AGRICULTURAL AND FORESTRY SCIENCES ACADEMY
"GHEORGHE IONESCU - SISESTI"

ACTA AGRICOLA ROMANICA

FIELD CROPS

Tom 6, An 6, Nr.6.1.1.
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CONTENT

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RESULTS REGARDING THE INFLUENCE OF GREEN MANURE USAGE ON SUNFLOWER CROPS ON ACIDIC SOILS IN THE NORTHWEST OF THE COUNTRY.

REZULTATE PRIVIND INFLUENȚA UTILIZĂRII ÎNGRĂȘĂMINTELOR VERZI ASUPRA CULTURII DE FLOAREA-SOARELUI PE SOLURILE ACIDE DIN NORD-VESTUL ȚĂRII.

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ABSTRACT

This study investigates the efficacy of green manures in raising soil fertility and enhancing crop productivity, focusing on Albic Luvisols in northwestern Romania.

Green manures, are cover crops that offer a multitude of benefits when incorporated into the soil. Peas emerge as particularly potent in enriching soil with organic nitrogen, leaving a substantial amount of 471.74 kg N(a.s.) per hectare. Despite pathogen pressures, notably from Septoria helianthi and Puccinia helianthi, the yield was not affected.

Incorporated green manures, especially peas and soybean, significantly boosts sunflower yield, surpassing the control by over 1000 kg/ha. Moreover, chemical fertilization further enhances yield, yielding a substantial difference of 398 kg/ha between fertilized and unfertilized variants. Furthermore, green manures influences sunflower seed fat content, with triticale green manure variant resulting in the highest fat content, with a difference of 3.02% compared to the control. However, it is important to note that the thousand-grain weight (TGW) of sunflower seeds is affected by green manures, particularly with triticale showing a considerable difference of (-) 8.47 g compared to the control.

These findings underscore green manures' impact on soil health, yield, and seed quality, affirming their potential as sustainable agricultural practices for enhancing agroecosystem resilience and productivity.

Keywords: green manure, sunflower, fertilizer, nitrogen

REZUMAT

Acest studiu investighează eficacitatea îngrășămintelor verzi în creșterea fertilității solului și creșterea productivității culturilor, concentrându-se pe luvisolurile albice din nord-vestul României.

Îngrășămintele verzi sunt culturi de acoperire care oferă o multitudine de beneficii atunci când sunt încorporate în sol. Mazărea apare ca fiind deosebit de puternică în îmbogățirea solului cu azot organic, lăsând o cantitate substanțială de 471,74 kg N(a.s.) pe hectar. Chiar și sub presiunea patogenilor, în special Septoria helianthi și Puccinia helianthi, producția nu a fost afectată.

Îngrășămintele verzi încorporate, în special mazărea și soia, sporesc semnificativ producția de floarea soarelui, depășind martorul cu peste 1000 kg/ha. Mai mult, fertilizarea chimică sporește și mai mult randamentul, producând o diferență substanțială de 398 kg/ha indiferent de variantele fertilizate și cele nefertilizate. În plus, îngrășămintele verzi influențează conținutul de grăsime din semințe de floarea soarelui, varianta de îngrășăminte verde cu triticale rezultând cel mai mare conținut de grăsime, cu o diferență de 3,02% față de martor. Cu toate acestea, este important de menționat că masa o mie de boabe (MMB) a semințelor de floarea soarelui este afectată de îngrășăminte verzi, în special cu triticale care prezintă o diferență considerabilă de (-) 8,47 g față de martor.

Aceste constatări subliniază impactul îngrășămintelor verzi asupra sănătății solului, randamentului și calității semințelor, afirmând potențialul lor ca practici agricole durabile pentru creșterea rezilienței și productivității agroecosistemelor.

Cuvinte cheie: îngrășăminte verzi, floarea soarelui, fertilizant, azot

INTRODUCTION

Green manures have emerged as a cornerstone of sustainable agricultural practices. These cover crops, incorporated into the soil while green or shortly after flowering, offer a multitude of benefits for soil health and subsequent crop performance. This study explores the scientific underpinnings of green manures positive impacts on sunflower focusing on nutrient dynamics, yield and the quality of the final product.

A primary benefit of green manures is their ability to enhance soil fertility. Decomposing green manure residues release essential nutrients like nitrogen (N), phosphorus (P), and potassium (K) that become readily available for succeeding crops (Dong et al., 2021) Leguminous green manures, such as clover and alfalfa, hold a particular advantage. Their root systems harbor symbiotic nitrogen-fixing bacteria (Rhizobium spp.), which convert atmospheric N2 into a usable form (NH4+), significantly enriching the soil N pool (Peoples et al., 2009). The extensive root systems of green manures play a crucial role in improving soil structure. These roots penetrate deep into the soil profile, creating channels that enhance aeration and drainage (Hamza et al. 2005). Additionally, the decomposition of green manures residues adds organic matter, which acts as a binding agent, improving soil aggregation and stability. This translates to better water infiltration and reduced soil compaction, fostering optimal root growth for subsequent crops (Bronick et al., 2005).

Green manures are composed of specific plants that are cultivated with the purpose of incorporating them into the soil during basic agricultural operations. The plants used as green manure should produce a rich vegetative mass in as short a time as possible and should not be demanding in terms of soil. The plants used for this purpose are mostly legumes, but other plants can also be used as well. (Dumitru et al., 2003). This technique involves growing plants, such as legumes or grasses, and subsequently incorporating them into the soil before they reach maturity. The decomposition of these plants enriches the soil with organic matter, nutrients, and beneficial microorganisms (Drinkwater et. al. 2007).

Naz et al. (2023) states that green manuring crops are comprised of above- and below-ground biomass. They have the ability to capture solar energy and convert it into carbon flux, which is useful for releasing macro and micronutrients to the soil biota. Green manuring with legumes can fix atmospheric N and provide it to the plants in an available form and also add organic matter to maintain soil fertility. Research has shown that the use of green manure can have several positive effects on agricultural systems. Firstly, it enhances soil structure, promoting better water infiltration and retention, which ultimately leads to improved moisture management. Additionally, green manure contributes to increased nutrient availability, particularly nitrogen, phosphorus, and potassium, reducing the reliance on synthetic fertilizers. This practice also aids in weed suppression, as the cover crops compete with undesirable plants for resources and space (Mäder et al., 2002).

Furthermore, green manure supports biodiversity by providing habitat and food sources for beneficial insects and soil organisms. It also reduces soil erosion by stabilizing the soil surface with a protective cover of vegetation. Moreover, green manure has been found to mitigate greenhouse gas emissions, sequestering carbon in the soil and reducing the need for energy-intensive farming practices (Tonitto et al., 2006).

Soil has always been the basis of human existence. The most pronounced degradation processes of illuvial-clay soils in northwestern Transylvania are acidification and excess moisture. The pedological and agrochemical studies carried out so far in the area have shown that approximately 60% of the agricultural land has an acid reaction, soil acidity being a natural phenomenon in areas with excess water regime. Practicing a sustainable agriculture requires a certain balance between the processes of degradation and regeneration in the soil, which can be influenced mainly by human activity.

Due to the increasingly frequent and insistent circulation of the concept of sustainability in agriculture, priority has been given to the issues of efficient, quality and non-polluting sustainable agriculture that conserves soil resources.

Brown luvic soils and albic luvisols occupy a percentage of over 35% of the arable land of the counties in NW Romania (Boieriu, 1987). Based on the ratio between humus (%) and total nitrogen (N %), which serves for the indicative assessment of the need for nitrogen fertilizers or organic fertilizers, it is on these soils below 20%, clearly showing the requirement for fertilization with manure to be high compared to nitrogen fertilization (Davidescu, 1981).

Research carried out at Livada ARDS, in the interval 1991-1993, demonstrated that the contribution of green fertilizers (lupine) to the improvement of the agrochemical indices of the soil and to the realization of productions is at the level of the use of fertilization with 20 tons/ha of animal manure (Sîrca, 1997) .

Soils, through agrochemical indicators, influence cultivation technologies as well as the plants that can be grown on certain types of soil. The pedogenetic framework of Satu-Mare county is notable for the fact that acid soils represent more than 30% of the county's surface.

Albic luvisol, classified under the World Reference Base for Soil Resources (WRB), is a type of soil found in various regions around the world. It is characterized by a distinctive horizon known as the albic horizon, which is typically light in color due to leaching of minerals and organic matter. (FAO, 2006) In the upper horizon, there is a low humus content, with a moderate supply of mobile phosphorus, low mobile potassium, and a strongly acidic reaction, with the pH in water of around 5.2. (Boeriu et al., 1987). Soil pH is the most important indicator measured for estimating soil health especially in mine soils, since it has a great influence on key soil processes. (Buta et al., 2019) The pronounced acidification, low supply of humus and potassium, and the defective air-water regime impose serious restrictions on crop cultivation. (Kurtinecz et al., 2022). The crust formation index has values between 1.8-2.2 (Canarache, 1987), often leading to the compromise of crops with epigeic germination, an aspect that can only be improved through the addition of organic matter, which facilitates soil structure. Additionally, the addition of organic matter improves water permeability, soil warming, and intensifies microbiological activity, which are deficient aspects in these types of soils, where surface puddles or erosions are frequent.

MATERIAL AND METHOD

The ecological framework of the experience was the area of Livada city in Satu Mare county, more precisely the experimental fields of Livada A.R.D.S. The experiment is located on an Albic Luvisol (Table 1).

Table 1. The main physico-chemical parameters of Albic Luvisol at Livada ARDS//
Principalii parametrii fizico-chimici al luvisolului albic la S.C.D.A. Livada

Horizon Horizon depth Sample depth	UM cm cm	Ap 0-18 0-15	Ao 18-40		AB 40-55 40-55	Bt1w 55-70 55-70	Bt2w 70-110 80-95
			20-30	30-40			
Humus(Cx1,72)	%	1,82	1,44	0,90	0,90	0,84	3,24
N total	%	0,168	0,102	0,072	0,068	0,064	-
C : N	-	8,21	9,15	10,14	10,34	10,57	-
pH (H_2O)	-	5,19	6,24	6,65	6,53	5,62	5,28
SB	me/100g soil	5,20	6,26	6,53	8,85	10,23	11,02
Ca^{2+}sch	me/100g soil	4,22	5,46	5,41	6,70	7,07	7,25
Mg^{2+}sch	me/100g soil	0,77	0,63	0,96	1,91	2,84	3,49
K^{+}sch	me/100g soil	0,18	0,12	0,12	0,20	0,25	0,23
Na^{+}sch	me/100g soil	0,03	0,05	0,04	0,04	0,06	0,06
V%	% din T	53,5	73,2	77,8	79,8	71,1	69,5
P- AL	ppm	13,6	24,0	10,2	-	-	-
K-AL	ppm	100	87	87	-	-	-
Clay(< 0,002 mm)	% g/g	20,9	21,1	23,1	27,0	32,4	33,1
Apparent density	g/cm³	1,35	1,54	1,49	1,48	-	1,48
Hydraulic conductivity	mm/h	1,3-4,0	5,87	3,11	0,35	-	1,04

In this area, the level of annual precipitation reaches a level of approximately 740-750 liters per square meter, precipitation being distributed more and more unevenly in recent years is distributed more and more unevenly. As can be seen from the graph below (Figure 1), the level of precipitation during the sunflower vegetation period suffered anomalies, especially in May when the level was 19.7 liters and August-September where the deviation from the multi-year average was significant.

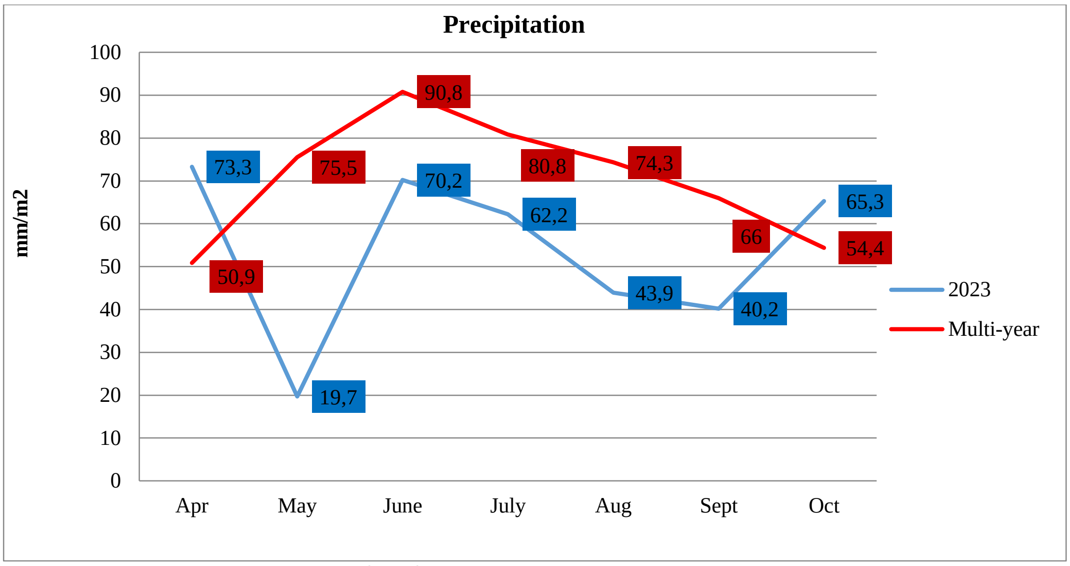

Figure 1. Comparison of Sunflower Vegetation Period Precipitation with Multi-Year Averages//
Comparația dintre precipitațiile perioadei de vegetație de floarea-soarelui cu mediile multianuale

In terms of temperatures during the vegetation period, a warming trend can be observed with temperatures of even 3 degrees Celsius compared to the multi-year. (Figure 2). The region experiences an average annual temperature range of 8˚C to 10˚C. The accumulation of heat units above the threshold of 10˚C in the plain area varies between 1200 and 1450˚C. Over the past six decades, the Livada station has recorded an average temperature of 9.9˚C.

Recently, climate changes are becoming more and more evident, and this is clearlyreflected by the lack of precipitation, the installation of the phenomenon of excessive heat and the increase in the average annual temperature. Temperature variations, positive or negative, are reflected in the evolution of the vegetation state of agricultural crops and implicitly in the production capacity.

These climate data stretch us towards new ways of approaching agriculture. Green manures or also called cover crops are beneficial to retain moisture in the soil.

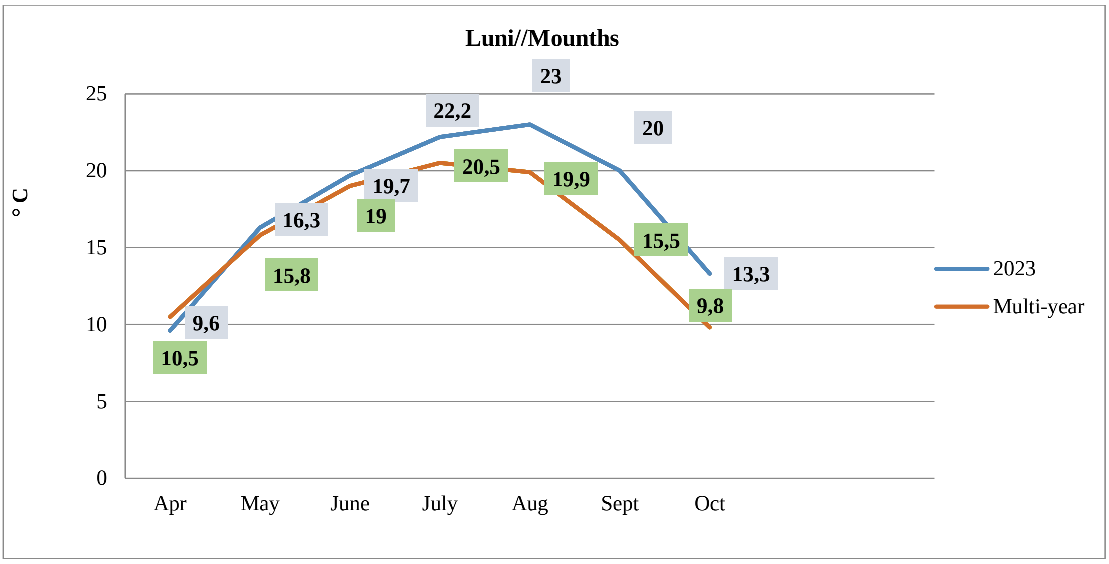

Figure 2. Comparison of Sunflower Vegetation Period Temperature Ranges with Multi-Year Trends//
Comparația dintre temperaturile perioadei de vegetație de floarea-soarelui cu mediile multianuale

The primary objective of this experiment is to assess the influence of green manures, both individually and in combination with chemical fertilizers, on the cultivation of sunflower. The comprehensive evaluation encompasses key parameters such as yield, resistance to diseases, as well as the overall quality of the main crop.

The experimental design incorporates three replications (R) and employs a split-plot configuration, featuring two distinct experimental factors. These factors are denoted as Factor A, pertaining to the type of green manure utilized; Factor B, concerning the application of chemical fertilizers (Figure 3.)

The five selected plant species, namely triticale (A6), peas (A5), soybeans (A4), sunflower (A3), and rapeseed (A2), and the control variant (A1) without cover crop, were sown during the summer season and subsequently integrated into the soil at the green growth stage. In terms of chemical fertilization, Calcium ammonium nitrate characterized by a nitrogen content of 27% was employed, (B1-fertilized and B2-unfertilized) administered at a rate of 450 kilograms per hectare (kg/ha) in the sping. This comprehensive experimental setup aims to elucidate the intricate interplay between green and chemical fertilizers, in conjunction with fungicide treatment, on the performance and outcomes of sunflower cultivation.

	A1	A2	A3	A4	A5	A6
R1	B1	B2	B1	B2	B1	B2
	B2	B1	B2	B1	B2	B1
R2	B1	B2	B1	B2	B1	B2
	B2	B1	B2	B1	B2	B1
R3	B1	B2	B1	B2	B1	B2
	B2	B1	B2	B1	B2	B1

Figure 3. The field layout of the experiment//Așezarea câmpului experimental

Cover crops were incorporated into the soil in the autumn of 2022 in order to enhance soil fertility. Prior to incorporation, the biomass of each plant species per hectare was quantified using sampling quadrants. (Figure 4). This method allowed us to determine the exact amount of plant material being added to the soil. Additionally, the amount of bioavailable nitrogen, the specific form of nitrogen usable by plants, contributed by each cover crop species was determined. This data provides valuable insights into the potential impact of the cover crops on soil nitrogen content and subsequent crop growth. The largest amount of green mass was obtained in the sunflower crop (over 22.7 t) , followed by peas and then rapeseed.

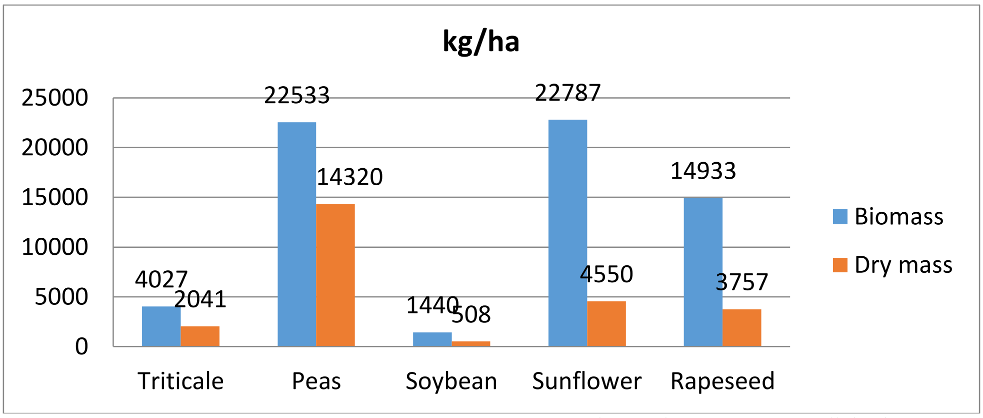

Figure 4. Biomass incorporated by plant species//Biomasă incorporată pe specii de plante

The determination of proteins is carried out by the Kjeldahl method, in which the samples are subjected to mineralization in a strongly acidic environment which determines the transformation of protein nitrogen into ammonium ion; after a distillation step, the titration (Figure 5) is carried out with a strong acid. By obtaining the amount of protein, the amount of active substance nitrogen incorporated per hectare was calculated (Table 2).

Table 2. Biometric determinations on the quantity of green fertilizer//Determinări biometrice asupra cantității de îngrășământ verde

	Biomass kg/ha	Dry mass kg/ha	Proteine %	Proteine kg ha	N (a.s.) kg ha
Triticale	4027	2041	13.56	276.81	44.29
Peas	22533	14320	20.59	2948.4	471.74
Soybean	1440	508	21.55	109.54	17.53
Sunflower	22787	4550	12.33	560.98	89.76
Rapeseed	14933	3757	12.95	486.57	77.85

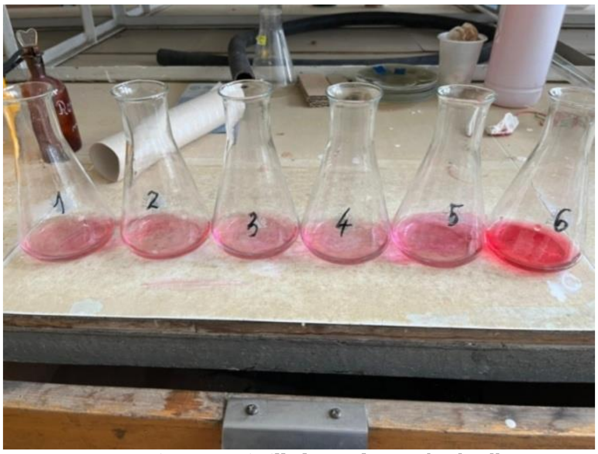

Figure 5. Distilled samples//Probe distillate

RESULTS AND DISCUSSIONS

In this experiment, observations were made regarding weed infestation in various cover crop species under different fertilization conditions. It was found that the number and species of weeds per square meter varied significantly depending on the fertilization regime and the green manure species.

Among the fertilized variants of rapeseed, soybean, and triticale, a higher number of weeds per square meter were observed compared to their respective unfertilized counterparts. This suggests that fertilization may have promoted weed growth in these particular crop species.

Conversely, in the fertilized control, sunflower and peas variants, the number of weeds was significantly lower. Notably, the fertilized pea variant exhibited the lowest weed count among all variants, with only 30 weeds per square meter.

On average, the control variant had the highest number of weeds per square meter, with 88 weeds observed. Among the control variants, the unfertilized control variant recorded the highest weed count, with 126 weeds per square meter (Figure 6).

