2017 and 2018, as seen below, mainly because of the smaller production and prices (*table 2*).

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Table 1

UE budget for CAP 2014-2020

Specification	billion euro
Pylon I – Direct payments and market expenses	317.20
Pylon II – Rural development	101.20
Total	418.40
Food security	2.50
Crisis reserve for agro sector	3.90
European Fund of globalization adjustment	up to 2.80
Research and innovation in food security, bioeconomy and sustainable agriculture	5.10
Total additional funds	up to 17.10
Total budget for 2014-2020	up to 435.5

According to INS, industry and agriculture pulled down on the economy, with a major impact on the GVA. Industry by 21,8%, reduced in activity by 1.0%, and agriculture by 4.1%, with reduced activity of 0.2.

Although it ranks first in corn and sunflower production in the EU, and with growing crop production in barley, the agro-food sector remains under the incidence of uncertainty generating factors such as weather conditions, small surface farms and de need of grants from the EU founds.

When referring to the cultivated surface in 2019 compared to 2017, it registered an increase in beans cereals, oleaginous and potatoes, and a decrease in beet, vegetables and barley.

The production indicators of the agro-branches (vegetal, animal and services), in monetary value, have increased, coming to a value of 90.768 million lei in 2019. Bigger values were noted in South-Muntenia, S-E and N-E, and lower financial values were in the Centre, N-W, S-W Oltenia and Bucharest-Ilfov.

Table 2

Contribution of the resources categories in forming and increasing the GVA during 2017-2019

	Contribution in GVA - %		
	2017	2018	2019
Agriculture, forestry and fishing	4.30	4.30	4.10
Industry	23.70	22.80	21.80
Constructions	5.20	5.50	6.40
Services	57.30	57.80	58.10
GVA– total	90.50	90.40	90.40
Net tax on product	9.50	9.60	9.60
Gross value added	100.00	100.00	100.00

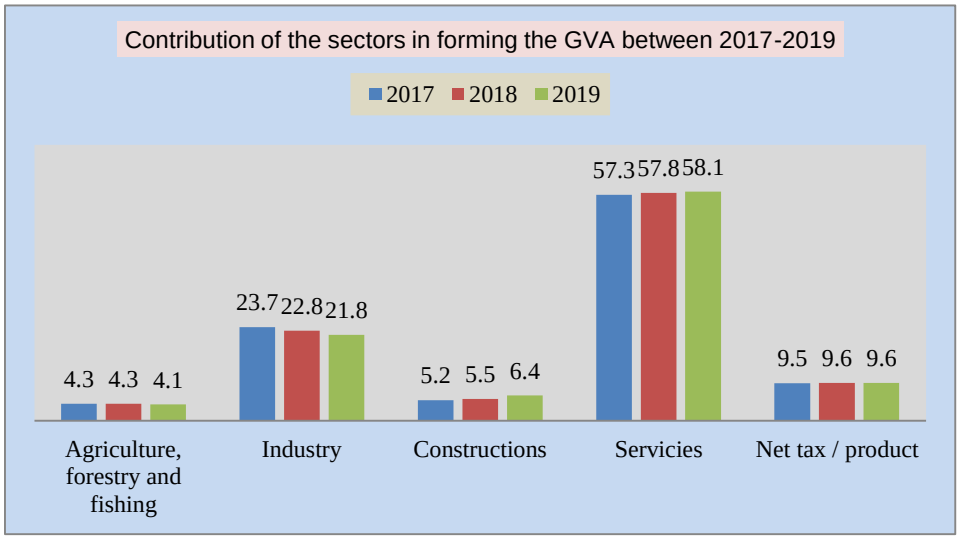

Figure 1 **Contribution of the sectors in forming the GVA between 2017-2019**

Table 3

Cultivated surface and production for the main crops in 2017, 2018 and 2019

	Cultivated surface -thousands ha-			Total production -thousand tones-			Differences (±) 2019 Compared to2017	
	2017	2018	2019	2017	2018	2019	-thousand ha-	-thousand tones-
Beans cereals	5192	5257	5431	27139	31553	29515	+ 239	+2376
-wheat	2053	2116	2106	10035	10144	9874	+ 53	- 161
-barley	455	424	460	1907	1871	1915	+ 5	+ 8
-oat	166	161	161	408	390	398	- 5	- 10
-corn beans	2402	2440	2599	14326	18664	16956	+ 197	+2630
Leguminous plants	119	133	119	302	191	244	0	- 58
Oleaginous plants:	1766	1815	1877	4986	5146	4687	+ 111	- 299
-sunflower	998	1007	1306	2913	3063	3450	+ 308	+ 537
-soy beans	165	169	145	393	460	402	- 20	+ 9
-rape	598	633	419	1673	1610	1628	- 179	- 45
Beet	28	24	27	1175	978	917	- 1	- 258
Potatoes	167	169	170	3117	3023	2717	+ 3	- 400
Vegetables	225	226	224	3638	3797	3488	- 1	- 150

Table 4

Agricultural production indicators on branches for 2017 – 2019-million lei

	2017	2018	2019
Vegetal production	53217	61216	63218
Animal production	24332	23903	25958
Agricultural services	945	1230	1592
Total	78494	86349	90768

CONCLUSIONS

The surface cultivated with cereals, oleaginous plants and potatoes registered a growth in 2019, compared to 2017. The corn cultivated surface was 4.4% higher in 2019, and corn production was also 8.05% higher, due to an increase of the medium production/ha. The surface cultivated with corn in 2019 represented 42.55% of the total surface cultivated with cereals in Romania, and wheat represented 33.45 of the rest. In leguminous plants, production dropped by 19.20%, due to a decrease of the yield / ha, compared to 2017, although the surface remained the same.

The production of oleaginous plants dropped by average by 300 tones / ha, due to a decrease of the cultivated surface by 7.7%, but in sunflower there was an increase both of the surface and the production. The trend in beet production was also decreasing by 20.3%, due to the fact that the cultivated surface dropped by 14.3%, and potatoes production was 1.4% lower, as the cultivated surface was also 0.9% lower in 2019.

The main factors that have a negative impact seem to be the fluidity of the market and the percent of people that practice agriculture on small areas and sell on small prices, disadvantaging those working in bigger, organized, technologized and integrated farms.

The financial indicators of 2019 show an increase of the agricultural production branches, due to the following of the CAP 2014-2020 context. Also, the management processes in agro-food exploitations indicate that a part of the labor force influences the capital (the agricultural fields and the number of farm animals), so as to obtain a higher efficiency in the production process, following the path conducted by the EU context and premises, and showing an improvement of the agricultural coordinates.

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