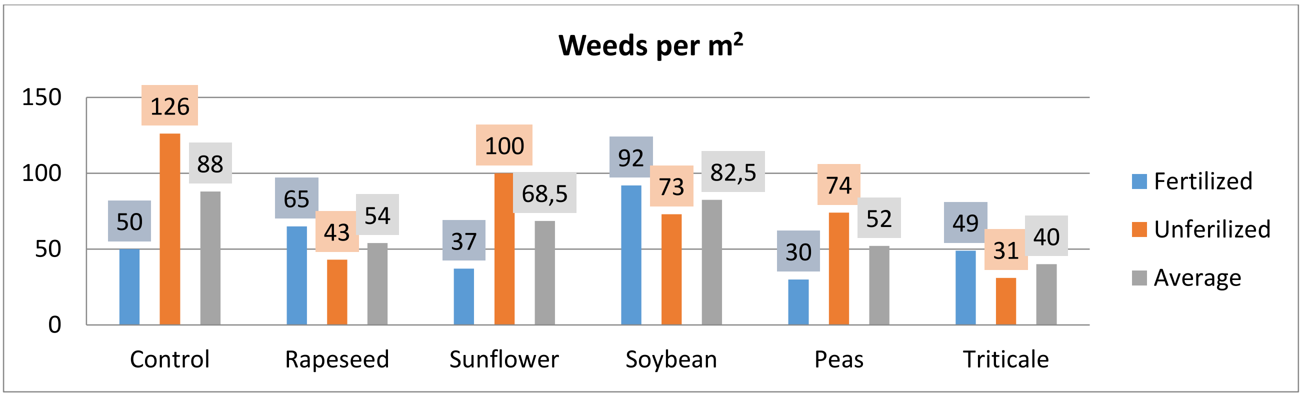

Figure 6. Weeding Degree per square meter//Gradul de îmburuienare pe metru pătrat

In terms of weed species composition, the dominant weed observed in this experiment was *Chenopodium album*, constituting 74% of the total weed population. *Ambrosia artemisiifolia* was the next most prevalent species, comprising approximately 12% of the weed population. The remaining weed species, collectively accounting for the remaining 14%, each constituted approximately 1-3% of the total weed population. This distribution highlights the predominance of *Chenopodium album* in the weed community, indicating its robust presence and potential impact on the ecosystem within the experimental context (Figure 7).

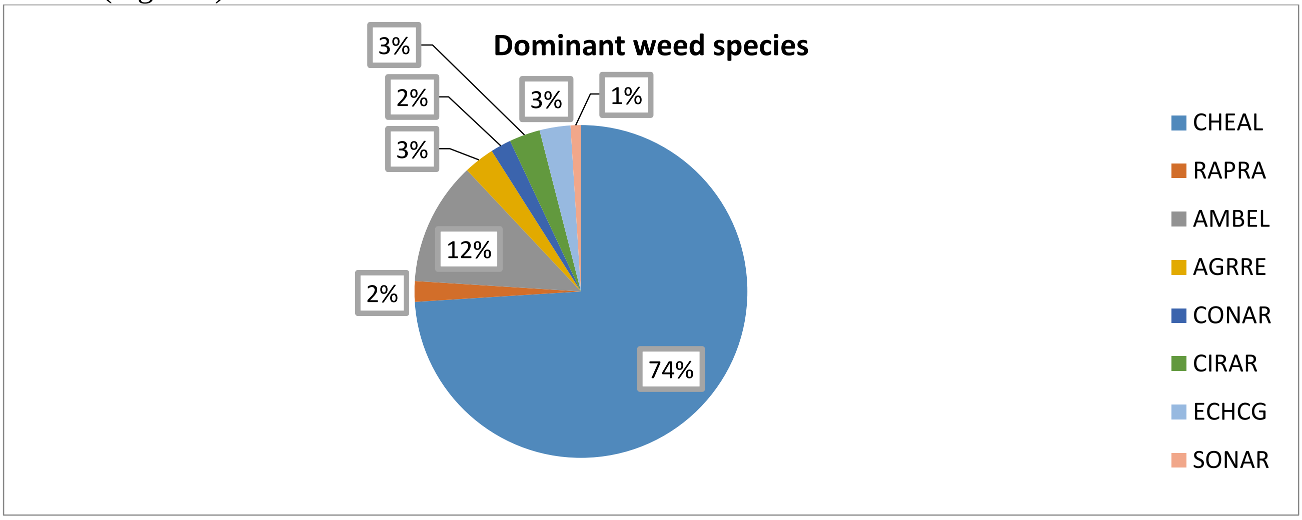

Figure 7. Dominant weed species//Specile dominate de buruieni

In the complex of pathogens affecting sunflower crops, *Septoria helianthi* and *Puccinia helianthi* emerged as the predominant. (Figure 9). The severity of *Septoria helianthi* infection peaked at 73.5% in the unfertilized control, whereas the lowest incidence, at 40%, was observed in the unfertilized rapeseed variant. The highest average was present at the pea green manure variant, with both fertilized and unfertilized variants exceeding a degree of attack of 70%(Figure 8)

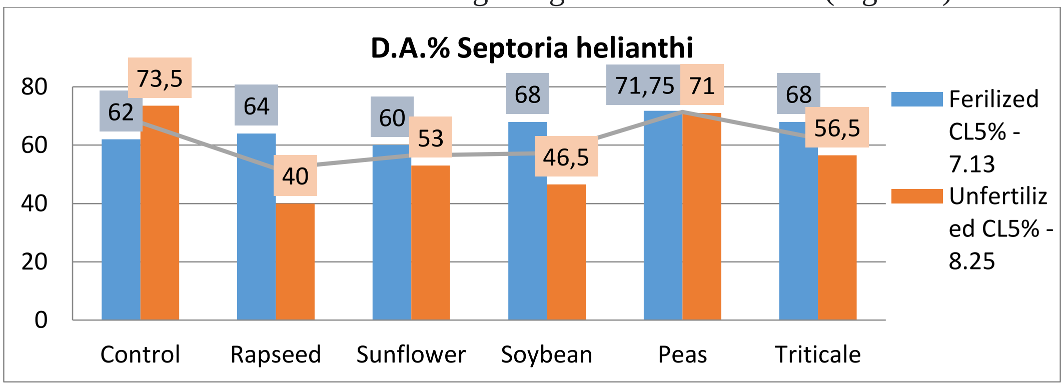

Figure 8. Degree of attack of *Septoria helianthi*//Gradul de atac de *Septoria helianthi*

In the context of the 2023 sunflower crop yield analysis, in comparison to the control achieving a yield of 2051 kilograms per hectare (kg/ha), noteworthy observations emerge regarding the influence of different green manure treatments. Notably, there is a substantial positive impact on yield when utilizing green manures derived from peas with a yield of 3194 kg/ha and soybean with a yield of 3060 kg/ha. Specifically, the influence is notably pronounced in the case of pea cover crops, exhibiting a distinct positive effect. Conversely, the influence on yield from triticale is comparatively negligible, with the sunflower yield attaining 2447 kg/ha, presenting an insignificant difference of merely 396 kg/ha in comparison to the control. (Table 3)

Figure 9. Septoria and Puccinia attack on the sunflower leaf//
Atac de Septoria și Puccinia pe frunza de floarea soarelui

Table 3. The influence of green manure factor on yield//Influența îngrășămintelor verzi asupra producției

Number	Variant	Average (kg/ha)	Difference (kg/ha)	Significance
1	Triticale	2447	396	-
2	Peas	3194	1143	**
3	Soybean	3060	1009	**
4	Sunflower	2685	643	*
5	Rapeseed	2681	630	*
6	Control	2051	-	-

CL (p 5%)	595
CL (p 1%)	846
CL (p 0.1%)	1225

The application of chemical fertilizer manifests a notably positive effect on yield, resulting in an increase of 398 kg/ha when compared to the average yield encompassing both fertilized and unfertilized conditions indifferent of the green manure. These findings are statistically robust, providing a confident indication of the beneficial impact of chemical fertilization on sunflower yield.(Table 4)

Table 4. The influence of chemical fertilization factor on the yield//Influența fertilizării chimice asupra producției

Number	Variant	Average (kg/ha)	Difference (kg/ha)	Significance
1	Fertilized	3084	398	**
2	Unfertilized	2288	-398	oo
3	Average	2686	-	

CL (p 5%)	248
CL (p 1%)	349
CL (p 0.1%)	492

The synergistic integration of green manure with chemical fertilizers yielded a significant increase in crop productivity across three green manure varieties. Notably, among the fertilized crops, the control displayed the lowest yield at 2541 kilograms per hectare. Conversely, the fertilized pea variant exhibited the highest yield at 3524 kg, representing a notable deviation of 982 kg from the control. Additionally, the fertilized soybean and sunflower variants demonstrated yields exceeding 850 kg in comparison to the control, further emphasizing the effectiveness of amalgamating green manure and chemical fertilizers in enhancing crop yield. (Table 5a).

In the context of chemically unfertilized crops, it is noteworthy that the utilization of green manure derived from peas and soybean resulted in the highest yields, reaching 2863 kg/ha and 2679 kg/ha, respectively.

Table 5a. The interaction of green manure and chemical fertilizer factors// Interacțiunea factorilor îngrășământ verde și îngrășământ chimic

Number	Green manure + Fertilized	Average (kg/ha)	Dif. (kg/ha)	Signif
1	Triticale F	2690	149	-
2	Peas F	3524	982	*
3	Soybean F	3440	899	*
4	Sunflower F	3398	857	*
5	Rapeseed F	2910	369	-
6	Control F	2541	-	-

Note. *F = Fertilized*

These figures represent substantial positive increments of 1304 kg/ha and 1119 kg/ha compared to the control, which yielded 1559 kg/ha. Additionally, rapeseed showcased a notable positive yield of 893 kg/ha. This data emphasizes the varying effects of different sources of green manure on crop yield when chemical fertilization is not employed. (Table 5b).

Table 5b. The interaction of green manure and chemical fertilizer factors// Interacțiunea factorilor îngrășământ verde și îngrășământ chimic

Number	Green manure + Unfertilized	Average (kg/ha)	Dif. (kg/ha)	Signif
1	Triticale UF	2203	643	-
2	Peas UF	2863	1304	**
3	Soybean UF	2679	1119	**
4	Sunflower UF	1970	411	-
5	Rapeseed UF	2452	893	*
6	Control UF	1559	-	

Note. *UF = Unfertilized*

CL (p 5%)	734,33
CL (p 1%)	1039,30
CL (p 0.1%)	1491,86

Sunflower seeds are prised for their high fat content, predominantly comprising healthy unsaturated fats like linoleic acid. In our study, we found that only triticale green manure led to a significant increase in fat content compared to the control. Triticale green manure resulted in a fat content of 47.40%, which was 3.02% higher than the control's 44.38%. Other green manure sources showed positive but insignificant differences in fat content. (Table 6).

Table 6. The influence of green manure factor on fat content// Influența îngrășămintelor verzi asupra conținutului de grăsimi

Number	Variant	Average %	Difference %	Significance
1	Triticale	47.40	3.02	**
2	Peas	44.72	0.33	-
3	Soybean	45.10	0.72	-
4	Sunflower	46.00	1.62	-
5	Rapeseed	45.72	1.33	-
6	Control	44.38	-	-

CL (p 5%)	1.66
CL (p 1%)	2.36
CL (p 0.1%)	3.42

In our experiment, we assessed the thousand-grain weight (TGW) of sunflower seeds. The control exhibited a TGW of 57.97g. Interestingly, across all green manure treatments, the TGW was consistently lower compared to the control. The lowest TGW was observed in the triticale green manure, with a value of 49.50g, representing a substantial difference of -8.47g compared to the control. Similarly, the soybean green manure exhibited a TGW of 50.87g, indicating a notable difference of -7.10g compared to the control. While the TGW for the remaining green manure treatments was also lower than the control, these differences were deemed insignificant. (Table 7).

Table 7. The influence of green manure factor on TGW//Influența îngrășămintelor verzi asupra MMB

Number	Variant	Average g	Difference g	Significance
1	Triticale	49.50	-8.47	oo
2	Peas	56.50	-1.47	-
3	Soybean	50.87	-7.10	o

Number	Variant	Average g	Difference g	Significance
4	Sunflower	53.33	-4.63	-
5	Rapeseed	56.80	-1.17	-
6	Control	57.97	-	-
	CL (p 5%)		5.03	
	CL (p 1%)		7.14	
	CL (p 0.1%)		10.34	

CONCLUSION

In conclusion, our study underscores the significance of green manures in enhancing soil fertility and crop productivity in acidic Albic Luvisols in the northwest part of Romania. Among the various green manure sources evaluated, peas stood out as particularly effective in enriching the soil with organic nitrogen, leaving a substantial amount of 471.74 kg nitrogen (active substanc) per hectare. Despite the presence of pathogen attacks, notably from *Septoria helianthi* and *Puccinia helianthi*, these did not detrimentally impact crop yield, highlighting the resilience of the cultivated sunflower varieties.

The incorporation of green manures, especially from peas and soybean, demonstrated a pronounced positive effect on sunflower yield, surpassing the control by over 1000 kg/ha. Additionally, chemical fertilization contributed significantly to yield enhancement across all green manure treatments, yielding a substantial difference of 398 kg/ha between fertilized and unfertilized variants.

Furthermore, the fat content of sunflower seeds was notably influenced by green manure application, with the triticale green manure resulting in the highest fat content, showcasing a difference of 3.02% compared to the control. However, it is important to note that the thousand-grain weight (TGW) of sunflower seeds was adversely affected by green manure incorporation, particularly with triticale showing a considerable difference of -8.47 g compared to the control.

Overall, our findings emphasize the multifaceted impact of green manures on soil fertility, crop yield, and seed quality on acidic Albic Luvisols, thereby highlighting their potential as sustainable agricultural practices for improving overall agroecosystem resilience and productivity.

Further research is warranted to optimize green manure utilization strategies and mitigate potential adverse effects on seed characteristics such as TGW.

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THE QUALITY OF CORN HYBRIDS CULTIVATED IN WESTERN OF ROMANIA

CALITATEA HIBRIZILOR DE PORUMB CULTIVAȚI ÎN VESTUL ROMÂNIEI

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ABSTRACT:
A comparative analysis of the corn hybrids cultivated mainly in the western part of Romania, highlights the quality of the hybrids created in research institutions in Romania. Compared to foreign commercial hybrids, a series of commercial hybrids created at ARDS Lovrin - western Romania, ARDS Turda - central Transylvania and NIARD Fundulea - south of the country, representative agricultural areas of the country, were analyzed in this paper. The protein content (%) and oil content (%) of 28 hybrids sown in a demonstration plot, located at SCDA Lovrin, were analyzed. Of the 28 hybrids, 14 belong to research institutions in Romania and 14 to private seed-producing companies. The comparative analysis, based on the average values, of the data series for the Romanian hybrids from Lovrin, Turda and Fundulea, with the data series of the foreign hybrids, showed that the differences showed statistical certainty for the hybrids from Lovrin in the case of protein and content of oil, and for hybrids from Turda in the case of oil content. In relation to the median value, the differences did not show statistical certainty.

Key words: corn, hibrids, germoplasm, protein content, oil content.

REZUMAT:
O analiză comparativă a hibrizilor de porumb cultivati preponderent în partea de vest a României, scoate în evidență calitatea hibrizilor creați în instituțiile de cercetare din România. Față de hibrizii comerciali străini, au fost analizați în prezenta lucrare o serie de hibrizi comerciali creați la SCDA Lovrin – vestul României, SCDA Turda – centrul Transilvaniei și INCDA Fundulea – sudul țării, zone agricole reprezentative ale țării. A fost analizat conținutul de proteină (%) și conținutul de ulei (%) la 28 de hibrizi semănați într-un lot demonstrativ, amplasat la SCDA Lovrin. Din cei 28 de hibrizi, 14 aparțin instituțiilor de cercetare din România și 14 companiilor private producătoare de sămânță. Analiza comparativa, pe baza valorilor mediei, a seriei de date pentru hibrizii romanesti de la Lovrin, Turda si Fundulea, cu seria de date a hibrizilor straini, a aratat ca diferentele au prezentat siguranta statsitica pentru hibrizii de la Lovrin in cazul proteinei si a continutului de ulei, si pentru hibrizii de la Turda in cazul continutului de ulei. In raport cu valoarea medianei, diferentele nu au prezentat siguranta statistica.

Cuvinte cheie: porumb, hibrizi, germoplasmă, conținut de proteină, conținut de ulei.

INTRODUCERE

Also called ”the food of the poor”, corn has a significant share in world agriculture, being the third most productive crop after wheat and rice. Being a crop of important global interest, used in various nutritional recipes for humans and animals, its contribution tofood security is of utmost interest. Breeding programs are focused on obtaining genotypes tolerant to climate changes (thermal and water stress), to soil reaction (acidity, salinity), to diseases and pests, associated with efficient and economic culture technologies (Bojtor și colab., 2021; Prasanna și colab., 2021; Mukaro și colab., 2023; Széles și colab., 2024).

Major concerns at the global level are the management of corn germplasm and the comparative study of genotypes in relation to the agro-ecological conditions of the production and cultivation areas (Matova et al., 2023).

Various methods have been studied in corn breeding programs to obtain valuable, time and cost sustainable genotypes (Bernardo, 2021).

The corn production of grains represents an important source of protein for human consumption, animal consumption, industrialization (Gunaratna N.S., 2019; Prandini, 2011; Wu Y., 2014). The quality production, and especially in terms of protein and oil content, depends on the cultivated genotype but also on the interaction between genotype and environmental conditions (Amegbor, 2022; Duarte, 2005; Katsenios, 2021; Shojaei, 2020).

The improvement of quality indices (protein and oil content) in corn has been addressed both through breeding programs, and through culture technologies. The protein content, as an important quality index of agricultural production, has been studied in field crops in relation to productivity elements, and different quantitative and qualitative production elements and indices. Corn is a plant with high ecological plasticity, and it is cultivated on extensive areas in the world and responds differently to the various pedoclimatic conditions. Corn culture, production and quality indices were studied in relation to soil conditions, climatic conditions, irrigation conditions, fertilizers, stress factors, and other influencing conditions.

In corn the protein can be found mainly in the endosperm (75 -80%), the rest being placed in the embryo (17-24%) and in the pericarp. The content of protein can fluctuate between 8% and 15%, depending of the hybrid, climatic conditions, nutrition. Proteins are made up of prolamins 45%, glutelins 35% and globulins 20%. The most important prolamin is zein, which contains significant amounts of glutamic acid, alanine, proline and leucine, but is poor in lysine and tryptofan, which essential aminoacides leads to a decrease in the nutritional value of the proteins in the grain (Gheorghe, 2014).

The oil made of corn contains in proportion of 56% polyunsaturated fatty acids, 14% saturated fatty acids and 30% monounsaturated fatty acids. After the refining process the corn oil has in it composition 1% linolenic acid, 25 to 31% oleic acid, 2 to 3% stearic acid, 11 to 13% palmitic acid and 54 to 60% linoleic acid. Two main forms of vitamin E, that are present in humans diet, are contained in corn oil, alpha (α) and gamma (γ) tocopherols (Rouf, 2016).

MATHERIAL AND METHODS

The study took place in the period 2022-2023 at ARDS Lovrin, in a demonstration batch including 28 hybrids. Of the 28 hybrids – 14 genotypes belong to Romanian research centers (3 hybrids – ARDS Lovrin, 5 hybrids – ARDS Turda and 6 hybrids – NIARD Fundulea) and 14 genotypes belong to private seed producing companies. Protein content (%) and oil content (%) were determined in the Corn Breeding Laboratory using Perten Inframatic 2001.

The climatic conditions of the area are specific to the temperate continental climate, with an annual average temperature of 10.1^0C and a rainfall regime of over 500 mm. Global climate changes have also affected the western area of Romania, with visible effects on agricultural crops. Thus, there is an increase in the average annual temperature by approximately 2^0C in the last 5 years and an uneven distribution of precipitation during the agricultural year, accompanied by long droughts, increased wind speed, atmospheric heat, etc.

The soil within the crop plot, ARDS Lovrin, is of typical chernozem type, weakly glazed, medium clay-clay, with the following physico-chemical parameters of fertility in the A horizon (0 – 20 cm): soil reaction, pH = 6.7; humus content, H = 3.55%; nitrogen index, NI = 3.07%; phosphorus content, P = 75.5 ppm; potassium content, K = 205 ppm.

The experimental data were analyzed mathematically and statistically through appropriate methods and tools (Hammer et al., 2001; JASP, 2022), to capture the relationships between the indices and the calculated ratios, to characterize the corn genotypes accurately, and to identify valuable genotypes (on each index studied), for corn breeding program, in the context of agro-ecological cultivated conditions, and the climatic change conditions.

RESULTS AND DISCUTIONS

Corn breeding at ARDS Lovrin has as its main objective the creation of productive hybrids, adapted to the impact of climate change, but which do not compromise quality. Protein content, one of the important qualitative indicators, is determined at ARDS Lovrin both in newly created hybrids and in their constituent parental forms.

Since the western plain is a representative agricultural area for Romanian agriculture, corn culture has a significant weight in the crop structure, occupying the first place in terms of yield and area. A varied range of hybrids is grown here, 90% coming from foreign seed producing companies and only 10% from Romanian research institutions.

In the present study, 28 corn hybrids were qualitatively analyzed - 14 Romanian hybrids (HRO) and 14 ex-Romanian hybrids (HExRO). Figure 1 shows the concentration of protein and oil, determined in the corn hybrids produced in Romania.

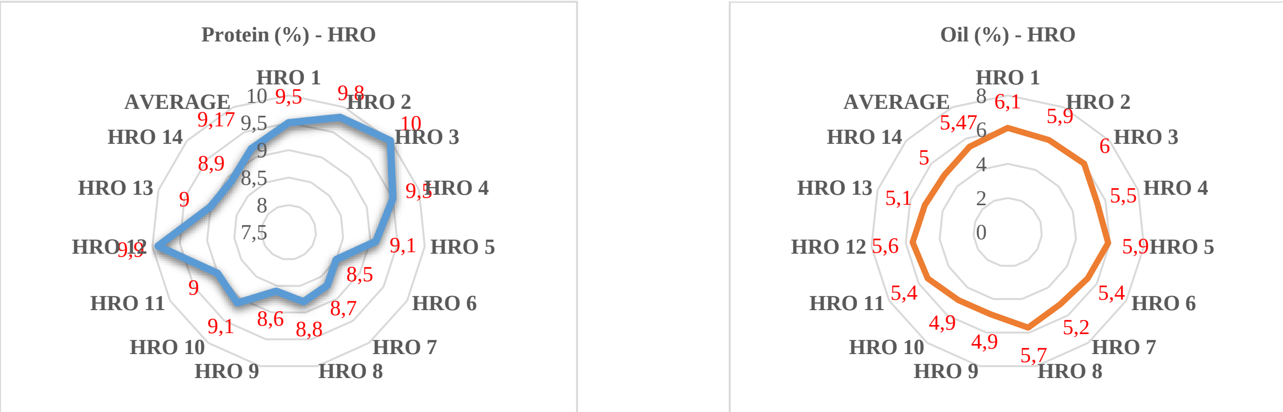

Figure 1. Protein concentration and oil content, determined in Romanian hybrids//. Concentrația de proteine și conținutul de ulei, determinat în hibrizii românești

Regarding Romanian hybrids, three representative areas for Romanian agriculture were analyzed - the west of the country (three hybrids), the center (five hybrids) and on the south (six hybrids). The determined protein content varies in the range of 8.6% - 10%, with the highest values belonging to hybrids created at ARDS Lovrin (9.5%, 9.8% and 10%), with differences up to 0.83% against the average of experience. Moreover, five hybrids exceed the average of experience, and nine hybrids are below this value, but with very small differences.

Oil content ranges from 4.9% to 6.1%, with the highest values recorded in hybrids that also have high protein content. Thus, eight of the hybrids exceed the experience average for oil content and only five hybrids are below this value.

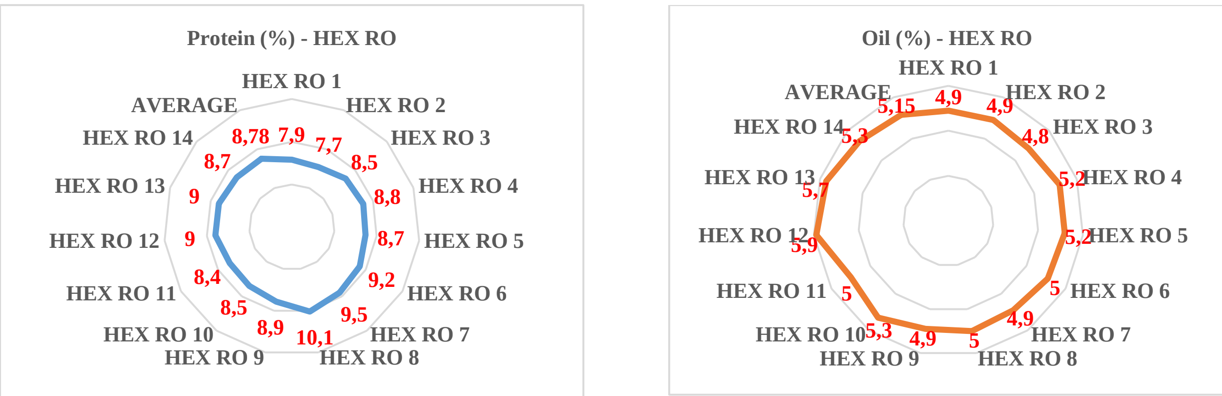

Figure 2. Protein concentration and oil content, determined in foreign hybrids// Concentrația de proteine și conținutul de ulei, determinate în hibrizi străini

From the point of view of foreign hybrids cultivated in the western part of the country, the amount of protein and oil determined is presented in figure 2. Thus, the protein content varies in the range of 7.7% - 10.1%, with 7 hybrids exceeding average experience – 8.78%. Protein content above 9% is prezent in five of the 14 hybrids. The determined oil content varies from 4.8% to 5.9%, with six values exceeding the average of experience, given as 5.15%.The significant trend of increasing the oil content with increasing protein content is noted (Figure 3).

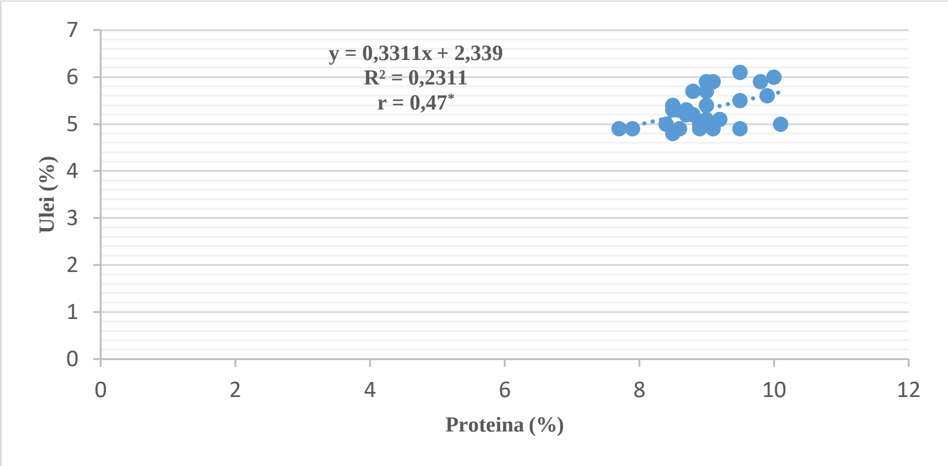

Figure 3. Correlation between protein content and oil content in corn // Corelația dintre conținutul de proteine și conținutul de ulei din porumb

„Between the two series of values presented, the quality of Romanian hybrids versus the quality of foreign hybrids, significant differences are highlighted. The protein content in HRO is, as an average presented among the 14 genotypes, 9.17%, while the average of the foreign hybrids indicates a value of 8.78%. Between the two series there is a difference of 0.39%, value statistically assured as significant for the probability of transgression of 0.05%. The same trend is also observed in terms of fat content, the difference between the two series being 0.32%, a value statistically assured as significant for the transgression probability of 0.05%. In relation to the median value, both parameters register distinctly significant differences, statistically ensured for the probability of transgression 0.01%. The comparative analysis, based on the mean and median values, of the data series for the Romanian hybrids, with the data series of the foreign hybrids, showed that the differences for the protein and oil content are statistically reliable, Table 1.

Table 1. Statistical data of the comparative analysis between Romanian and foreign corn hybrids// Valorile statistice ale analizei comparative între hibrizii de porumb români și cei străini

Statistical parameters	Protein	Oil
Given mean: Hybrids ExRomania	8.78	5.15
Sample mean: Hybrids Romania	9.17	5.47
Difference:	0.39143	0.32143
95% conf. interval:	(0.10909 0.67377)	(0.083445 0.55941)
t :	2.9951	2.9179
p (same mean):	0.010336	0.01199
The meaning of the differences	*	*
Given median: Hybrids Ex-Romania	8.75	5.05
Sample median: Hybrids Romania	9.05	5.45
p (same median):	0.0090444	0.0056942
The meaning of the differences	**	**

Table 2 presents the comparative statistical analysis between the Romanian corn hybrids, created at ARDS Lovrin, ARDS Turda and FNIARD Fundulea and foreign hybrids.

Table 2. Comparative analysis between Romanian, Lovrin, Turda and Fundulea corn hybrids and foreign hybrids//Analiză comparativă între hibrizii de porumb români, Lovrin, Turda şi Fundulea şi hibrizii străini

Statistical parameters	Lovrin		Turda		Fundulea	
	Protein	Oil	Protein	Oil	Protein	Oil
Given mean:	8.78	5.15	8.78	5.15	8.78	5.15
Sample mean:	9.77	6	8.92	5.54	9.08	5.15
95% conf. interval:	(9.1415 10.392)	(5.7516 6.2484)	(8.4359 9.4041)	(5.2045 5.8755)	(8.6263 9.5404)	(4.8477 5.4523)
Difference:	0.98667	0.85	0.14	0.39	0.30333	8.88E-16
95% conf. interval:	(0.36151 1.6118)	(0.60159 1.0984)	(-0.34409 0.62409)	(0.054521 0.72548)	(-0.1537 0.76037)	(-0.30234 0.30234)
t :	6.7907	14.722	0.80296	3.2277	1.7061	-7.55E-15
p (same mean):	0.021005	0.0045819	0.467	0.032047	0.14871	1
The meaning of the differences	*	**	ns	*	ns	ns
Given median:	8.75	5.05	8.75	5.05	8.75	5.05
Sample median:	9.8	6	8.8	5.5	9	5.05
W :	6	6	10.5	15	19.5	12.5
Normal appr. z :	1.6036	1.6036	0.81274	2.0226	1.8974	0.42164
p (same median):	0.10881	0.10881	0.41637	0.043114	0.05778	0.67329
p (exact):	0.25	0.25	0.5	0.0625	0.09375	0.75
The meaning of the differences	ns	ns	ns	ns	ns	ns

The comparative analysis, based on the average values, of the data series for the Romanian hybrids from ARDS Lovrin, ARDS Turda and FNIARD Fundulea, with the data series of the foreign hybrids, showed that the differences showed statistical certainty for the hybrids from Lovrin in the case of protein and content of oil, and for hybrids from Turda in the case of oil content. In relation to the median value, the differences did not show statistical certainty.

CONCLUSIONS

1. The comparative analysis, based on the mean and median values, of the data series for the Romanian hybrids, with the data series of the foreign hybrids, indicatedthat the differences for the protein and oil content showed statistical certainty.
2. The comparative analysis, based on the average values, of the data series for the Romanian hybrids from Lovrin, Turda and Fundulea, with the data series of the foreign hybrids, indicatedthat the differences showed statistical certainty for the hybrids from Lovrin in the case of protein and content of oil, and for hybrids from Turda in the case of oil content. In relation to the median value, the differences did not show statistical certainty.

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THE EFFECT OF CLIMATE CHANGES IN THE NORTHWEST OF THE COUNTRY ON THE MANIFESTATION OF YELLOW RUST (*PUCCINIA STRIIFORMIS* F. SP.*TRITICI*) IN THE TRITICALE CROP

EFECTUL SCHIMBĂRILOR CLIMATICE DIN NORD-VESTUL ȚĂRII ASUPRA MANIFESTĂRII ATACULUI DE RUGINĂ GALBENĂ (*PUCCINIA STRIIFORMIS* F. SP. *TRITICI*) LA CULTURA DE TRITICALE

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ABSTRACT

Triticale, thanks to more extensive studies, have started to be used in many other fields than those known in the past. They are used in fields such as: medicine, bakery, biofuel, alcohol, cellulose industry etc. especially in the winter months and the absence of negative temperatures during the winter period, led to the appearance of the attack of yellow rust (Puccinia striifomris f. sp. tritici) including the triticale crop.

At A.R.D.S. Livada, within the complex ecological testing of triticale, 17 varieties of triticale werw tested in comparative cultures during 2020-2023 and highlighting the degree of attack and the obtained production were taken into account.

It was concluded that the manifestation of the yellow rust attack was non-existent or almost non-existent in the years 2021 and 2022 when temperatures in the winter periods were negative and the pathogens were destroyed. In 2023, when the average temperatures in the winter months were positive, the triticale plants showed a degree of yellow rust attack of up to 75%, which led to a drastic decrease in the productions obtained. In 5 of the 17 varieties tested, productions below 1000 kg/ha were recorded. The most resistant variety of triticale was the Zaraza variety, which, even in the climatic conditions that favored the intense manifestation of the yellow rust attack, confirmed a good genetic resistance (GA 6.5%), a resistance that led to obtaining productions of over 8500 kg /ha.

Key words: triticale, attack, resistence, yellow rust.

REZUMAT

Triticale, datorită studiilor tot mai ample au început să fie utilizate în multe alte domenii decât cele cunoscute în trecut. Acestea se utilizează în domenii precum: medicină, panificație, biocombustibil, industria alcoolului, celulozei, *etc. Acestea sunt cunoscute pentru rezistența lor la manifestarea atacului agenților patogeni, dar însă schimbările climatice actuale care constau în creșterea temperaturilor medii lunare cu mult peste media multianuală în special în lunile de iarnă și inexistența temperaturilor negative din perioada de iarnă, a dus la apariția atacului de rugină galbenă (Puccinia striifomris* f. sp. *tritici) inclusiv la cultura de triticale.*

La S.C.D.A. Livada, în cadrul testărilor ecologice complexe la triticale, s-au luat în evidență 17 soiuri de triticale testate în culturi comparative în perioada 2020-2023 și evidențierea gradului de atac și a producției obținute.

S-a concluzionat că manifestarea atacului ruginii galbene a fost inexistent sau aproape inexistent in anii 2021 și 2022 când temperaturile din perioada de iarnă au fost negative iar agenții patogeni au fost distruși. În anul 2023 când temperaturile medii din lunile de iarnă au fost pozitive, plantele de triticale au manifestat un grad de atac al ruginii galbene de până la 75% ceea ce a dus la diminuarea drastică a producțiilor obținute. La 5 din cele 17 soiuri teste s-au înregistrat producții sub 1000 kg/ha. Cel mai rezistent soi de triticale a fost soiul Zaraza, care și în condițiile climatice care au favorizat manifestarea intensă a atacului de rugină galbenă, a confirmat o bună rezistență genetică (GA 6,5%) rezistență care a dus la obținerea unor producții de peste 8500 kg/ha.

Cuvinte cheie: triticale, atac, rezistență, rugină galbenă.

INTRODUCTION

Triticale is the result of man crossing the species *Triticum aestivum* and *Secale cereale* (Miller, 1987). By crossing these species to obtain triticale, high production capacity, high protein content and high adaptation capacity and resistance to biotic and abiotic stress factors were transmitted (Gaşpar and Reichbuch, 1978).Triticale has gained ground due to the expansion of the fields in which it can be used. Besides their well-known use in feeding birds and pigs due to the content of phytase, an enzyme that helps to synthesize the vitamin complex B, the enzyme that is missing from corn (Natasa Glamoclija et al., 2018), triticale has expanded into areas such as medicine (Nakurte et al., 2012), the bakery industry (Galoburda et al., 2020), in the beer industry (Ambriz-Vidal et al., 2019), the manufacture of packaging for food products (Salvucci et al., 2019), in the cellulose industry (Bates et al., 2020), in the bioethanol industry (Pejin, 2011), in fish feed (Hughes, 1990) and in the alcohol industry (Cioch-Skoneczny, 2019).

The triticale crop is also used in grazing mixed with other species of perennial grasses, such as annual ryegrass (Baron et al., 2015). The pedoclimatic conditions in the northwest of the country are a favorable factor for the appearance and manifestation of the attack of yellow rust (*Puccinia striifomris* f. sp. *tritici*) in the triticale crop. The humid and cold climate favour the manifestation of diseases that slow down or stop when the temperatures reach high values. Above 15°C, the viability of uredospores is substantially reduced (Lidia Cană and Georgescu, 2019).

Climate changes can positively or negatively influence yellow rust epidemics depending on humidity and temperature in the transition seasons. It was observed that more severe epidemics occurred after warm winters that increased the survival of the pathogen (Indira Galit et al., 2023).

Considering that one of the most effective methods to counteract the damage caused by pathogens is the use of varieties with genetic resistance, in the north-west of Romania, at A.R.D.S. Livada, genotypes of triticale (*Triticosecale,* Wittmack) are tested annually in comparative crops, which are evaluated from the point of view of adaptability, stability and productivity, but also of resistance to the attack of specific pathogens. The analysis of the foliar pathogen complex in triticale under the conditions of the 2017-2018 agricultural year at A.R.D.S. Livada led to the conclusion that the rusts have a very pronounced dynamic manifestation reaching values of the degree of attack in the milk-wax phenophase of over 90% (Goga, 2019).

MATERAL AND METHOD

The study was located at the Livada Agricultural Research-Development Station, Satu Mare county in the period 2021-2023 in comparative cultures, and is part of the complex ecological testing at the national level. Testing was done on a typical preluvosol that has a humus content of 2.82% in the arable layer and an acid to slightly acidity reaction with a pH between 5.82 and 6.65.

The experiment was established using the balanced grid method (Figure 1), within which 17 varieties of triticale were sown, all created by N.I.A.R.D. Fundulea, in 3 repetitions. These were sown in plots of 10 m², at 12.5 cm between rows and at a sowing rate of 500 b.g./m2 with the Wintersteiger experimental seeder (Figure 2).

Figure 1. The experimental field//Câmpul experimental

Figure 2. The Wintersteiger seed drill//Semănatoarea Wintersteiger

The technology applied in all 3 experimental years was the same. The preceding plant was fodder pea which, the fall it was fertilized with NPK complex fertilizer 18:46:0 in a dose of 150 kg/ha, and in the spring was additionally fertilized with a nitrogen-based fertilizer (Nitrolimestone 27.5% N) in a dose of 300 kg/ha, and when the straw was lengthened, the weeds were controlled with the herbicide Sekator Progress OD in a dose of 0.15 l/ha. During the entire vegetation period of the triticale, no other technological measures were used. Fungicide treatments were non-existent due to the fact that it is desired to highlight the most resistant triticale genotypes to the manifestation of diseases specific to the culture. During the vegetation period, the main foliar diseases of triticale were determined, after which the degree of attack was calculated for each individual cultivar, and at the end of the vegetation period, the production capacity was determined (kg/ha at 14% humidity).

RESULTS AND DISCUSSION

The results were obtained after complex ecological testing of 17 varieties of triticale over a period of 3 years. Climatic conditions were monitored during the triticale vegetation period (October-June).

As can be seen in figure 2, the month of October of the agricultural year 2020-2021 recorded the highest temperature, and the month of January was the coldest month in all three years of testing. From March to June, average monthly temperatures below normal values were recorded.

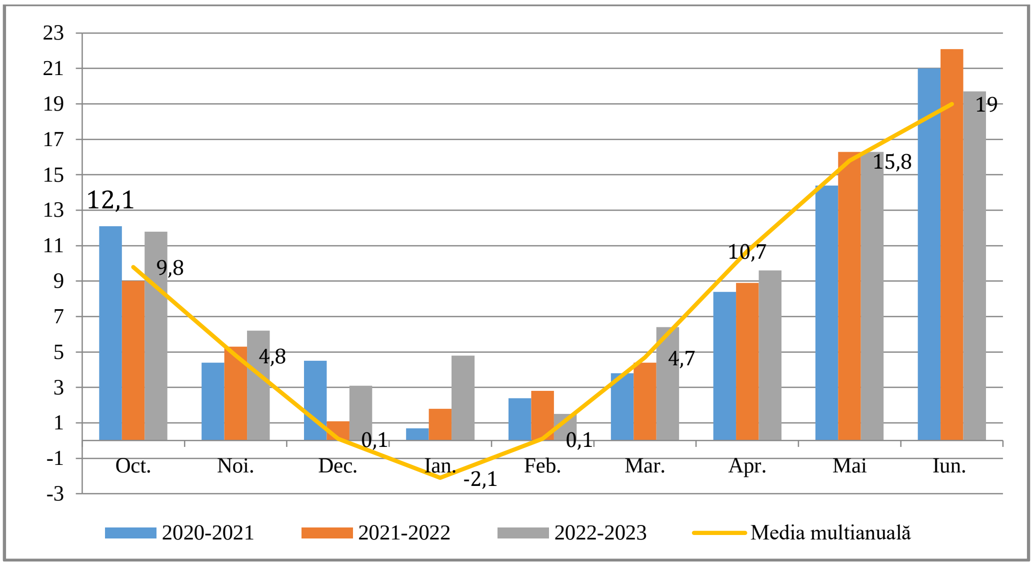

Figure 2. Average temperatures during the vegetation period, 2020-2023//Temperaturi medii în perioada de vegetație, 2020-2023

The largest amount of precipitation accumulated in the 2020-2021 agricultural year, which was the rainiest of the test period. The rainiest was February/2021 with 120 mm/m^2, followed by October/2021 with over 117 mm/m^2. The driest year was 2021-2022, especially due to the lack of precipitation in May when only 1.3 mm/m^2 was recorded compared to the normal values of 74.6 mm/m^2 (Figure 3).

In 2021, due to the low temperatures during the winter, the manifestation of yellow rust symptoms in all varieties were non-existent (D.A. 0%) (Figure 4).

As a result, as can be seen in table 1, the productions were between 7467 kg/ha and 9961 kg/ha. The variety Cascador recorded very significantly negative differences compared to the control, and Titan, Stil, Haiduc, Negoiu and ODA FD registered distinctly significantly negative differences. The average production of the 17 varieties was 8614 kg/ha.

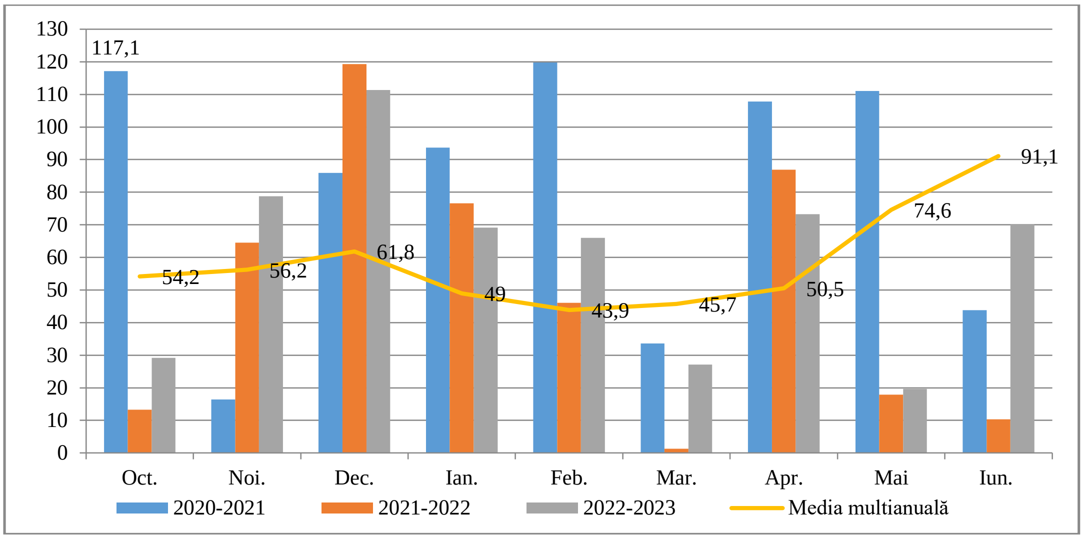

Figure 3. The amount of precipitation during the vegetation period, 2020-2023// Suma de precipitații în perioada de vegetație, 2020-2023

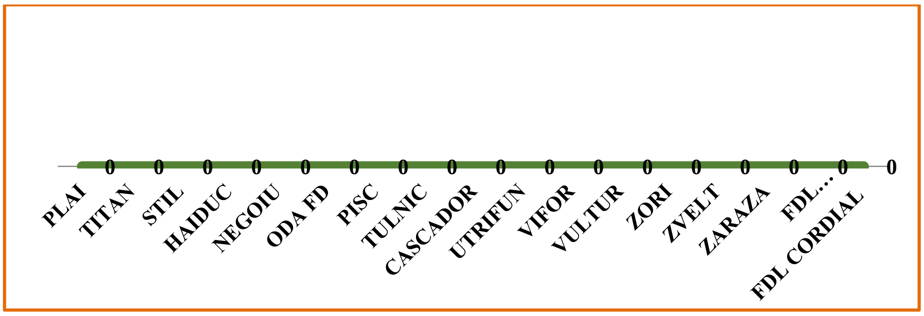

Figure 4. The degree of attack of yellow rust, 2021// Gradul de atac al ruginii galbene, 2021

Tabel 1. Production per hectare of the 17 varieties of triticale in 2021/ Producția pe hectar la cele 17 soiuri de triticale in 2021

Crt. No.	Variety	Production (kg/ha)	Crt. No.	Variety	Production (kg/ha)
1	**PLAI**	9437 (MT)	10	UTRIFUN	9326
2	**TITAN**	7930^{00}	11	VIFOR	9508
3	**STIL**	7938^{00}	12	VULTUR	8449
4	**HAIDUC**	7715^{00}	13	ZORI	8892
5	**NEGOIU**	7847^{00}	14	ZVELT	9476
6	**ODA FD**	7569^{00}	15	ZARAZA	9334
7	**PISC**	8040^{0}	16	FDL ATRACTIV	9001
8	**TULNIC**	8555	17	FDL CORDIAL	9961
9	**CASCADOR**	7467^{000}		Media soiurilor	8614

L.D. 5% =1085 kg/ha L.D. 1%=1470 kg/ha L.D. 0.1% =1968 kg/ha

In 2022, the winter temperatures were higher than the previous year, but still, these temperatures did not favor the manifestation of the yellow rust attack. Only the Zori variety showed a weaker resistance, registering an attack rate of 1.5%. This pathogen did not appear in the rest of the varieties (Figure 5).

Under these conditions, productions of over 9200 kg/ha were recorded for the Zori variety, registering distinctly significantly positive differences compared to the control. The productions obtained in 2022 varied between 8004 kg/ha (OD FD) and 9994 ka/ha (Vifor). The most productive varieties were Vifor and Utrifun, which registered very significantly positive differences compared to the control. The average of the 17 triticale varieties was 8843 kg/ha (Table 2).

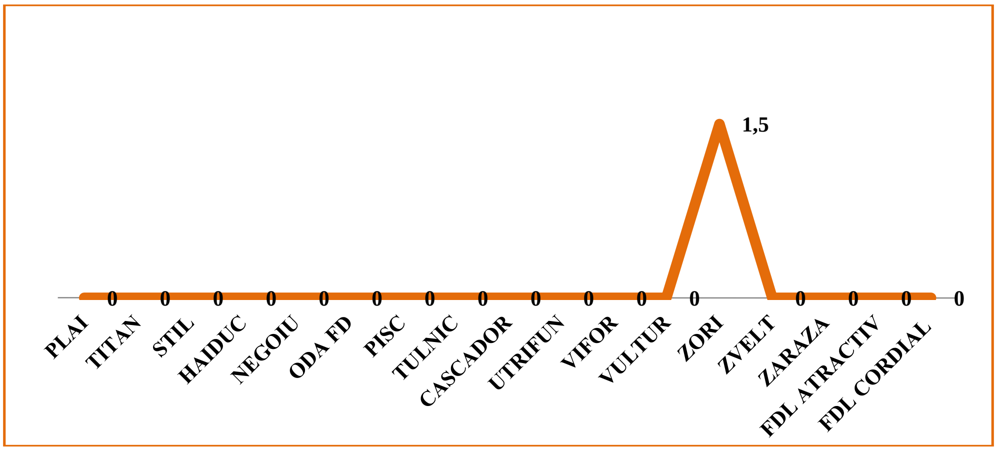

Figure 5. The degree of attack of yellow rust, 2022// Gradul de atac al ruginii galbene, 2022

Tabel 2. Production per hectare of the 17 varieties of triticale in 2022// Producția pe hectar la cele 17 soiuri de triticale in 2022

Crt. No.	Variety	Production (kg/ha)	Crt. No.	Variety	Production (kg/ha)
1	**PLAI**	8306 (MT)	10	CASCADOR	8885
2	**TITAN**	7993	11	UTRIFUN	9749***
3	**STIL**	8740	12	VIFOR	9994***
4	**HAIDUC**	8516	13	VULTUR	8413
5	**NEGOIU**	8509	14	ZORI	9283**
6	**ODA FD**	8004	15	ZVELT	9168*
7	**PISC**	8596	16	ZARAZA	9048*
8	**TULNIC**	8884	17	FDL ATRACTIV	9358**
9	**CASCADOR**	8885	**Media soiurilor**		**8843**

L.D. 5% =668 kg/ha L.D. 1%=905 kg/ha L.D. 0.1% =1212 kg/ha

The high temperatures of the winter of 2023 together with the high rainfall regime favored the manifestation of the yellow rust attack. In January 2023, the average annual temperature was 4.8°C, registering a difference of 6.9°C compared to the multiannual average temperature (-2.1°C). The average temperature in February was 1.5°C compared to the normal 0.1°C. The precipitation regime in these months was over 66 mm/m^2. The average temperature in March was 6.4°C, 1.7°C higher than the annual average.

Due to these increases in average monthly temperatures, the degree of yellow rust attack on the triticale crop was between 6.5 and 75%. The most resistant variety to yellow rust Zaraza, followed by the Vultur variety with an attack rate of 10%. A degree of attack of 75% was noted in the varieties Cascador and Haiduc, varieties sensitive to this pathogen (Figure 6).

The high degree of attack negatively influenced triticale production. The average production was 2284 kg/ha. The lowest productions were recorded by the varieties Tulnic (558 kg/ha), with a degree of attack of 62.5%, Zvelt (643 kg/ha), with a degree of attack of 25%, Haiduc (659 kg/ ha ha) , with a degree of attack of 75%, ODA FD (763 kg/ha), with a degree of attack of 50% and the variety Negoiu (803 kg/ha), which had a degree of attack of 50% , they registered very significantly different negatives compared to the control. The most productive variety was Zaraza, which recorded a production of 8554 kg/ha, registering a very significant positive difference compared to the control, being the most resistant to the attack of yellow rust (6.5% D.A.). This is followed by the control variety Plai, with a production of over 5000 kg/ha and an attack degree of 25 % (Table 3).

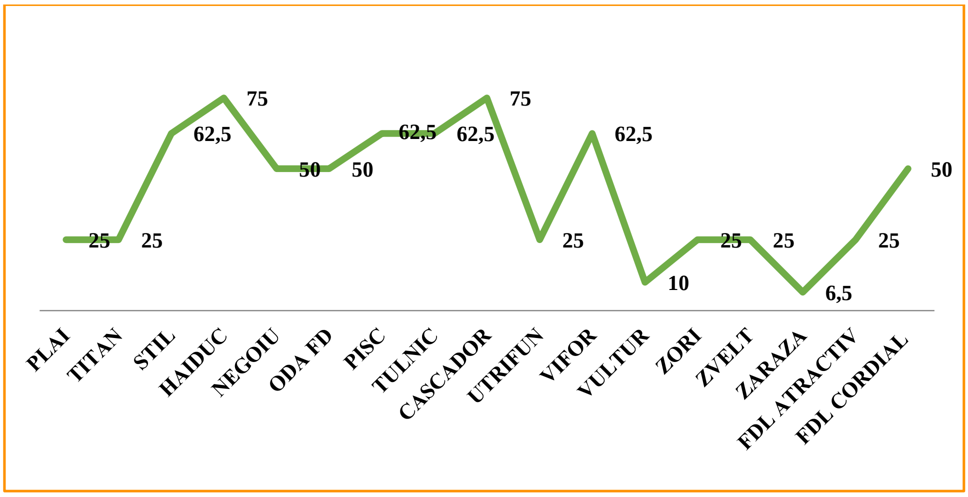

Figure 6. The degree of attack of yellow rust, 2023// Gradul de atac al ruginii galbene, 2023

Tabel 3. Production per hectare of the 17 varieties of triticale in 2023// Producția pe hectar la cele 17 soiuri de triticale in 2023

Crt. No.	Variety	Production (kg/ha)	Crt. No.	Variety	Production (kg/ha)
1	**PLAI**	5433 (MT)	10	UTRIFUN	3852^{00}
2	**TITAN**	1533^{000}	11	VIFOR	2433^{000}
3	**STIL**	1391^{000}	12	VULTUR	2553^{000}
4	**HAIDUC**	659^{000}	13	ZORI	1977^{000}
5	**NEGOIU**	803^{000}	14	ZVELT	643^{000}
6	**ODA FD**	763^{000}	15	ZARAZA	8554^{***}
7	**PISC**	1881^{000}	16	FDL ATRACTIV	2004^{000}
8	**TULNIC**	558^{000}	17	FDL CORDIAL	2350^{000}
9	**CASCADOR**	1443^{000}		**Media**	**2284**

L.D. 5% =1073 kg/ha L.D. 1%=1454 kg/ha L.D. 0.1% =1947 kg/ha

CONCLUSIONS

The climatic changes of the last period are more and more evident and they are reflected in the evolution of the plants throughout the vegetation period. The high temperatures recorded in winter are a dominant factor in the manifestation of the yellow rust attack, the pathogen not being destroyed by the negative temperatures.At A.R.S.D. Livada the winter of 2023 was recorded as the warmest since 1962 until now. The January average was 4.8°C, registering a difference from the multiannual average temperature of + 6.9°C. The high temperature in January, February and March combined with the high rainfall regime (69.1 mm/m^2 in January, 66 mm/m^2 in February) favored the attack of the pathogen *Puccinia striiformis* f. sp. *triticale*.

The results obtained under the conditions at A.R.D.S. Livada represent a confirmation. In the year 2020-2021, yellow rust did not appear, and productions ranged between 7467 kg/ha (Cascador) and 9961 kg/ha FDL Cordial. In the conditions of the year 2021-2022, of all the 17 varieties of triticale tested, only one variety showed a slight sensitivity (D.A. 1.5%) without influencing significantly the production obtained. Productions ranged between 8004 kg/ha (OD FD) and 9994 ka/ha (Vifor).

The high temperatures of the 2022-2023 winter period were felt in the manifestation of the degree of attack, which was between 6.5 and 75%. The most resistant variety was Zaraza (6.5%) and the least resistant were the Haiduc and Cascador varieties with a degree of attack of 75%. The varieties that registered a high degree of attack obtained productions below 1000 kg/ha. The Zaraza variety, being classified as the most resistant, recorded a production of over 8500 kg/ha.

Following the research carried out in the three years of testing, it is obvious that the current climate changes cause serious problems in agricultural crops, therefore the cultivation of varieties resistant to the attack of pathogens and the fungicide treatment are mandatory measures to ensure high and quality productions .

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CONSIDERATIONS ON CROPS AREAS AND FORAGE CROPS TYPES UNDER CLIMATE CHANGES CONDITIONS

CONSIDERAȚII PRIVIND ZONELE DE CULTURĂ ȘI SORTIMENTELE DE CULTURI FURAJERE ÎN CONDIȚIILE SCHIMBĂRILOR CLIMATICE

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ABSTRACT
The aim of the paper is to bring to the fore the evolutions of the most important inputs of animal production, namely forages, in the current environmental and climate conditions, descriptively and comparatively analyzing the surfaces and productions of these resources and following the trends through the regression functions used. Thus, the data indicate a decrease in areas, but especially in the production of fodder crops, reflecting the fact that these resources are affected, and the trends are still negative. The estimates regarding the technical-economic indicators for a farm of 500 dairy cows, with an average production of 5,000 liters of milk/head, with designed rations containing alternative forages adapted to drought conditions, such as green sorghum and sorghum silage, are encouraging, in the sense of reducing the vulnerability of the economic results of the farmers' activity and obtaining profit, in the context of the current environmental and climate conditions.

Keywords: forages, corn , sorghum, farms, climate changes

REZUMAT
Lucrarea are drept scop aducerea în prim-plan a evoluțiilor celor mai importante input-uri ale producției animaliere, respectiv furajele, în condițiile actuale de mediu și climă, analizând descriptiv și comparativ suprafețele și producțiile acestor resurse și urmărind tendințele prin funcțiile de regresie utilizate. Astfel, datele indică o scădere a suprafețelor, dar în special a producțiilor culturilor furajere, reflectând faptul că aceste resurse sunt afectate, iar tendințele sunt în continuare negative. Estimările privind indicatorii tehnico-economici ai unei ferme de 500 vaci de lapte, cu o producție medie de 5.000 litri lapte/cap, cu rații proiectate ce conțin furaje alternative, adaptate la condiții de secetă, precum sorgul masă verde și silozul de sorg, sunt încurajatoare, în sensul scăderii vulnerabilității rezultatelor economice ale activității fermierilor și obținerea de profit, în contextul actualelor condiții de mediu și climă.

Cuvinte cheie: furaje, porumb, sorg, ferme, schimbări climatice

INTRODUCTION

Fodder crops represent the basis of ensuring animal production for all species of economic interest. Climate change may affect the level and quality of forage production, including grasslands and pastures. The level of a crop's response to environmental and climate change depends on the interaction between plant genetics, soil moisture levels and nutrient availability. Developing countries have a higher degree of vulnerability to environmental and climate changes compared to developed ones, due to the predominance of the agricultural sector in their economies, as well as limited resources to adapt to new technologies in the field. It is estimated that due to large fluctuations in the distribution of precipitations during the plant growing season in different regions of the world, forage production will be affected, and the negative effects will be more significant in tropical and subtropical areas. That is why it is necessary to apply adaptation measures that minimize the effects of climate change and ensure the productivity of animals through the optimal availability of forages assortments (Giridhar, K., Samireddypalle, A., 2015). Adaptation strategies to mitigate the impacts on livestock sectors will need to be multidimensional. Although climate forecasts at a regional scale have a certain degree of uncertainty, adaptation planning is done on the basis of changes already observed by farmers, in order to maintain at a certain level the productivity and economic profitability of activities (Henry B.K., Eckard R.J., Beauchemin K.A., 2018). Biodiversity is an important element in the adaptation of agricultural sectors to climate change. The diversity of responses reflects the ability of the systems to function in varied conditions, as well as the ability of a function to adapt to the changes that occur (Hanna Mäkinen, Janne Kaseva, Perttu Virkajärvi, Helena Kahiluoto, 2015).

From a climatic point of view, the most contrasting regions of Europe are the Mediterranean and those in the north of the continent, having a latitudinal temperature gradient. Thus, in the northern part of Europe, the vegetation season has a shorter duration, limiting agricultural production. Longer growing seasons are favorable, especially in spring, when the presence of water and solar radiation are optimal for plant growth (Å. Ergon, G. Seddaiu, P. Korhonen, P. Virkajärvi, G. Bellocchi, M. Jørgensen , L. Østrem, D. Reheul, F. Volaire, 2018).

On the European continent, there are different climates, different soils and infrastructure, different land-use patterns and different economic conditions, and these influence the capacity to react to climate change. Farmers in Europe who adapt to environmental and climate change are addressing the change in sowing dates and the choice of resistant species and varieties. In most European areas, there are options for mitigating the negative effects of climate change on agricultural production, but the impact is felt over wide regions. Thus, the most affected were those from the Pannonian area, with a continental climate, respectively countries such as Hungary, Serbia, Bulgaria and Romania. These regions are predicted to suffer from heat waves and drought compared to those in cold climates, which can respond more effectively (J.E. Olesen, M. Trnka, K.C. Kersebaum, A.O. Skjelvåg, B. Seguin, P. Peltonen-Sainio , F. Rossi, J. Kozyra, F. Micale, 2011).

MATERIAL AND METHODS

The data sources were those from the official statistics, and as research methods in the paper, descriptive and comparative analysis of the data, the analysis of statistical indicators, the regression functions, R-squared, graphic design of the official data available from the National Institute of Statistics (NIS), as well as the analysis of technical-economic indicators were used.

RESULTS AND DISCUSSIONS

The evolution of areas and productions of fodder crops in Romania followed different trends, having as determinants both domestic and international economic context, as well as the effects of environmental and climate conditions. According to data illustrated in Figure 1 for 2013-2022, the area cultivated with green fodder in arable land evolved upward by 2018, after which a downward trend followed. General trend described by the regression equation is, however, upward, estimating an increase of 2.2 thousand ha annually. Regarding the related productions, they decreased during the analyzed period, by 19.2%, from 13 million tons to 10.5 million tons, and the trend remains negative.

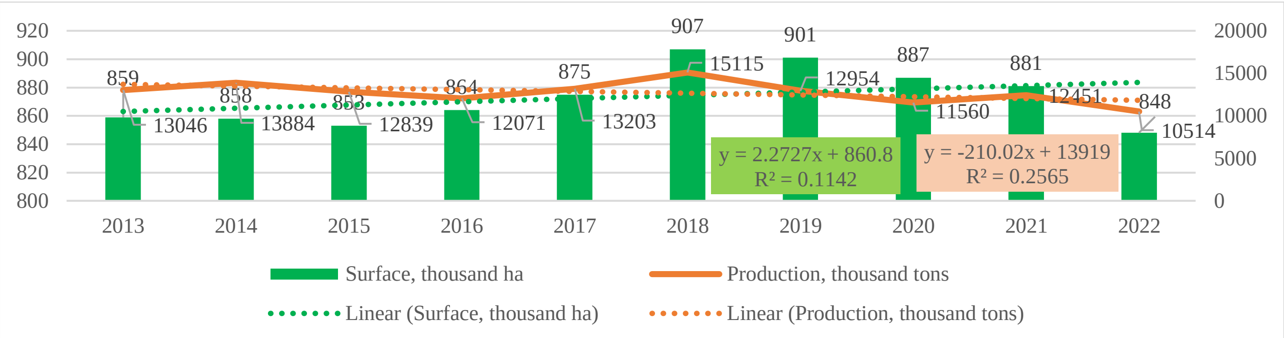

Figure 1 – The surface and production of green forages from arable land// Graficul 1 – Suprafața și producția de furaje verzi din teren arabil

Source: own graphic representation, according to NIS data

Forage crops are generally adapted to certain climatic regions, and genotypic and phenotypic variability influence the level of adaptation, the latter resulting from the interaction between genotype and environment.

Regarding perennial forages, statistical data show that their area expanded until 2018, after which it decreased, reaching 675 thousand ha (an increase of only 3.6%). However, the general trend described by the regression equation is increasing, with an increase of 4.4 thousand ha/year. In the same time, the production of perennial forages decreased during 2013-2022 by 15.1%, from 9.7 million tons to 8.2 million tons, and the trend is still negative, with reductions of approximately 131 thousand tons annually.

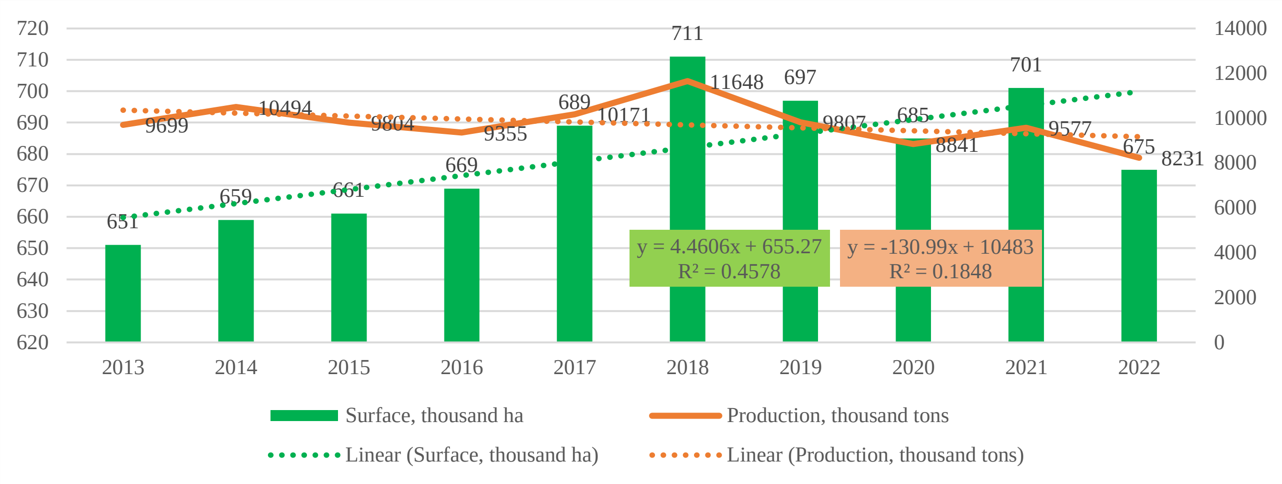

Figure 2 – The surface and production of perennial forages// Graficul 2 – Suprafața și producția de furaje perene

Source: own graphic representation, according to NIS data

Alfalfa is a forage plant with great genotypic and phenotypic plasticity, these characteristics allowing it to adapt to varied environmental and climatic conditions. The dynamics of alfalfa areas and productions are generally positive, +4% in area and +23.7% in production respectively, reflecting the choice and appreciation of farmers for this valuable forage plant (Figure 3).

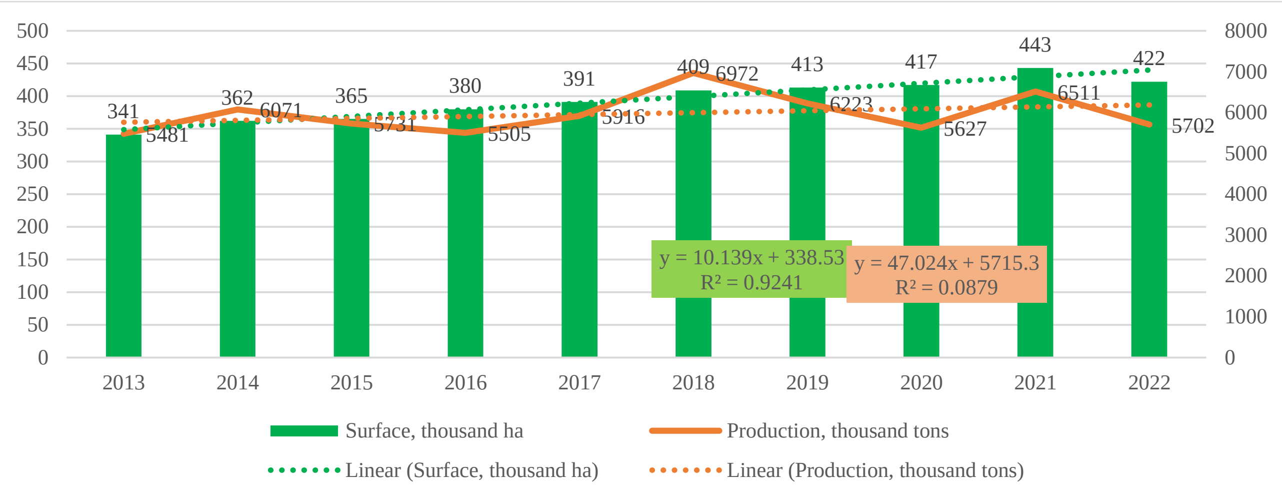

Figure 3 – The surface and production of alfalfa// Graficul 3 – Suprafața și producția de lucernă

Source: own graphic representation, according to NIS data

For annual green forages, both areas and productions were decreasing, by 31.7% in areas, respectively by 16.8% in productions (Figure 4).

Thus, analyzing the evolution of green corn , both the area decreased, by 12.5%, and the production, by 20.9% (Figure 5).

The roots for forages are in the same situation, where the area in 2022 represented only 14.6% of that cultivated in 2013, and the production is 5 times lower in 2022, compared to 2013 (Figure 6).

Following these decreases in the areas and productions of green and succulent fodder, which are lactogenic, the right question arises whether milk and meat productions are not also in danger from this point of view. That is why, in the current environmental and climate conditions, it is necessary to use some fodder that can substitute, at least partially, in the structure of fodder rations, the deficient assortments. One of these forages is sorghum, which, in the last 10 years, has been on an oscillating curve, both in terms of cultivated areas and production, both of which, however, are decreasing (Figure 7).

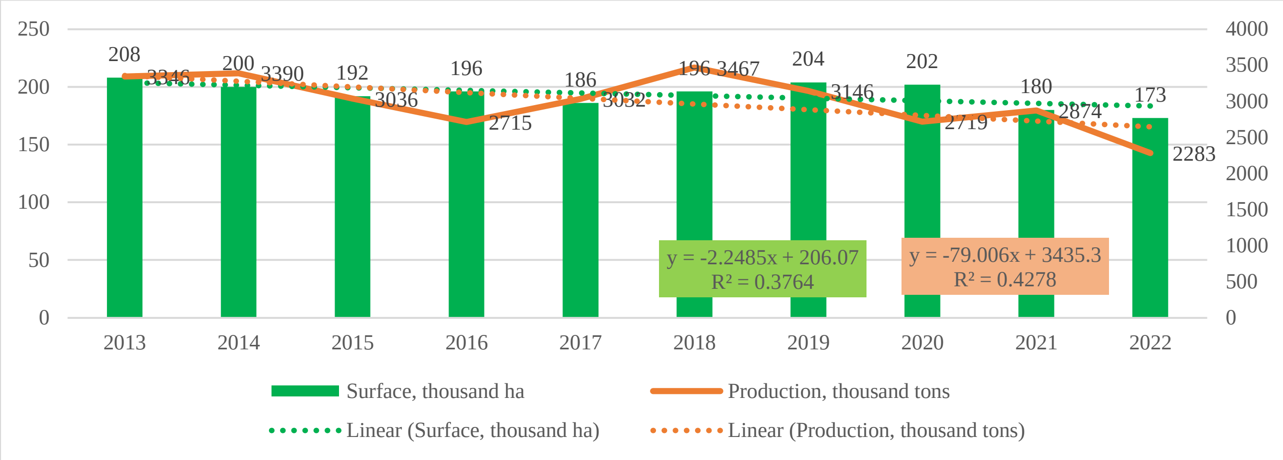

Figure 4 – The surface and production of annual green forage //Graficul 4 – Suprafața și producția de furaje verzi anuale

Source: own graphic representation, according to NIS data

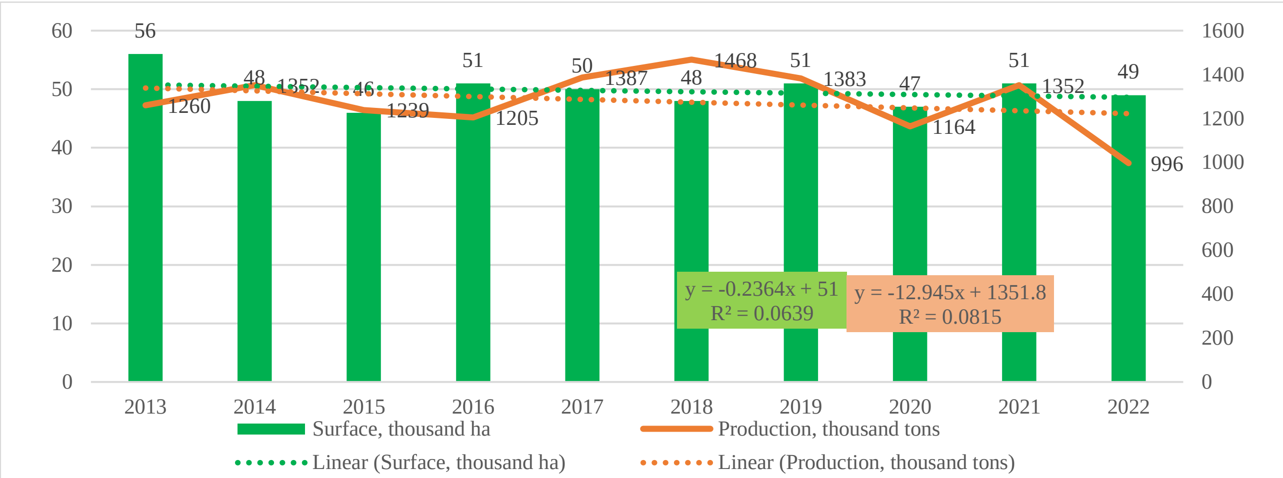

Figure 5– The surface and production of green corn // Graficul 5 – Suprafața și producția de porumb verde furajer

Source: own graphic representation, according to NIS data

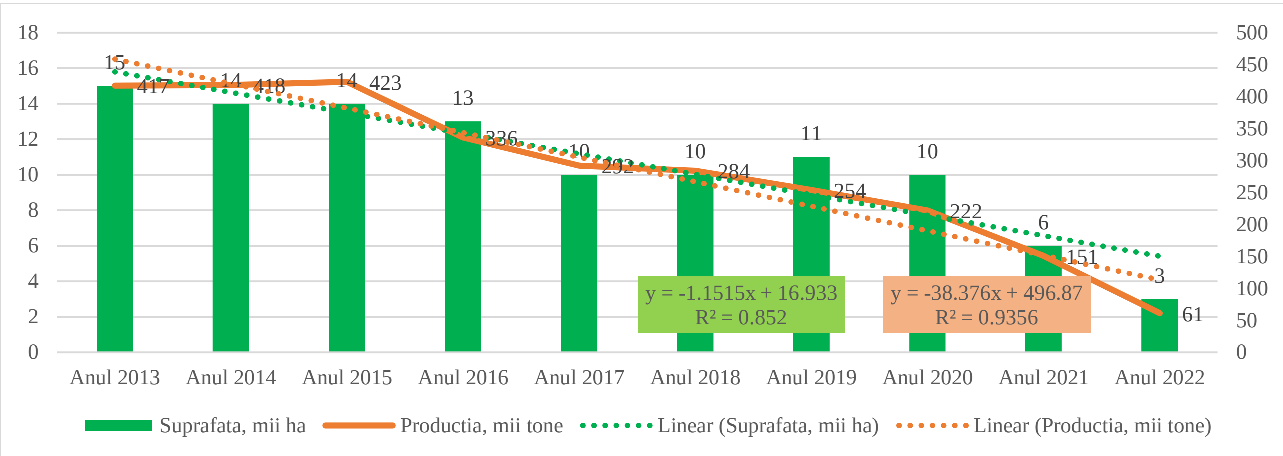

Figure 6 – The surface and production of roots for forages// Graficul 6 – Suprafața și producția de rădăcinoase furajere

Source: own graphic representation, according to NIS data

According to researchers from the National Research and Development Institute for Animal Biology and Nutrition (Mihaela Hăbeanu, Nicoleta Aurelia Lefter, Anca Gheorghe, 2019), sorghum can replace corn and is adaptable to semi-arid areas, to soils with low fertility. Sorghum tolerates extreme temperatures compared to other cereals, has a nutritional value close to that of corn and is easily accepted by animals (Fapohunda O. Olusola, Omotoso B. Oluwatosin and Fajemisin N. Adebowale, 2022).The areas cultivated with sorghum are small and decreasing, apparently due to the prices of certified seeds, non-observance of cultivation technology, harvesting, treatment of seeds against diseases and pests.

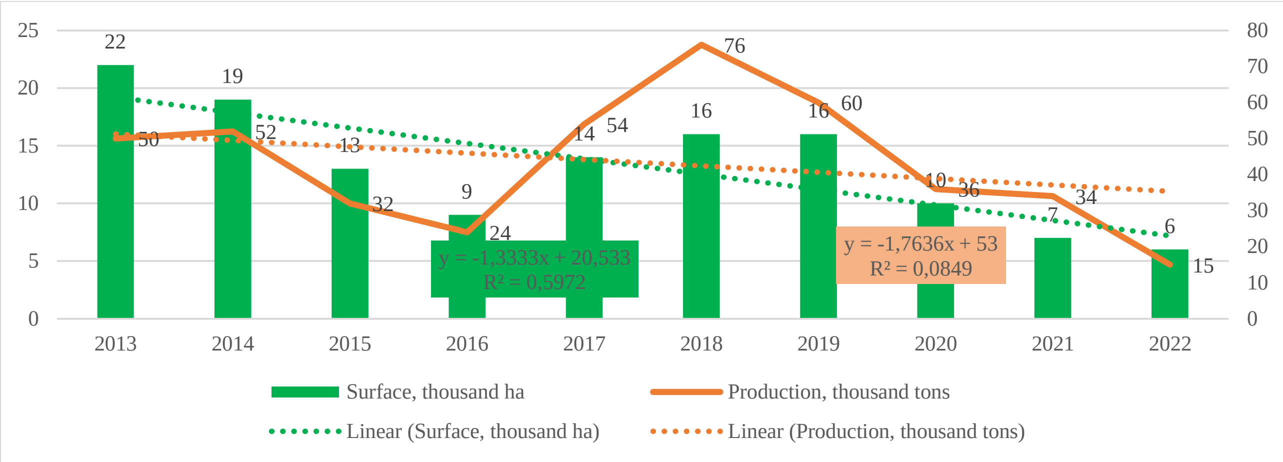

Figure 7 – The surface and production of sorghum// Graficul 7 – Suprafața și producția de sorg

Source: own graphic representation, according to NIS data

On development regions, the areas in the west of the country are highlighted, which obtained during the analyzed period, the highest sorghum productions, especially in the period 2016-2019 (Figure 8).

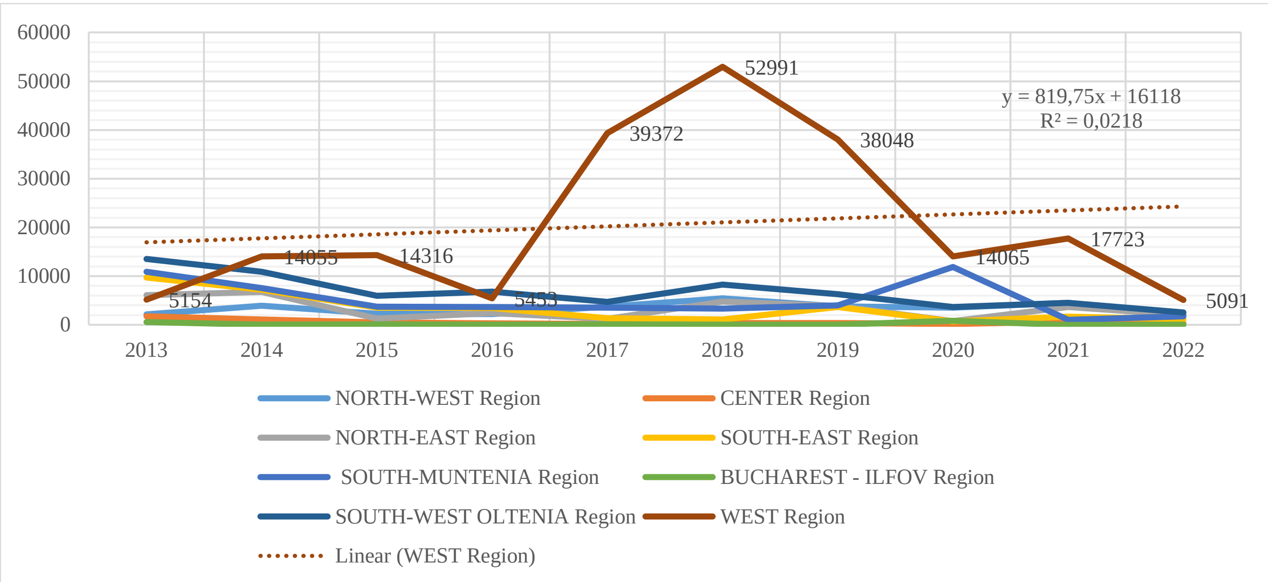

Figure 8 - The evolution by development regions of sorghum production, during 2013-2022, tons // Graficul 8 - Evoluția pe regiuni de dezvoltare a producției de sorg boabe, în perioada 2013-2022, tone

Source: own graphic representation, according to NIS data

As an application, an estimate of the economic results was made for a farm of 500 dairy cows, with an average production of 5,000 liters/head, introducing into the ration, as a partial replacement feed, green mass sorghum in the summer ration and sorghum silage in winter ration (ICEADR, 2024).

Forages from the own fodder base covers a total area of 498.31 ha, and soybean meal, sunflower meal and wheat bran are purchased (Table 3, Figure 9).

Table 1 - Summer ration designed, with green sorghum, for dairy cows - production 5,000 liters/head/ Tabelul 1 - Rație de vară proiectată, cu sorg masă verde, pentru vaci de lapte – producția 5000 litri/cap

Fodder	**kg /head/day**	**UNL**	**PDIN (g)**	**Quantity /head/summer**	**Price lei/kg**	**Value / head/year**
Alfalfa hay	4.00	2.28	300.00	728	0.90	655
Green alfalfa	12.00	2.28	336.00	2,184	0.14	306
Green sorghum	12.00	1.92	144.00	2,184	0.14	306

Fodder	kg /head/day	UNL	PDIN (g)	Quantity /head/summer	Price lei/kg	Value / head/year
Soybean meal	0.52	0.64	164.84	95	2.39	226
Grain corn	3.00	3.81	219.00	546	1.08	590
Grain barley	1.50	1.70	97.50	273	1.09	298
Total		12.63	1,261.34			2,380
Norm		12.60	1,260.00			

Source: own calculations

Table 2 - Winter ration designed with sorghum silage for dairy cows – 5,000 liters/head// Tabelul 2 - Rație de iarnă proiectată, cu siloz de sorg, pentru vaci de lapte - 5000 litri/cap

Fodder	kg /head/day	UNL	PDIN (g)	Quantity /head/ summer	Price lei/kg	Value / head/year
Alfalfa hay	5.00	2.85	375.00	915	0.90	824
Sorghum silage	10.00	2.00	120.00	1,830	0.30	549
Alfalfa semi-silage	10.00	3.80	380.00	1,830	0.35	641
Sunflower meal	0.50	0.39	113.00	92	1.17	107
Grain corn	1.00	1.27	73.00	183	1.08	198
Grain barley	0.90	1.02	58.50	165	1.09	180
Wheat bran	1.50	1.26	151.50	275	0.90	247
Total		12.59	1,271.00			2,744
Norm		12.60	1,260.00			

Source: own calculations

Table 3 – Estimation of forages requirements per farm and forages area// Tabelul 3 – Estimarea necesarului de furaje pe fermă și a suprafeței pentru furaje

Fodder	Quantity, kg	kg/ha	Surface/head, ha	Surface/farm, ha
Alfalfa hay	1,643	5,000	0.33	164.30
Green sorghum	2,184	30,000	0.07	36.40
Green alfalfa	2,184	20,000	0.11	54.60
Sorghum silage	1,830	25,000	0.07	36.60
Alfalfa semi-silage	1,830	20,000	0.09	45.75
Grain corn	729	3,300	0.22	110.45
Grain barley	438	4,359	0.10	50.21
Soybean meal	95	purchase		
Sunflower meal	92	purchase		
Wheat bran	384	purchase		
TOTAL NECESSARY SURFACE				**498.31**

Source: own calculations

Rezultatele economice ale fermei cu 500 vaci de lapte și cu producție medie de 5.000 litri lapte/cap, indică obținerea unui venit impozabil anual de 874.138 lei/fermă și o rată a profitului net de 21,4% pe an (Tabelul 4).

The economic results of the farm with 500 milk cows and with an average production of 5,000 liters of milk/head, indicate the obtaining of an annual taxable income of 874,138 lei/farm and a net profit rate of 21.4% per year (Table 4, Figure 10).

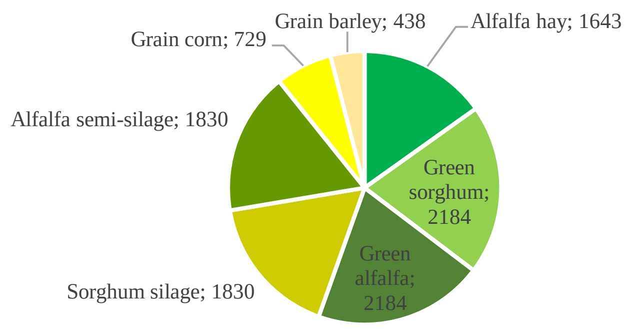

Figure 9 - Surface structure for the fodder base// Graficul 9 – Structura suprafeței pentru baza furajeră

Source: own calculations

Table 4 – Milk production budget per head, per liter and per farm// Tabelul 4 – Bugetul producției de lapte pe cap, pe litru și pe fermă

INDICATORS	Lei/head	Lei/l	Value/farm
A. PRODUCTION VALUE	11,474.5	2.29	5,737,254
A1. Of which the main production	10,500.0	2.10	5,250,000

INDICATORS	Lei/head	Lei/l	Value/farm
B. Subsidies	303.0	0.06	151,500
C. GROSS PRODUCT	11,777.5	2.36	5,888,754
D. TOTAL EXPENSES	9,726.2	1.95	4,863,116
D1. Of which for the main production	8,751.7	1.75	4,375,862
I. VARIABLE EXPENSES	6,994.5	1.40	3,497,269
1. Feed expenses	5,124.4	1.02	2,562,214
2. Biological material	1,000.0	0.20	500,000
3. Electricity + fuel	250.0	0.05	125,000
4. Medicines and sanitary material	200.0	0.04	100,000
5. Other material expenses	250.0	0.05	125,000
6. Quota of supply	158.1	0.03	79,055
7. Insurance	12.0	0.00	6,000
II. FIXED EXPENSES	2,731.7	0.55	1,365,847
Labor costs	2,021.0	0.40	1,010,500
General expenses	157.0	0.03	78,481
Interest on loans	153.7	0.03	76,866
Amortization	400.0	0.08	200,000
E. TAXABLE INCOME	1,748.3	0.35	874,138
Taxes and fees	174.8	0.03	87,414
F. NET INCOME + subsidies	1,876.4	0.38	938,224
G. TAXABLE INCOME RATE (%)	20.0	20.0	20,0
H. NET INCOME RATE + subsidies (%)	21.4	21.4	21,4
PRODUCTION COST	8,751.7	1.75	4,375,862
MILK PRICE	10,500.0	2.10	5,250,000

Source: own calculations

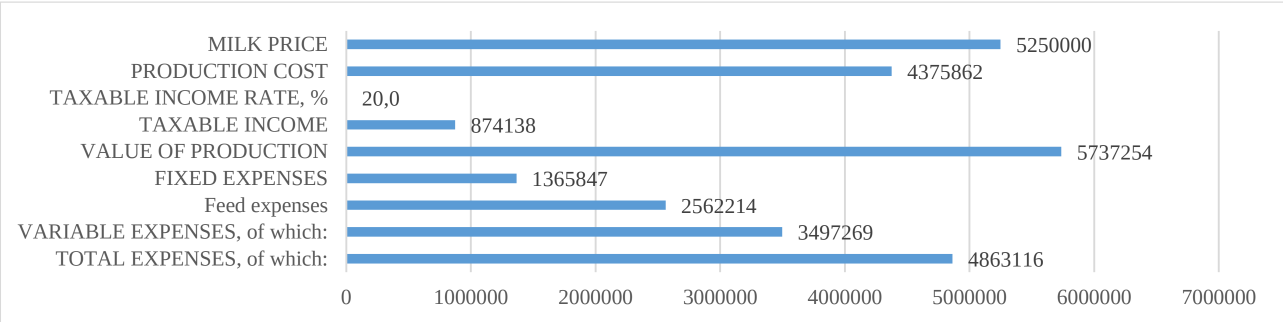

Figure 10 – The main technical-economic indicators per farm// Graficul 10 – Principalii indicatori tehnico-economici pe fermă

Source: own calculations

CONCLUSIONS

The data presented indicate a decrease in the many areas, but especially in the production of fodder crops, reflecting the fact that these essential resources for the livestock sector are affected by climate changeand the trends are still negative, so, there is a major reason for why it is necessary to take measures, including the use of substitute feed, totally or partially, adapted to the conditions of climate change, compatible with the species and direction of animal production.

Technical-economic estimates made with designed rations containing green sorghum and sorghum silage for the dairy farm are encouraging, in the sense of decreasing the vulnerability of the economic results of the farmers' activities in the context of the current environmental and climate conditions.

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STRUCTURE OF WEED SPECIES WHEN USING UNCONVENTIONAL SYSTEMS OF SOIL WORK AT CORN CROP

STRUCTURA SPECIILOR DE BURUIENI ÎN CAZUL UTILIZĂRII SISTEMELOR NECONVENȚIONALE DE LUCRARE A SOLULUI LA CULTURA PORUMBULUI

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ABSTRACT
The paper presents the influence of the soil tillage system on the degree of weeding and corn yield in the period 2018-2023. The research was carried out at the Agricultural Research and Development Station Turda, unit located in the hill area of the Transylvanian Plain. Compared to 2018 there was an increase a number of weed species, in the conventional system (CS) from 16 to 20 species/m^2 and in the variant with direct sowing (NT) from 19 to 43 species/m^2. In the Turda area, dicotyledonous weed species predominated. The yield results obtained in the six years showed that on the type of soil with a high clay content (41%), the corn does not lend itself to cultivation in the NT variant (directly sown), requiring soil mobilization, yield data confirming this fact (CS 8073 kg/ha; NT 5012 kg/ha).

Keywords: ***tillage system, weeds, clime, corn , yield***

REZUMAT
Lucrarea prezintă rezultate privind influenţa sistemului de lucrare a solului asupra gradului de îmburuienare și producției la porumb, în perioada 2018-2023. Cercetările au fost efectuate la Staţiunea de Cercetare Dezvoltare Agricolă Turda, unitate situată în zona colinară a Câmpiei Transilvaniei. Comparativ cu anul 2018 s-a înregistrat o creștere deosebită a numărului de buruieni, în sistemul convențional (SC) de la 16 la 20 specii/m^2 iar in varianta cu semănat direct (NT) de la 19 la 43 specii/m^2. În zona Turda predomină speciile de buruieni dicotiledonate. Rezultatele de producție obținute în cei șase ani au evidențiat faptul că în condițiile solurilor cu un conținut ridicat în argilă (41%), porumbul nu se pretează la cultivarea în varianta NT (semănat direct), necesitând mobilizarea solului, datele de producție confirmând acest fapt (SC 8073 kg/ha; NT 5012 kg/ha).

Cuvinte cheie**: **sistem de lucrare, buruieni, climă, porumb, producție

INTRODUCTION

Maize (*Zea mays*) ranks in the second place among the world's cultivated plants. This importance is mainly given by the following feeds the economic growth of countries all over the world because it is food ingredient, feed, fuel, fiber, ingredient in building materials, ingredient in the pharmaceutical industry; it is used for the manufacture of various materials, such as bio-plastic or fuel; in the manufacture of bioethanol, corn becoming one of the plants that will help save fossil fuels and and preserving environment; the crop is fully mechanized, importance also underlined by Alda (2011), Gwirtz & Garcia-Casal (2014), Dincă et al. (2020). Other information about these uses can be found on-line (www.ziuaporumbului.ro). The corn crop for grains in Romania occupies ≈ 45% (2373 thousand ha) of the total area cultivated with cereals that at the level of 2023 year was 5238 thousand ha. The slight increase in corn -grown areas suggests that it is a traditional crop in all economic regions of the country with a trend of multiannual consolidation according to Badiu et al. (2020). Particular successes in corn crop would not have been possible without the use of herbicides, which allowed the expansion of low-impact crop technologies, by partially or entirely waiving the manual and/or mechanical soil preparation and maintenance work. The large diversity of herbicides and the multiple methods of treatment that are currently used make it possible to maintain the crop, without manual slingshots throughout the growing season according to Berca (2004), Ionescu (2008), Șerban & Măturaru (2020) and others.

From the research conducted at the Fundulea Institute in the long-term experiences it follows that „crop rotation has been proved a real measure for reducing the weed infestation, which must be taken into consideration, having in view the requirement for diminishing the chemicals (herbicides, pesticides) utilized in crop production and its contribution to cutting down the yield costs (Sin & Partal, 2020).

Corn requires a series of works to ensure the proper growth and development of plants and high cultural hygiene. Combating weeds is one of the most important works included in corn cultivation technology, according Swinton and Van Deynze (2017), Alptekin et al. (2023), Chețan et al. (2016, 2020). The high weeding degree can lead to considerable loss of yield, sometimes even to the complete compromise of crop mention the authors Soltani et al. (2016), Shi et al., (2021), Tamado et al. (2002), Horvath et al., (2023), Gharde et al. (2018) etc.

Weed control can be carried out by preventive or curative methods, manual, mechanical and chemical treatments, methods presented by Rana, (2018) and others (www.eagri.org). Some of these methods are shown in Figure 1.

Figure 1. Weeds combating methods// Metode de combatere a buruienilor

The most common weeds present in agricultural crops in the area are: *Xanthium strumarium, Polygonum convolvulus, Viola tricolor, Cirsium arvense, Stelaria media, Matricaria inodora, Papaver dubium, Chenopodium album, Hibiscus trionum, Galiopsis tetrahit, Elymus repens, Consolida regalis, Veronica persica, Setaria glauca, Convolvulus arvensis, Amaranthus retroflexus, Echinochloa crus-galli, Rubus caesius, Lactuca serriola, Datura stramonium* and *Lathyrus tuberosus*. As Bogdan et al., (2007) state „the high degree of weeding of corn crops in the Cluj-Napoca area is due to the massive reserve of weed seeds in the arable layer and the climatic conditions favorable to the rising and staggered development of weeds, on one hand, and the development of weed problem species during the corn growing period, when the herbicides can no longer be applied, on the other hand”. Tillage technology can influence weed population dynamics and consequently the choice of proper weed management, also reported by Drăghici et al., (2023), Ozpinar (2006) and Demjanová et al., (2016).

The paper presents result on the influence of the soil tillage system on the degree of weeding and corn yield during 2018-2023 period, at the Agricultural Research and Development Station (ARDS) Turda, unit located in the hill area of the Transylvanian Plain.

MATERIAL AND METHOD

The placement of the experience was done according to the method of subdivided plots with two replications. The type of soil specific to the research area is a vertical Phaeozem soil, by classification of the Romanian Soil Taxonomy System (SRTS, 2012), with loam-clay texture (41%

clay content), neutral pH (6.9), humus content 2.95%, total nitrogen 0.211%, phosphorus 23 ppm and potassium 283 ppm 28, according to the analysis carried out by the Office of Pedologycal and Agrochemical Studies (OSPA) Cluj-Napoca. It is known that clay soils have a high clay content that gives them a fine texture and high nutrient content but they can become heavy and difficult to work with when they are too wet (www.hectarul.ro). The experiment designed includes two tillage systems: conventional-plow (CS) and direct sowing-no till (NT), in three years crop rotation (soybean - winter wheat - corn).The biological material used is represented by "Turda 332" corn hybrid (FAO 380).

In the conventional system (CS) the land was plowed in autumn at 30 cm depth (Kuhn Huard Multi Master 125T plow), in the spring the seedbed preparation (HRB 403 D rotary harrow), the simultaneous sowing with the basic fertilization (MT-6 sowing machine), the maintenance of the culture-treatments (MET 1500) and the harvested. In the no-till (NT) sowing directly in unprocessed field with basic fertilization (MT-6 sowing machine), crop maintenance-treatments (MET 1500 sprayer) and harvested. The sowing was done at the density of 65,000 plants/ha, the seed treated with fungicide MAXIM XL 035 FS produced based on 25 g/L fludioxonil 9.7 g/L metalaxil-M (mefenoxam) in dose de 1.0 L/t of grain which was later replaced by REDIGO PRO. Fertilization was carried out in stages, namely: 300 kg/ha NPK 16:16:16 ($N_{48}P_{48}K_{48}$ s.a/ha) simultaneous with sowing + in the corn phase of 6-7 leaves with 100 kg/ha Urea (46% N).

Weed control was realized pre-emergence with: 0.4 L/ha MERLIN FLEX produced based on isoxaflutol 240 g/L and ciprosulfamide (safener) 240 g/L) + 1.4 L/ha FRONTIER FORTE based on dimethenamid-P (active optical) 720 g/L). The pre-emergent herbicide was applied after sowing, before the crop emergence. Post-emergence treatment was applied in the 4-6 leaf phase of corn with: 1.0 L/ha CERLIT product based on fluroxypir 250 g/L + 1.5 L/ha ASTRAL 40 OD based on nicosulfuron 40 g/L. Weeding degree and the weeds spectrum were determined: visual, numerical and gravimetric. Experimental data were processed by analyzing the variant (Poly Fact, 2015) and setting the limit differences (LDS, 5%, 1%, 0.1%).

If we refer to the 65-year multiannual temperature average (Figure 2) which is 9.3°C we can see that, in the county, the average temperatures measured at the Turda Meteorological Station (longitude 23°47'; latitude 46°35'; altitude 427 m) have increased from one year to another and the six years of experimentation are no exceptions (Table 1) especially in the summer period (June-August). The multiannual average rainfall is 532.4 mm.

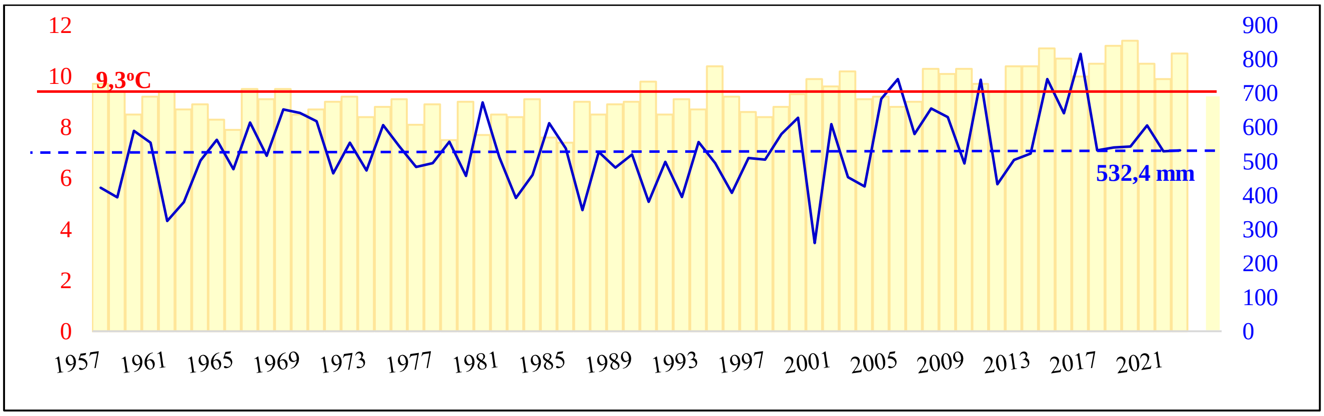

Figure 2. Thermal and rainfall regime at Turda, 1957-2023// Regimul termic şi pluviometric la Turda, 1957-2023

In the Turda area there is an uneven distribution of rainfall quantities, after periods of prolonged drought torrential rains followed, sometimes accompanied by strong winds or hail. According to Șimon (2022), the average air temperature presents exclusively trends of significant irreversible growth and which imposes a new approach to current agricultural systems, and not only, to manage the effects of global warming.

Table 1. Weather condition during corn growing season, in the 2018-2023 period/ Starea vremii pe perioada sezonului de creștere a porumbului, în perioada 2018-2023

Month/ Year	Rainfall (mm)							Temperatures (ºC)						
	2018	2019	2020	2021	2022	2023	65 years	2018	2019	2020	2021	2022	2023	65 years
April	26.2	62.6	17.8	38.4	42.5	30.5	**45.6**	15.3	11.3	10.3	7.8	8.8	8.8	**10.0**
May	56.8	152.4	44.4	80.8	82.9	33.2	**69.4**	18.7	13.6	13.7	14.1	16.3	15.4	**15.0**
June	98.3	68.8	166.6	45.0	41.8	144.5	**84.6**	19.4	21.8	19.1	19.8	21.1	19.0	**18.0**
July	85.7	35.0	86.8	123.1	25.2	85.8	**78.0**	20.4	20.4	20.2	22.7	23.1	21.8	**19.8**
August	38.2	63.8	58.0	52.9	94.6	98.5	**56.1**	22.3	22.1	21.5	19.7	22.3	22.1	**19.5**
September	29.8	19.4	57.4	39.1	56.1	116.1	**42.4**	16.7	17.1	17.8	15.0	14.3	19.2	**15.2**
Total (mm)	**335**	**402**	**431**	**379.3**	**343.1**	**508.6**	**376.1**	-	-	-	-	-	-	-
Average (ºC)	-	-	-	-	-	-	-	**18.8**	**17.7**	**17.1**	**16.5**	**17.7**	**17.7**	**16.3**

RESULTS AND DISCUSSION

At the beginning of the vegetation the corn crop was infested by the dicotyledonous species *Chenopodium album, Amaranthus retroflexus, Xanthium strumarium, Cirsium arvense, Hibiscus trionum, Convolvulus arvensis, Sonchus arvensis, Sinapis arvensis, Rubus caesius* and later with annual monocotyledonous *Echinochloa crus-galli*, *Avena fatua* and *Setaria glauca* and of perennial monocotyledonous species with *Elymus repens* (isolated).

There have been identified 30 weed species in corn crop some of which have been consistently found in the crop in both soil tillage systems, such *as Polygonum convolvulus*, *Viola arvensis*, *Veronica persica*, *Xanthium strumarium*, *Sinapis arvensis* and some of them also refer to the perennial species *Taraxacum officinale*, *Arctium lappa* and *Symphytum officinalis* only in the NT variant. The species *Bromus tectorum* also recorded a high number/m^2 in the no-till variant (Table 2).

The crop infestation with the species *Xanthium strumarium* (with staggered germination in the period April to June) represents a real problem in the area. The specialized literature mentions that the seeds of *Xanthium strumarium* have a viability up to five years and the species can quickly become dominant in one area, due to the prolific of seeds and high rates of germination and survival, vigorous specimens can produce from 500 to 2300 thistle/plant, as the mentions of Ullah et al., (2022), Saeed et al., (2020), Chețan & Chețan, (2023) and other.

Following the gravimetric determination of weeds (Table 3), an increase in both the number of weeds and their weight is observed so that, in the SC variant, the largest mass of weeds was made by annual dicotyledonous species (AD) with 8.2 t/ha and annual monocotyledonous (AM) with 6.7 t/ha and in the NT variant of annual dicotyledonous species (AD) with 10 t/ha and perennials dicotyledonousones (PD) with 9 t/ha. In the Turda area, the dicotyledonous species predominate.

Compared to 2018 there was an increase in all species. In the classical system from 16 to 20 species/m^2 and in the NT variant from 19 to 43 species/m^2, overall an increase of 26 species more (Table 4). This can also be caused by low-temperature in spring when the growth rate of corn is slowed down and weeds being better adapted grow rapidly and invade the crop and, because of the rains it was impossible to enter the field in time and the plants and weeds are too advanced in vegetation the effectiveness of herbicides on weeds is diminished, weed resistance to herbicides etc. All these come to confirm that in the Turda area the effects of climate change are reflected on corn crop and implicitly on weeds.

Table 2. Weed spectrum from corn crop 2018, 2023//Spectrul de buruieni din cultura de porumb 2018, 2023

No.	Weed species	Group	Tillage system/no. weeds/m^2			
			CS 2018	NT 2018	CS 2023	NT 2023
1	*Echinochloa crus-galli*	AM	0	1	2	0
2	*Chenopodium album*	AD	1	1	1	0
3	*Convolvulus arvensis*	PD	0	1	0	2

No.	Weed species	Group	Tillage system/no. weeds/m^2			
			CS 2018	NT 2018	CS 2023	NT 2023
4	*Polygonum convolvulus*	AD	1	1	1	1
5	*Setaria glauca*	AM	1	1	3	1
6	*Agropyron repens*	PM	1	1	0	3
7	*Symphytum officinalis*	AD	0	0	0	1
8	*Capsella bursa-pastoris*	AD	0	1	0	0
9	*Sonchus oleraceus*	AD	1	0	1	1
10	*Rubus caesius*	PD	1	1	0	2
11	*Arctium lappa*	AD	0	0	0	1
12	*Cirsium arvense*	PD	0	2	1	4
13	*Cardaria draba*	PD	0	0	0	1
14	*Viola arvensis*	AD	1	1	1	1
15	*Avena fatua*	AM	0	0	1	1
16	*Matricaria inodora*	AM	0	1	1	2
17	*Lamium purpureum*	AM	1	0	0	0
18	*Stellaria media*	AD	0	0	1	0
19	*Galeopsis tetrahit*	AD	1	1	0	1
20	*Sonchus asper*	AD	0	0	1	1
21	*Veronica persica*	AD	1	1	1	1
22	*Datura stramonium*	AD	1	0	0	0
23	*Taraxacum officinale*	PD	0	0	0	1
24	*Bromus tectorum*	MA	0	0	1	11
25	*Xanthium strumarium*	AD	3	5	2	8
26	*Lathyrus tuberosus*	PD	1	0	0	1
27	*Euphorbia helioscopia*	AD	0	0	0	1
28	*Sinapis arvensis*	AD	1	1	1	1
29	*Lactuca serriola*	AD	0	0	0	3
30	*Erigeron canadensis*	AD	0	0	0	1

Table 3. Gravimetric determination of weeds//Determinarea gravimetrică a buruienilor

Tillage system/year		Annual dicotyledonous (AD)			Perennials dicotyledonous (PD)			Annual monocotyledonous (AM)			Perennials monocotyledonous (PM)		
		no/m^2	g/m^2	t/ha	no/m^2	g/m^2	t/ha	nom^2	g/m^2	t/ha	no/m^2	g/m^2	t/ha
CS	2018	12	425.3	4.3	2	170.6	1.7	1	42.1	0.4	1	3.3	0.03
	2023	11	391.1	3.9	1	68.0	0.7	7	630.1	6.3	-	-	-
	Total	**23**	**816.4**	**8.2**	**3**	**238.6**	**2.4**	**8**	**672.2**	**6.7**	**1**	**3.3**	**0.03**
NT	2018	13	402.7	4.0	4	484.3	4.8	2	78.1	0.8	1	7.2	0.07
	2023	16	603.8	6.0	11	419.0	4.2	13	582.9	5.8	3	32.6	0.3
	Total	**29**	**1006.5**	**10**	**15**	**903.3**	**9**	**15**	**661**	**6.6**	**4**	**39.8**	**0.37**

Table 4. Structure of weed species in case of use of unconventional soil working system//Structura speciilor de buruieni în cazul utilizării sistemului neconvențional de lucrare a solului

Year	Tillage system	Weeds species/m^2				Total
		AM	PM	AD	PD	
2018	CS	1	1	12	2	16
	NT	2	1	13	4	20
	Total	3	2	25	6	36
	Differences ± CS at NT	**-1**	**0**	**-1**	**-2**	**-6**
2023	CS	7	0	11	1	19
	NT	13	3	16	11	43
	Total	20	3	27	12	62
	Differences ± CS at NT	**-6**	**-3**	**-5**	**-10**	**-19**
Differences ± 2023 at 2018		**+ 17**	**+1**	**+2**	**+6**	**+26**

As regards the yield of corn (Table 5), in CS the average achieved in the six years is 8073 kg/ha. In the NT variant the yield was only 5012 kg/ha, which indicates a very significant negative influence on the yield, the difference being 3061 kg/ha (very significantly), the yields average is so low and due to the very unfavorable years of corn cultivation, especially 2022 and 2023.

Table 5. Average corn yield (grains) obtained in 2018-2023/ /Producția medie de porumb (boabe) obtinuta in perioada 2018-2023

Factor		**Yield (kg/ha)**	**%**	**Differences ± control**
Tillage system	CS-plow	8073	100	*control*
	NT- direct sowing	5012	62.1	**-3061^{000}**
LSD (p 5%) = 293; LSD (p 1%) = 456; LSD (p 0.1%) = 748.				

Application of a product based on glyphosate in the NT variant, before the crop emergence, would be a handy and quick variant of combating weeds existing at that time. We chose not to apply this product precisely to track over time the influence of this system on weeding degree (Figure 3).

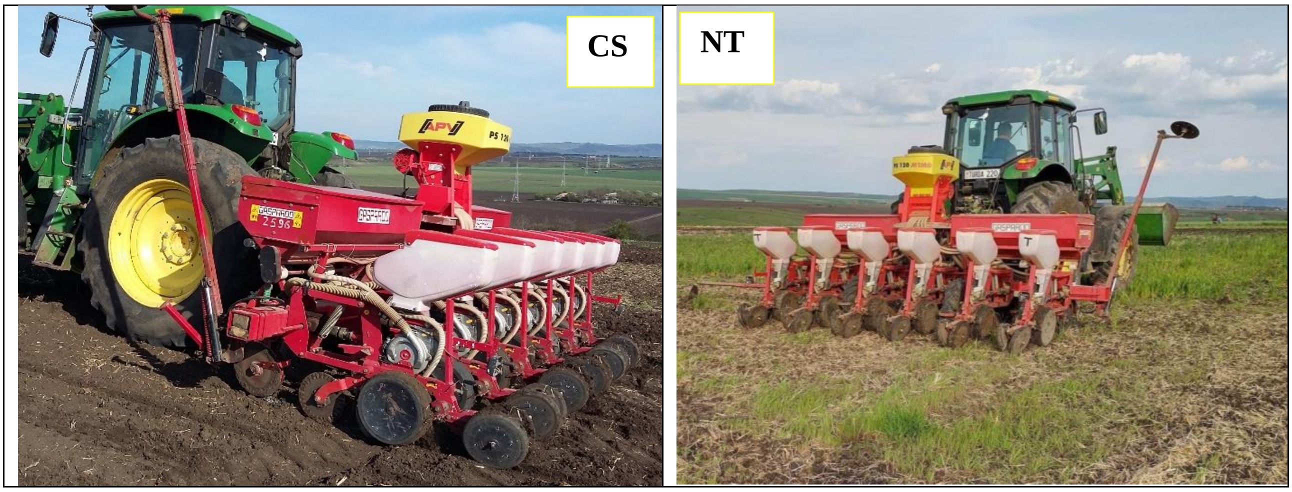

Figure 3. Corn sowing conditions in the two soil tillage systems, after six years of experimentation/ /Condițiile de semănat a porumbului în cele două sisteme de lucrare a solului, după sase ani de experimentare

CONCLUSION

1. Experimental results obtained during 2018-2023, highlighted the fact that under the vertical Phaeozem soil conditions with a high clay content, corn does not lend itself to cultivation in the NT variant (directly sown), requiring soil mobilization, yield data confirming this fact.
2. *Elymus repens, Sonchus arvensis*, some winter weeds such as *Matricaria odorora, Bromus tectorum* or *Xanthium strumarium* species are among the most difficult to combat without the plowing.
3. *Agropyron repens, Taraxacum officinale, Cirsium arvense* and *Lactuca serriola* also extended, when used direct sowing variant.
4. The plowing and the chemical treatments are the best option in reducing the number of weeds;
5. The number of annual monocotyledonous weeds increased in CS, while in the NT system increased the number of perennial weeds, and from the annual weeds the *Bromus tectorum* stand out.
6. Even if the corn does not lend itself to cultivation in this system on the land of the unit, probably on the lighter lands in the Turda area, with more performing sowing machines, this system can also be implemented in corn cultivation.

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STUDIES ON THE USE OF ROM-AGROBIOFERTIL NP FERTILIZER IN DIFFERENT CROPS AND IN DIFFERENT AREAS IN ROMANIA

STUDII PRIVIND UTILIZAREA INGRASAMANTULUI ROM-AGROBIOFERTIL NP IN CULTURI DIFERITE SI IN ZONE DIFERITE DIN ROMANIA

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ABSTRACT

The researchers created a biofertilizer - Rom-Agrobiofertil NP - consisting of a mixture in equal parts of three live germ cultures: Azospirillum lipoferum, Azotobacter chroococcum and Bacillus megaterium.

Embedded in the soil, the three bacteria enter into a partnership with the plants and act synergistically to provide the nitrogen and phosphorus necessary for their development through complex mechanisms: accelerating the decomposition of plant residues, greening the soil through the decomposition of chemical fertilizer residues, fixing atmospheric nitrogen, the metabolism of insoluble phosphates into easily assimilable soluble forms, the production of bacteriocins (antibiotics) as well as substances with antifungal action.

The product is presented as a set of three components in liquid form, which are mixed together, diluted with water and can be administered by spraying on the soil surface.

This study presents the results obtained in testing Rom-Agrobiofertil NP for increasing productivity in different areas of the country. The testing concerned 2 crops: potato and corn.

Key words: Agrobiofertilizer, biofertilizers, live germs, plants, synergy

REZUMAT

Cercetătorii au creat un biofertilizator - Rom-Agrobiofertil NP - constând dintr-un amestec în părți egale a trei culturi de germeni vii: Azospirillum lipoferum, Azotobacter chroococcum și Bacillus megaterium.

Încorporate în sol, cele trei bacterii intră într-un parteneriat cu plantele și acționează sinergic pentru a furniza azotul și fosforul necesare dezvoltării lor prin mecanisme complexe: accelerarea descompunerii reziduurilor vegetale, ecologizarea solului prin descompunerea reziduurilor de îngrășăminte chimice, fixarea azotului atmosferic, metabolizarea fosfaților insolubili în forme solubile ușor asimilabile, producerea de bacteriocine (antibiotice), precum și substanțe cu acțiune antifungică.

Produsul este prezentat ca un set de trei componente în formă lichidă, care sunt amestecate împreună, diluate cu apă și pot fi administrate prin pulverizare pe suprafața solului.

Acest studiu prezintă rezultatele obţinute în testarea Rom-Agrobiofertil NP pentru creşterea productivităţii în diferite zone ale ţării. Testarea a vizat 2 culturi: cartofi și porumb

Cuvinte cheie: Agrobiofertilizator, biofertilizatori, germeni vii, plante, sinergie

I. INTRODUCTION

Considering the need to increase production and productivity in the agricultural sector, over time the soil was helped by human intervention, using a series of substances, including synthetic ones - chemical fertilizers that often have an adverse effect. Different categories of organic, inorganic, organomineral fertilizers, soil improvers, mineral amendments, inhibitors, biostimulators, as well as different fertilizing products are known.

A whole series of biofertilizer products is known and are on the market, an alternative to synthetic fertilizers, which use different bacteria such as: *B. subtilis, B. licheniformis, B. megaterium, B. laterosporus, Azospirilium lipoferum, Azotobacter, B. polymyxa* etc.

Based on the experience gained in the cultivation and multiplication of bacteria, the company's specialists, through appropriate scientific research, managed to obtain a series of bacterial cultures of economic interest.

The study was carried out in Mureș, Teleorman and Dâmbovița counties with two crops: potato and corn.

The efficiency of the product is known and production increases have been recorded in crops from all work points.

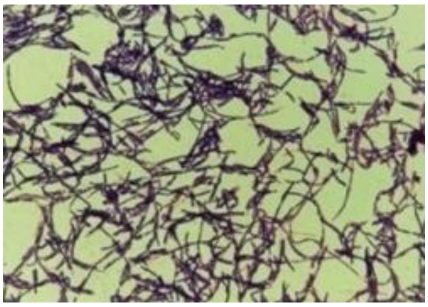
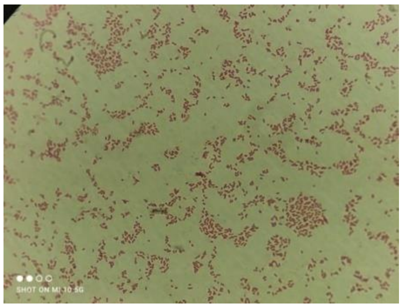
II. MATERIAL AND METHOD

The bacterial strains were purchased from European strain banks, are not pathogenic, non-genetically modified (non-GMO) and have a fertilizing action.

a. ***Azotobacter chroococcum***, from a morphological point of view, it is presented in the form of ovoid cells, with a diameter of 1.5 – 2.0 μm. It stains Gram-negative. In liquid media it produces moderate and uniform turbidity. In old cultures, a quantitatively reduced deposit forms at the bottom of the tube.

b. ***Azospirillum lipoferum,*** morphologically, it is a straight or vibrioid-shaped bacillus, 0.9 – 1.5 μm thick, often with sharp ends. It stains Gram-negative. In liquid media it produces moderate and uniform turbidity. In old cultures, a quantitatively reduced deposit forms at the bottom of the tube, which rises after shaking.

c. ***Bacillus megaterium,*** as morphological characteristics are straight bacilli, with dimensions of 0.9 – 2.5 x 1.2 – 10 μm, often arranged in pairs or chains. The ends are rounded or cut straight. It stains Gram-positive. In liquid environments it produces abundant turbidity. In old cultures, a deposit forms at the bottom of the tube, which rises after shaking. The microscopic aspects of the respective microorganisms are presented below (figures 3-5).

The tests carried out in different pedoclimatic zones, on two crops: potato and corn.

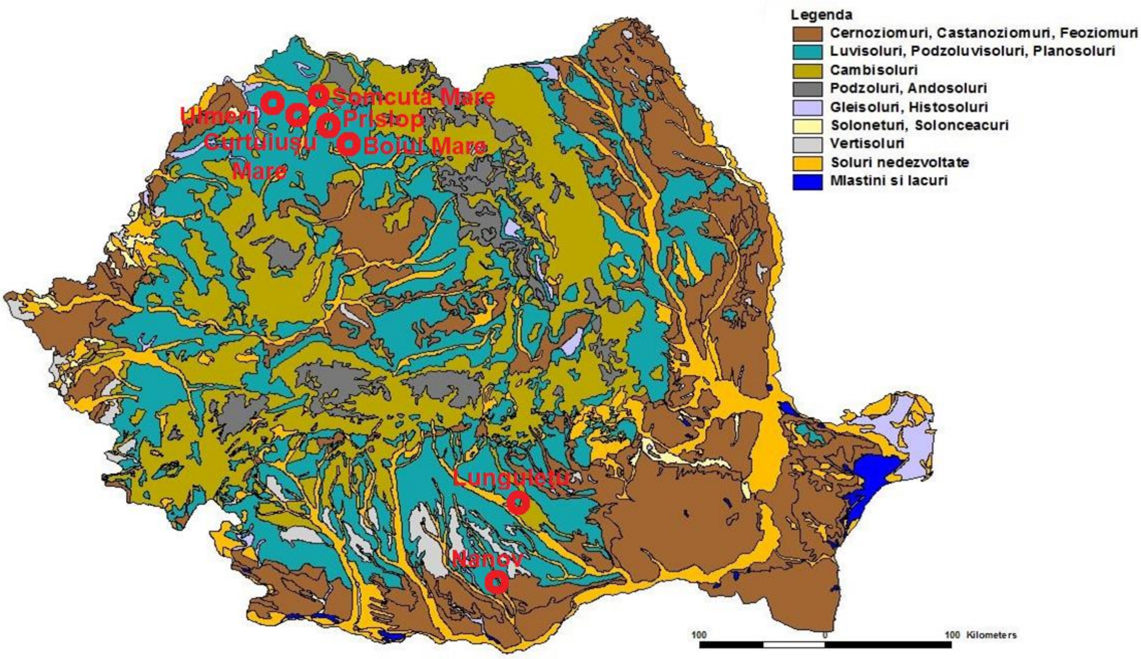
The increase in production was monitored using for comparison unfertilized control lots and in some cases also chemically fertilized control lots as shown in table 2.

Analyzed results are highlighted for two relevant cultures at all test points.

The tests on corn and potato crops were carried out during the autumn-spring period of the 2022-2023 crop cycle.

The relief and bioclimatic position of Romania's territory determine the main zonal (latitudinal, longitudinal, altitudinal) and intrazonal features of the soil cover. Climate and vegetation determine the latitudinal and altitudinal zonation of the soil cover. Following the concentric arrangement of relief steps, another feature of the distribution of soils is: the black soil of the plain area, the luvisol of the hills and plateaus; cambisols, spodisols and umbrisols in the mountain region concentricity of soil zones (as a horizontal projection of altitudinal zonation).

A first differentiation is made from south to north, with chernisols predominating in the southern part, and luvisols in the northern part, another direction of differentiation being from west to east, from the silvosteppe of the tabular and transitional plains (with varied chernozims) to the area forest of the Piedmont plains, higher, with preluvosols.



In the south-eastern part of Romania, the Cernozioms predominate. They are characteristic of the steppe and silvosteppe, constituting significant areas in the Romanian Plain, they have a glomerular or granular structure, the rich humus content (3-6%), the soil being saturated in bases, with a slightly alkaline to neutral reaction . It has very high fertility in normal climatic years. It lends itself to the cultivation of cereals, technical plants, vineyards and orchards. They are an important component of the soil fund for Romania's granaries.

In the north-western part, the Kastanoziums are predominant. They have a moderate glomerular structure, predominantly medium texture, low humus content (2-3%), alkaline reaction (7.5-8), saturation in bases and a good supply of nutrients. Provided with water and fertilizers, they are used with good results for cereal crops and technical plants, vineyards and orchards.

Luvisols represent the zonal class of soils that are characterized by an A horizon (or A and E) and argic horizon (Bt), having colors with values and chromas above 3.5 when wet, starting from the upper part of the horizon.

Table 1 – Cultures on working points// Culturi in punctele de lucru

The city	Tests performed on
Hunedoara- Prislop **Maramureș-Boiul Mare** **Curtuiușul Mare** **Șomcuta Mare**	Onion: Potato; Onion: Potato; Corn Potato; Corn; Tomatoes Potato; Corn
Dâmbovița-Lungulețu	Potato; Corn
Teleorman- Nanov	Potato; Corn

Two applications were made: in autumn after the previous crop was abolished before plowing, and the second one in spring when preparing the seed bed.

A single indicator was followed, namely the increase in production on different types of soil in Romania.

III. RESULTS AND DISCUSSIONS

From the analysis of the data from the farmers, a 10%-35% increase in production is observed, both on chernozioms/castasioms in the south-eastern part, and on Luvisols in the north-western part of Romania.

The increase in production obtained after the application of ROM-AGROBIOFERTIL fertilizer is highlighted in table no. 2.

Table 2 – Differences in production for the batches in which Agrobiofertilizant was used// Diferențele de producție pentru loturile în care a fost utilizat Agrobiofertilizant

Year of testing/Area	City	Culture	Batch	Production difference
NorthWest Maramures	**Prislop**	**Potato**	- control batch 15000kg/ha	
			batch Agrobiofertilizant 25000 kg/ha	+ 10000 kg/ha
		Corn	- control batch 2000 kg/ha	
			batch Agrobiofertilizant 3000 kg/ha	+ 1000 kg/ha
	Boiul Mare	**Corn**	- control batch 2,500 t/ha	
			batch Agrobiofertilizant 3,0 t/ha	+1 t/ha
		Potato	control batch chemically fertilized 10 t/ha	
			batch Agrobiofertilizant 10t/ha	+0 t/ha
	Curtuiușul Mare	**Potato**	control batch fertilized with manure 30t/ha	
			batch Agrobiofertilizant 30t/ha	+ 0 kg/ha
		Corn	control batch fertilized with manure 5000 kg/ha	
			batch Agrobiofertilizant 5500 kg/ha	+500kg/ha
	Șomcuta Mare	**Potato**	control batch chemically fertilized 30 t/ha	
			batch Agrobiofertilizant 33t/ha	+3 t/ha
	Ulmeni	**Corn**	control batch chemically fertilized 5 t/ha	
			batch Agrobiofertilizant 6 t/ha	+1 t/ha
South East Dâmbovița, Teleorman	**Lungulețu Nanov**	**Potato**	control batch 29500 Kg/ha	
			batch Agrobiofertilizant 30000 kg/ha	+ 10000 kg/ha
		Potato	control batch chemically fertilized 31 t/ha	
			lot Agrobiofertilizant 31,3 t/ha	+0,3 t/ha
		Potato	control batch fertilized with manure 29870 kg/ha	
			batch Agrobiofertilizant 31550 kg/ha	+1680 kg/ha
		Corn	control batch 2,500 t/ha	
			batch Agrobiofertilizant 3,0 t/ha	+1 t/ha

An aspect related to the direct advantage (from the economic point of view) of fertilizers based on bacterial cultures is the application technologies. Bacterial biopreparations are recommended for two applications. The fact that the farmer will carry out two treatments (one at soil preparation and one in spring) will reduce the cost, but especially soil compaction. This aspect represents for farmers a decrease in costs by up to approx. 35%

Through the activity and processes carried out in the soil structure (decomposition, solubilization, permeability, etc.), bacteria provide elements that plants need for their growth and development (N and P).

Another aspect directly related to the cost reduction and advantage of microorganisms is the enrichment of the soil with nitrogen and phosphorus. The fact that nitrogen, along with phosphorus and potassium, are basic elements of plant growth and development. The fact that the nitrogen-fixing bacteria in this product fix atmospheric nitrogen in the soil through certain processes, which lead to an increase in the amount of nitrogen and phosphorus in the soil (increase in the percentage of humus). The product favored the vegetative growth of the plants, compared to the control lots.

a

b

Figure 6 – AGROBIOFERTILIZANT – presentation: a) bottles x 10 l and b) bottles x 250 ml // AGROBIOFERTILIZANT - prezentare: a) flacoane x 10 l și b) flacoane x 250 ml

Figure 6 shows the way of marketing - a set of three containers with bacterial suspensions (Azotobacter chroococcum, Azospirillum lipoferum, Bacillus megaterium) marked with a label containing the name of the product, application instructions and the manufacturer.

The results regarding the level of production achieved within the company in recent years are presented below (figure 7):

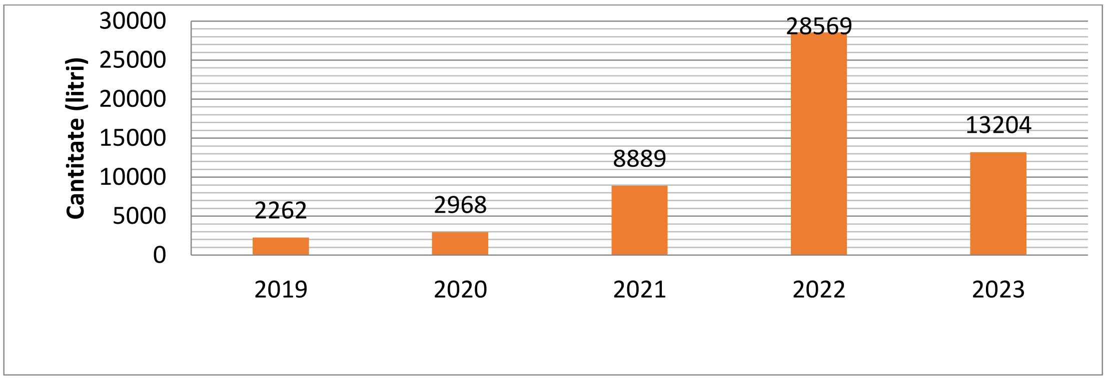


Figure 7 – Agrobiofertil – production dynamics (quarterly) achieved within the company in recent years// Agrobiofertil - dinamica producției (trimestrială) realizată în cadrul companiei în ultimii ani

IV. CONCLUSIONS

1. Considering the needs imposed by the transition to ecological agriculture based on the results and experience in the cultivation of microorganisms and the production of veterinary vaccines, the company's team of specialists, following scientific research activities, managed to adapt three bacterial strains for multiplication, to characterize and preserve them safely in liquid nitrogen.
2. The multiplication technology in bioreactors was realized, establishing the working times, stirring speed, temperature, the multiplication curve and the pilot and production series were realized, which represent the basis of the realization of the industrial production programs.
3. The basis of the results represents the basis and necessity for the further development of the production of this biofertilizer, as well as of other bacterial products necessary for agriculture (antifungal, antiviral, insecticides, etc.), thus contributing to the provision of organic biofertilizers for agricultural production and the reduction of the use of as much as possible of the products of chemical synthesis with a high degree of pollution.

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DECREASE OF YIELD AND QUALITY OF WINTER CEREALS IN 2023 DUE TO THE ATTACK OF THE NEW WAVE OF STRIPE RUST AT S.C.D.C.B. TG. MURES

REDUCEREA PRODUCȚIEI ȘI CALITĂȚII LA CEREALELE DE TOAMNĂ ÎN ANUL 2023 CA URMARE A ATACULUI NOULUI VAL DE RUGINĂ GALBENĂ LA S.C.D.C.B. TG. MUREȘ

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ABSTARCT

Recent climate change has led to a stronger development of cereal diseases. One of the diseases that created huge problems was Stripe Rust (Puccinia striiformis f. sp tritici).

The pathogen Stripe Rust appears in different areas and time intervals and with different intensity from one area to another. The conditions for the manifestation are known the favorable climatic condition for the pathogen at least one year before the attack are the responsible for the disease manifestation.

For our area, all the waves of Stripe Rust were particularly virulent and for the triticale culture it was devastating, it simply led to the total decimation of numerous varieties where we did not intervene in time with specific products. To elucidate the dilemma that although we are going through a general phenomenon of climate warming in 2023 there was a new wave of stripe rust, we set out to analyze the evolution of climatic conditions (temperature and precipitation) in the agricultural year 2022-2023 compared to the conditions climatic conditions from the period of the grain yield of the penultimate wave of rust (2013-2014) in the area.

Keywords: stripe rust, wheat, triticale, grain yield, climate conditions

REZUMAT

Schimbările climatice din ultimul timp a dus la o dezvoltare mai puternică a prezenței bolilor la cereale. Una din bolile care a creat mari probleme în 2023 a fost Rugina Galbenă (Puccinia striiformis f. sp tritici).

Agentul patogen Rugina Galbenă apare pe areale și intervale de timp diferite și cu intensitate diferită de la o zonă la alta. Condițiile climatice prielnice pentru agent cu cel puțin un an înainte sunt responsabile de manifestarea bolii.

Pentru zona noastră toate valurile de Rugină galbenă au fost deosebit de virulente iar pentru cultura de triticale a fost devastatoare, pur și simplu ducînd la decimarea totală a numeroase soiuri acolo unde nu s-a intervenit la timp cu produse specifice. Pentru elucidarea manifestării, că deși parcurgem un fenomen general de încălzire a climei în 2023 a avut loc un nou val de Rugina Galbenă, ne-am propus să analizăm evoluția condițiilor climatice (temperatură și precipitație) în anul agricol 2022-2023 în comparație cu condițiile climatice din perioada producerii penultimului val de rugină (2013-2014) în zonă.

Cuvinte cheie: rugină galbenă, grâu, triticale, producție, condiții climatice

INTRODUCTION

Wheat is the mostly grown crop in the world, as it was harvested from more than 218 million hectares with a production of about 772 million tons in 2017 (FAO 2017).

Stripe rust, caused by *Puccinia striiformis*, is an important disease of wheat worldwide. The disease is old, but often appears as a re-emerging problem and also expands to new areas. Large-scale stripe rust epidemics occur when new races overcoming specific resistance genes develop in the pathogen population and/or when extreme disease-favorable weather conditions occur. Research progress has been made in the understanding of the biology, genomics, and evolution of the pathogen; host-pathogen interaction; and epidemiology and management of the disease (Chen, 2020).

Climate change influences stripe rust epidemics, with positive or negative effects depending on the directions of moisture and temperature changes and on the seasons when changes occur. Warmer winters enhance the survival of the pathogen, leading to more severe epidemics. Cooler and wetter late springs and early summers allows more infection, favoring stripe rust epidemics. Geographic changes in climate may change the distribution of the disease. As a result, areas that were previously less favorable to stripe rust may become favorable to the disease. Recently, high temperature adaptive strains have been identified in different regions of the world (Hovmøller et al. 2008).

Major yellow rust attacks have been reported in more than 60 countries on all wheat-growing continents, the cost of global disease control measures has been estimated at at least US$ 1 billion (Chen, 2020). In the same work, 51 cases of yellow rust epidemics of large proportions are recorded in Asia, Europe, North America, Australia and Africa. Recently, severe yellow rust epidemics were recorded in the United States in 2003, in China in 2002, in Central Asia in 2009 and 2010, and in Australia in 2003 (Chen, 2005; Wellings, 2011).

Several stripe rust attacks were observed in wheat cultivars yield trials in six locations from different regions of Romania. Results suggested that the stripe rust races present in 2023 were better adapted to higher temperatures and showed some variation of virulence at the respective sites (Galit et al., 2023).

Figure 1. Image from the micro plots with winter wheat and triticale cultivars and lines at S.C.D.C.B. Târgu Mureş //Imagine din cultura comparativă cu soiuri și linii de grâu și triticale la S.C.D.C.B. Târgu Mureş

In 2023, Cotuna (2023) and Voica at all. (2023) warns us about the danger represented by stripe rust and also an increase in the frequency of attacks can be observed, which is a serious alarm signal in several areas, including the south of Romania.

Harvest losses caused by yellow rust can be reduced or even eliminated by treatments with appropriate fungicides, but this involves both additional expenses and possible unwanted effects on the environment, being in contradiction with the European Directives. Although until recently no evidence of resistance of the pathogen *Puccinia striiformis* to fungicides had been found, in 2021 the appearance of resistance of this pathogen to chemical treatments was already reported (Cook et al., 2021). That is why preventing attacks by cultivating resistant varieties remains the most desirable solution, being cheap, ecological and effective, even if sometimes it is not sustainable.

MATERIAL AND METHODS

The observations regarding the attack of yellow rust and the production results from comparative crops with autumn wheat and triticale varieties coordinated by INCDA Fundulea were carried out at the Research and Development Station for Cattle Breeding –Tg. Mures, located on the territory of Sangeorgiu de Mures, which is located 3 km north of the city of Targu Mures, having the geographical coordinates: the meridian 24°33’ east longitude and the parallel 46°33’ north latitude.

The culture was placed on a brown forest soil, weakly podzolic (representative of over 80% of the surface of Targu Mures), with a humus content of 2.2, pH of 5.8, P2O5 supply is 17.4 mg/100 g soil, K2O 21.7 mg/100 g soil and an N index of 1.4

The comparative crops were placed as a balanced square grid, with 25 variants in 3 repetitions, with harvestable plots of 5 m².

The intensity of *Puccinia striiformis* attack was graded using a scale from 1 to 9 (McNeal et al., 1971). According to this scale, infection types 1-9 are defined as follows: 1: minor chlorotic and necrotic spots, 2: chlorotic and necrotic spots without sporulation, 3-4: chlorotic and necrotic areas with limited sporulation, 5-6: spots chlorotic and necrotic. necrotic areas with moderate sporulation, 7: abundant sporulation with moderate chlorosis and 8-9: abundant and dense sporulation without noticeable chlorosis and necrosis.

This scale is commonly used as a uniform system for recording and processing yellow rust attack data. Markings were made following uncontrolled natural infection.

Temperature and precipitation data were studied and analyzed in 2022-2023 compared to 2013-2014. Correlation coefficients and linear regressions were calculated to evaluate the results regarding yellow rust attack and production.

RESULTS AND DISCUSSIONS

A comparative analysis of the climatic conditions of the years 2021-2022 and 2022-2023 highlighted the fact that the average temperature in 2021-2022 was 8.2 °C and the year 2022-2023 was 9.2 °C, so a plus of 1.01 °C, and against the multi-year average it was 2.09 °C.

Table 1. Evolution of the average temperature during wheat growing season in 2021-2022 and 2022-2023// Evoluția temperaturii medii în perioada de vegetație a grâului în anii 2021-2022 și 2022-2023

Temp.	**2021**				**2022**						
Month	**IX**	**X**	**XI**	**XII**	**I**	**II**	**III**	**IV**	**V**	**VI**	**Avg.**
2022 Avg.	17.0	8.7	4.9	2.0	-4.2	2.6	3.7	9.3	16.6	21.7	8.2
M.y. Avg..	13,9	9,3	3,7	0,24	-4,4	-0,6	5,6	9,97	14,7	18,7	7,11
Deviation	3.1	-0.6	3.7	1.8	-0.2	2.0	-1.9	-0.7	1.9	3.0	1.12
Year	**2022**				**2023**						
Month	**IX**	**X**	**XI**	**XII**	**I**	**II**	**III**	**IV**	**V**	**VI**	**Avg.**
2023 Avg.	14.8	12.1	6.2	2.5	3.9	1.4	6.4	9.6	16.1	19.1	9.21
M. y. Avg.	13,9	9,3	3,72	0,3	-4,4	-0,6	5,6	9,97	14,7	18,7	7,12
Deviation	0.9	2.8	2.5	2.2	0.5	0.8	0.8	-0.4	1.4	0.4	2,09

And as for the precipitation contribution in 2021-2022, there was an accumulation of 413.2 mm during the wheat vegetation period and in 2022-2023 721.4 mm with an increase of 260.6 mm over the multi-year average. So both the temperature and precipitation were higher compared to the previous year.

Table 2. Evolution of precipitation during wheat growing season in 2021-2022 and 2022-2023// Evoluția precipitațiilor în perioada de vegetație a grâului în anii 2021-2022 și 2022-2023

Precipitation	**2021**				**2022**						
Month	**IX**	**X**	**XI**	**XII**	**I**	**II**	**III**	**IV**	**V**	**VI**	**Sum.**
2022 Avg.	59.7	12.5	34.0	87.7	27.4	11.2	3.6	118.9	49.0	9.2	413.2
M.y. Avg..	46,6	42,7	36,4	35,6	28,5	28,1	28,0	49,9	75,2	89,3	460,2
Deviation	13.1	-30.2	-2.4	52.1	-1.1	-16.9	-24.4	69.0	-26.2	-80.1	- 47
Year	**2022**				**2023**						
Month	**IX**	**X**	**XI**	**XII**	**I**	**II**	**III**	**IV**	**V**	**VI**	**Sum.**
2023 Avg.	176.4	45.7	71.5	47.5	28.2	55.8	31.6	74.0	39.2	151.5	721.4
M. y. Avg.	47,3	42,7	35,9	35,7	28,5	28,3	28,0	50,0	74,9	89,5	460,8
Deviation	129.1	3.0	35.6	11.8	-0.3	27.5	3.6	24.0	-35.7	62,0	260.60

We also analyzed the climatic conditions of 2013-2014 when the penultimate wave of Stripe Rust appeared, in our area when an average temperature of 8.5 °C and an amount of 421 mm of precipitation was recorded, so temperatures and precipitation were very close to 2021-2022, but below the level of 2023.

Table 3. Evolution of the average temperature during wheat growing season of penultimate attack wave with Stripe Rust in 2012-2013 and 2013-2014 // Evoluția temperaturii medii în perioada de vegetație a grâului la penultimul val de atac cu Rugina galbenă în anii 2012-2013 și 2013-2014

Temp.	**2012**										
Month	**IX**	**X**	**XI**	**XII**	**I**	**II**	**III**	**IV**	**V**	**VI**	**Avg.**
2013 Avg.	17.9	12.1	4.5	-3.7	-3.4	2.3	3.9	12.2	17.0	19.5	8.23
M.y. Avg..	13,8	9,2	3,7	-0,2	-4,5	-1,7	3,8	9,8	14,6	18,5	6,7
Deviation	4.1	2.7	0.8	-3.5	1.1	0.6	0.1	2.4	2.4	1,0	1.53
Year	**2013**				**2014**						
Month	IX	X	XI	XII	I	II	III	IV	V	VI	Avg.
2014 Avg.	13.8	10.0	6.9	-2.1	0.8	2.1	8.0	11.5	15.8	18.0	8.4
M. y. Avg.	13,8	9,1	3,7	-0,2	-4,5	-1,7	7,7	9,7	14,5	18,3	7,0
Deviation	-0.1	0.7	3.2	-1.9	3.6	0.4	4.2	1.6	0.8	-0.7	1.4

Table 4. Evolution of precipitation during wheat growing season of penultimate attack wave with Stripe Rust in 2012-2013 and 2013-2014// Evoluția precipitațiilor în perioada de vegetație a grâului la penultimul val de atac cu Rugina galbenă în anii 2012-2013 și 2013-2014

Precipitation	**2012**				**2013**						
Month	**IX**	**X**	**XI**	**XII**	**I**	**II**	**III**	**IV**	**V**	**VI**	**Sum.**
2013 Avg.	36.5	25.5	40.0	42.0	24.5	11.5	41.0	40.5	66.5	75.0	403
M.y. Avg..	46,0	42,6	36,7	33,7	28,4	27,7	27,0	49,3	74,5	88,8	454,7
Deviation	-9,5	-17.1	3.3	8,3	-3,9	-16.2	-14,0	-8,8	-8	-13,8	-51,7
Year	**2013**				**2014**						
Month	IX	X	XI	XII	I	II	III	IV	V	VI	Sum.
2014 Avg.	56.0	46.5	33.0	17.0	57.0	17.0	11.0	37.5	91.5	54.5	421.0
M. y. Avg.	45,9	42,2	36,4	33,4	28,0	27,5	26,8	48,9	73,8	88,0	450,9
Deviation	10,1	4,3	-3,4	-16,4	29.0	-10.5	-15,8	-11,4	17,7	-33.5	-29,9

Knowing that Stripe Rust develops in colder climates, we also compared the sum of temperatures below 10 °C and the number of days with temperatures below 10 °C and found that in 2014 there were 255 days with temperatures below 10 °C during the vegetation period of the crop with 1120.3 °C and in 2023, 212 days with 840.4 °C were recorded, which means that 2023 was a warmer year than 2014.

Table 5. Sum of temperatures and no. days with temperatures below 10 °C during the wheat vegetation period // Suma temperaturilor și nr. zile cu temperaturi sub 10 °C în perioada de vegetație a grâului

Year	**2013**				**2014**						
Month	**IX**	**X**	**XI**	**XII**	**I**	**II**	**III**	**IV**	**V**	**VI**	**Sum**
∑ temp.	170.0	146.8	108.0	158.4	98.0	41.0	91.6	156.7	126.0	23.8	1120.3
Avg.	583.2				537.1						
No. days	24.0	30.0	30.0	31.0	31.0	28.0	31.0	27.0	19.0	4.0	255.0
Sum	115.0				140.0						
Year	**2022**				**2023**						
Month	**IX**	**X**	**XI**	**XII**	**I**	**II**	**III**	**IV**	**V**	**VI**	**Sum**
∑ temp.	104.8	158.6	99.8	75.6	68.9	59.8	46.9	142.3	83.7	0.0	840.4
Avg.	438.8				401.6						
No. days	14.0	29.0	30.0	31.0	31.0	28.0	7.0	30.0	12.0	0.0	212.0
Sum	104.0				108.0						

Next we present the grain yield, main yield elements and quality elements of the year 2023 compared to 2022 in relation to the attack of Stripe Rust

Table 6. Grain yield kg/ha in 2022 and 2023 and scores of stripe rust attack for winter wheat cultivars tested in 2023 // Producția kg/ha în anul 2022 și anul 2023 și nota la Rugină galbenă în 2023

No.	**Cultivars**	**2022**	**2023**	**Dif. 2023**	**%**	**Score of Stripe Rust attack**
1	**GLOSA**	8853.411	7143.256	1710.2	19.3	4
2	**FDL MIRANDA**	9569.209	4235.488	5333.7	55.7	8
3	**OTILIA**	8988.806	7527.442	1461.4	16.3	4
4	**PITAR**	8492.403	6979.938	1512.5	17.8	3

5	**SEMNAL**	8830.109	7645.488	1184.6	13.4	5
6	**URSITA**	9496.512	7813.132	1683.4	17.7	3
7	**VOINIC**	9389.922	7108.403	2281.5	24.3	3
8	**FDL ABUND**	9278.884	7916.651	1362.2	14.7	2
9	**FDL COLUMNA**	10121.89	7425.86	2696.0	26.6	1
10	**FDL**	9391.349	7784.016	1607.3	17.1	2
11	**FDL**	8896.744	8681.845	214.9	2.4	2
12	**DACIC**	9329.3	2375.209	6954.1	74.5	9
13	**Andrada**	8939.411	4453.581	4485.8	50.2	3
14	**Codru**	8611.473	6012.434	2599.0	30.2	2
15	**Cezara**	9602.729	5503.86	4098.9	42.7	3
16	**T 109-12**	9574.171	6331.256	3242.9	33.9	3
17	**T 7-15**	9280.403	6936.093	2344.3	25.3	3
18	**T 75-16**	9070.698	5658.372	3412.3	37.6	2
19	**T 42-17**	8683.07	6427.953	2255.1	26.0	2
20	**T 61-18**	8358.14	4857.054	3501.1	41.9	2
21	**BEZOSTAIA**	8703.38	4162.946	4540.4	52.2	3
	Avg.	**9117.239**	**6332.394**	**2784.8**	**30.5**	

The analyzes were made by correlating the grain yield losses with the degree of attack, which was noted with score from 1-9, where 1 represents resistant and 9 maximum attack.

We analyzed the differences in yield, where the average losses for the whole experiment was 2784 kg/ha, at varieties the highest yield losses we can observ at Dacic of 6954 kg/ha, which represents a loss of 74.5% and at Miranda with a yield difference of 5333 kg/ha representing 55.7%.

From the analysis of the correlation between the difference in grain yield and the scor of the Stripe Rust attack, it shows that the yieald loss increased in relation with the score for Stripe Rust attack. Grain yield loss was dependent on rust attack in a percentage of 35%.

The analysis of the quality indices highlighted a decrease in 1000 of grains weight by 7.1 g on average, ranging between 17.1 g at Miranda and 0 at Codru. The biggest decreases in1000 of grains weight were found at Miranda 17.1 and Dacic 16.7 g.

The dependence of the decrease of 1000 of grain weight on the score of Stripe Rust was 54.5%.

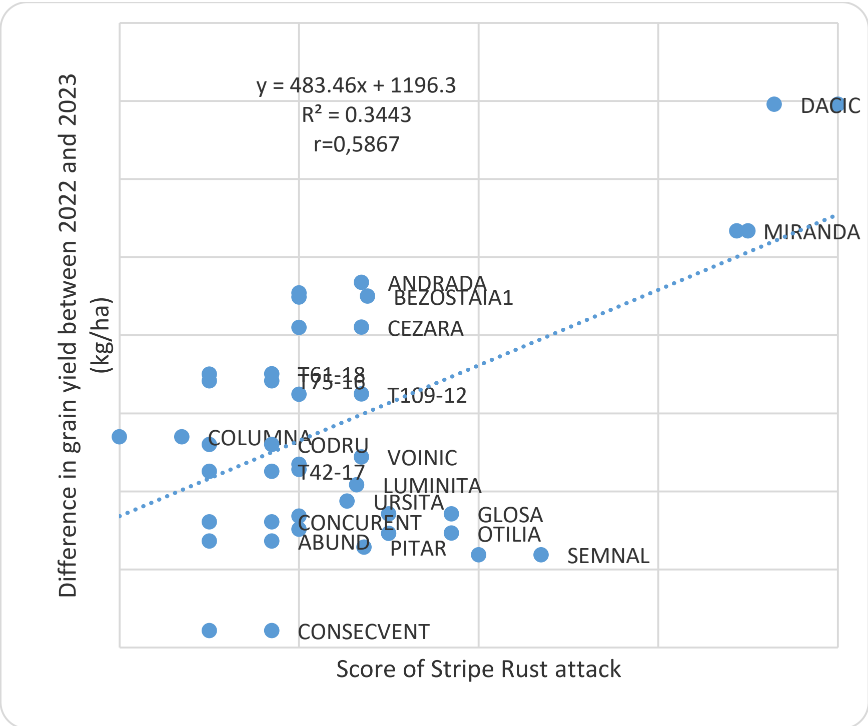

Figure 2. Relationship between the scores for Stripe Rust attack and the difference in grain yield kg/ha between 2022 and 2023// Analiza de corelație între diferența de producție 2022-2023 și nota de atac la Rugina Galbenă

Table 7. 1000 of grains weight in 2022 and 2023 // MMB în anul 2022 și anul 2023

No.	Cultivars	2022	2023	Dif.	Score of Stripe Rust attack
1	GLOSA	46	36.01	10.0	4
2	FDL MIRANDA	43	25.86	17.1	8
3	OTILIA	40.1	33.54	6.6	4
4	PITAR	46.1	38.1	8.0	3
5	SEMNAL	41	37.43	3.6	5
6	URSITA	41.6	36.61	5.0	3
7	VOINIC	41.2	36.06	5.1	3
8	FDL ABUND	40.1	38.81	1.3	2
9	FDL COLUMNA	44.8	43.67	1.1	1
10	FDL CONCURENT	44	33.43	10.6	2
11	FDL CONSECVENT	41.2	39.07	2.1	2
12	DACIC	46.3	29.6	16.7	9
13	Andrada	45.64	36.89	8.8	3
14	Codru	44.2	44.69	-0.5	2
15	Cezara	42.5	33.75	8.8	3
16	T 109-12	45.3	35.59	9.7	3
17	T 7-15	47.7	39.49	8.2	3
18	T 75-16	47.6	38.57	9.0	2
19	T 42-17	38.9	34.03	4.9	2
20	T 61-18	41.3	36.72	4.6	2
21	BEZOSTAIA	46.9	37.45	9.5	3
	Avg.	**43.6**	**36.4**	**7.2**	

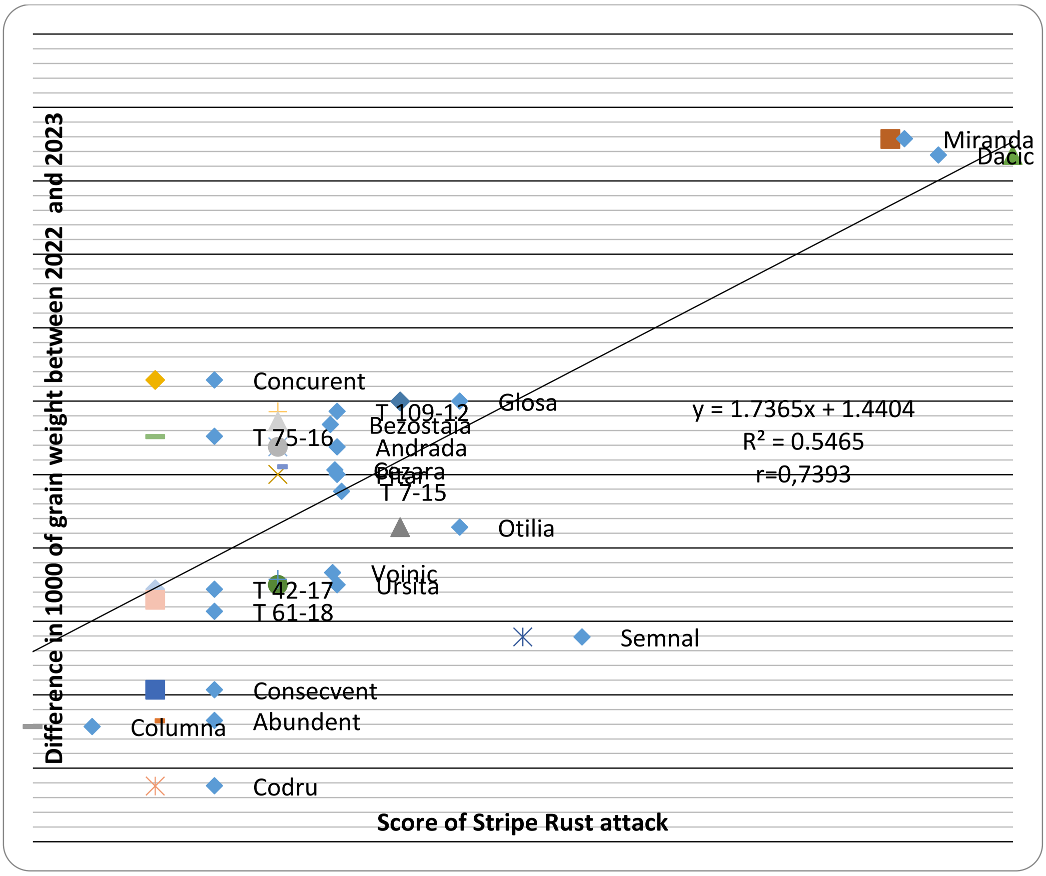

Figure 3. Correlation analysis between the difference in 1000 of grain weight in 2022-2023 and the score of Stripe Rust attack// Analiza corelației între diferența la MMB 2022-2023 și nota de atac de rugina galbenă

At volumetric weight, a comparative analysis between 2022 and 2023 shows a decrease at Miranda of 147 g and at Dacic of 101 g. The decrease in VW was dependent on score of Stripe Rust in a percentage of 37.3%

Table 8. Volumetric weight in 2022 and 2023 // Masa hectolitrică în anul 2022 și anul 2023

No.	Cultivars	2022	2023	Dif.	Score of Stripe Rust attack
1	**GLOSA**	828	751	77	4
2	**FDL MIRANDA**	802	655	147	8
3	**OTILIA**	816	750	66	4
4	**PITAR**	804	755	49	3
5	**SEMNAL**	806	752	54	5
6	**URSITA**	832	764	68	3
7	**VOINIC**	818	771	47	3
8	**FDL ABUND**	808	756	52	2
9	**FDL COLUMNA**	798	752	46	1
10	**FDL CONCURENT**	810	729	81	2
11	**FDL CONSECVENT**	808	755	53	2
12	**DACIC**	785	684	101	9
13	**ANDRADA**	796	722	74	3
14	**CODRU**	800	750	50	2
15	**CEZARA**	834	752	82	3
16	**T 109-12**	816	724	92	3
17	**T 7-15**	820	735	85	3
18	**T 75-16**	820	726	94	2
19	**T 42-17**	802	739	63	2
20	**T 61-18**	818	733	85	2
21	**BEZOSTAIA**	844	753	91	3
	Avg.	**813**	**738**	**71**	

The loss of volumetric weight was dependent on Stripe Rust in a percentage of 37.3 %

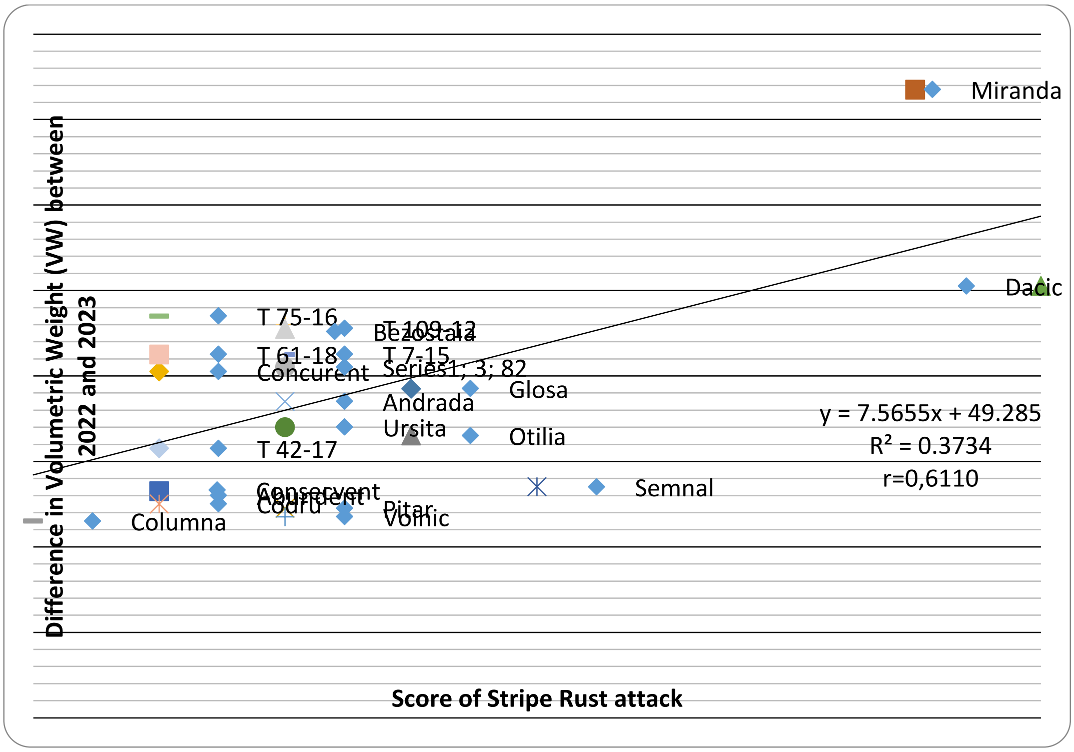

Figure 4. Correlation analysis between the difference in VW 2022-2023 and the score of Stripe Rust attack // Analiza corelației între diferența la MH 2022-2023 și nota de atac la rugina galbenă

Starch content decreased in 2023 by 2.38% compared to 2022. The biggest differences were reported for the same varieties, Dacic 6% and Miranda 4.3%. It should be noted that Bezostaia did not show a decrease in the percentage of starch between the two years of study.

Table 9. Starch content in 2022 and 2023
Conținutul de amidon în anul 2022 și anul 2023

No.	Cultivars	2022	2023	Dif.	Score of Stripe Rust attack
1	**GLOSA**	67.8	66.2	1.6	4
2	**FDL MIRANDA**	69	64.7	4.3	8
3	**OTILIA**	67.9	65.2	2.7	4
4	**PITAR**	67.7	66.7	1	3
5	**SEMNAL**	68.8	66.6	2.2	5
6	**URSITA**	69.1	65.7	3.4	3
7	**VOINIC**	67.1	65.7	1.4	3
8	**FDL ABUND**	67.2	64.5	2.7	2
9	**FDL COLUMNA**	66	65.9	0.1	1
10	**FDL CONCURENT**	67	65.1	1.9	2
11	**FDL CONSECVENT**	66.6	64.5	2.1	2
12	**DACIC**	68.9	62.9	6	9
13	**ANDRADA**	66.9	63.2	3.7	3
14	**CODRU**	67.3	65.2	2.1	2
15	**CEZARA**	68	64.8	3.2	3
16	**T 109-12**	66.2	63.1	3.1	3
17	**T 7-15**	67.7	64.1	3.6	3
18	**T 75-16**	66.4	64.5	1.9	2
19	**T 42-17**	65.9	65.2	0.7	2
20	**T 61-18**	66.8	64.5	2.3	2
21	**BEZOSTAIA**	65.9	65.9	0	3
	Avg.	67.34	64.96	2.4	

Stripe Rust attack controlled the starch content with 47%.

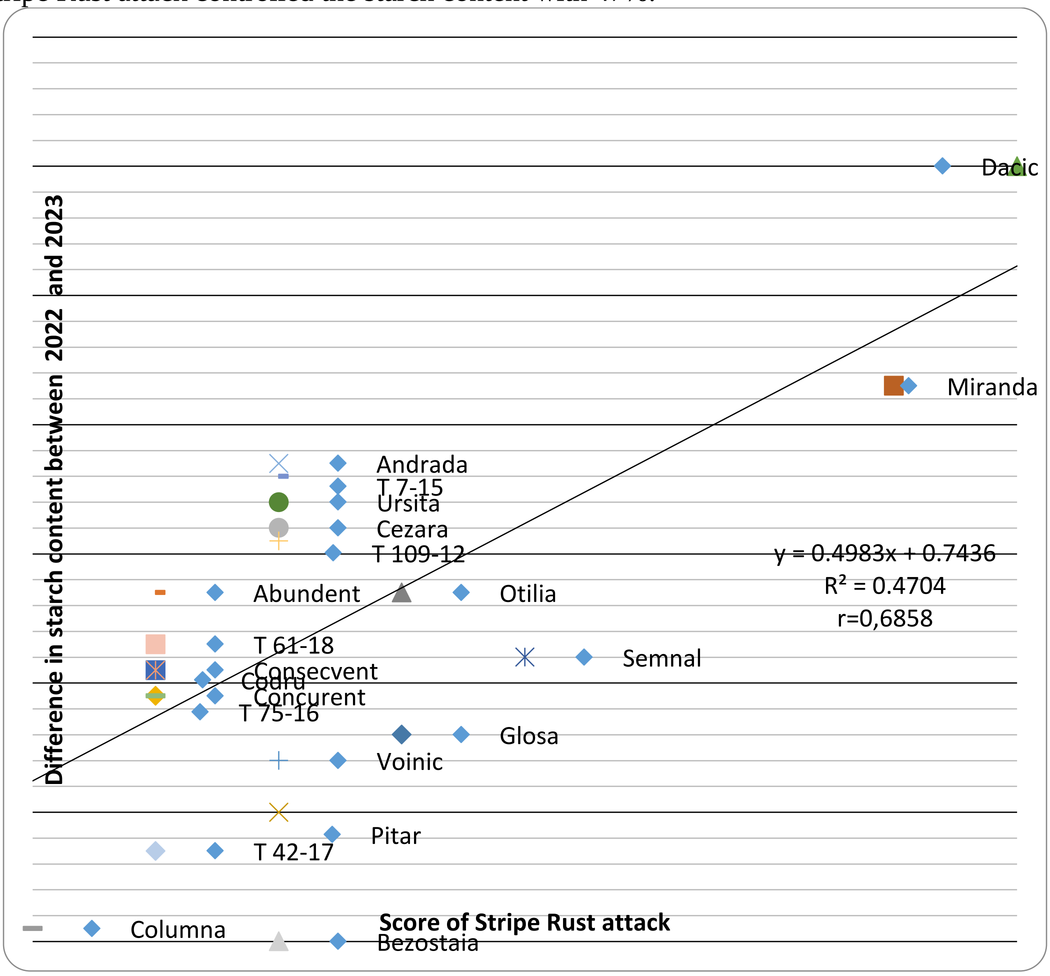

Figure 5. Correlation analysis between the difference in Starch Content 2022-2023 and the score of Stripe Rust attack // Analiza corelației între diferența la conținut de amidon 2022-2023 și nota de atac la Rugina Galbenă

The protein content in 2023 was 14.6%, 2.2% higher than in 2022, so the Stripe Rust attack did not negatively influence protein accumulation.

Table 9. Protein content in 2022 and 2023 // Conținutul de proteină în anul 2022 și anul 2023

No.	Cultivars	2022	2023	Dif.	Score of Stripe Rust attack
1	**GLOSA**	12.9	14.1	-1.2	4
2	**FDL MIRANDA**	11.7	13.6	-1.9	8
3	**OTILIA**	11.9	14.6	-2.7	4
4	**PITAR**	12.9	14.3	-1.4	3
5	**SEMNAL**	11.8	13.7	-1.9	5
6	**URSITA**	11.4	13.8	-2.4	3
7	**VOINIC**	12.7	14.3	-1.6	3
8	**FDL ABUND**	11.9	14	-2.1	2
9	**FDL COLUMNA**	13.1	14.4	-1.3	1
10	**FDL CONCURENT**	12.6	14.1	-1.5	2
11	**FDL CONSECVENT**	12.1	14.5	-2.4	2
12	**DACIC**	12.3	13.5	-1.2	9
13	**ANDRADA**	13.2	15.5	-2.3	3
14	**CODRU**	11.9	15	-3.1	2
15	**CEZARA**	11.7	15.8	-4.1	3
16	**T 109-12**	12.6	15.1	-2.5	3
17	**T 7-15**	12	15.1	-3.1	3
18	**T 75-16**	12.3	14.2	-1.9	2
19	**T 42-17**	12	14.7	-2.7	2
20	**T 61-18**	13.1	15.5	-2.4	2
21	**BEZOSTAIA**	14.8	16	-1.2	3
	Avg.	12.4	14.6	-2.2	

The protein content was addictive only in a percentage of 5.8%.

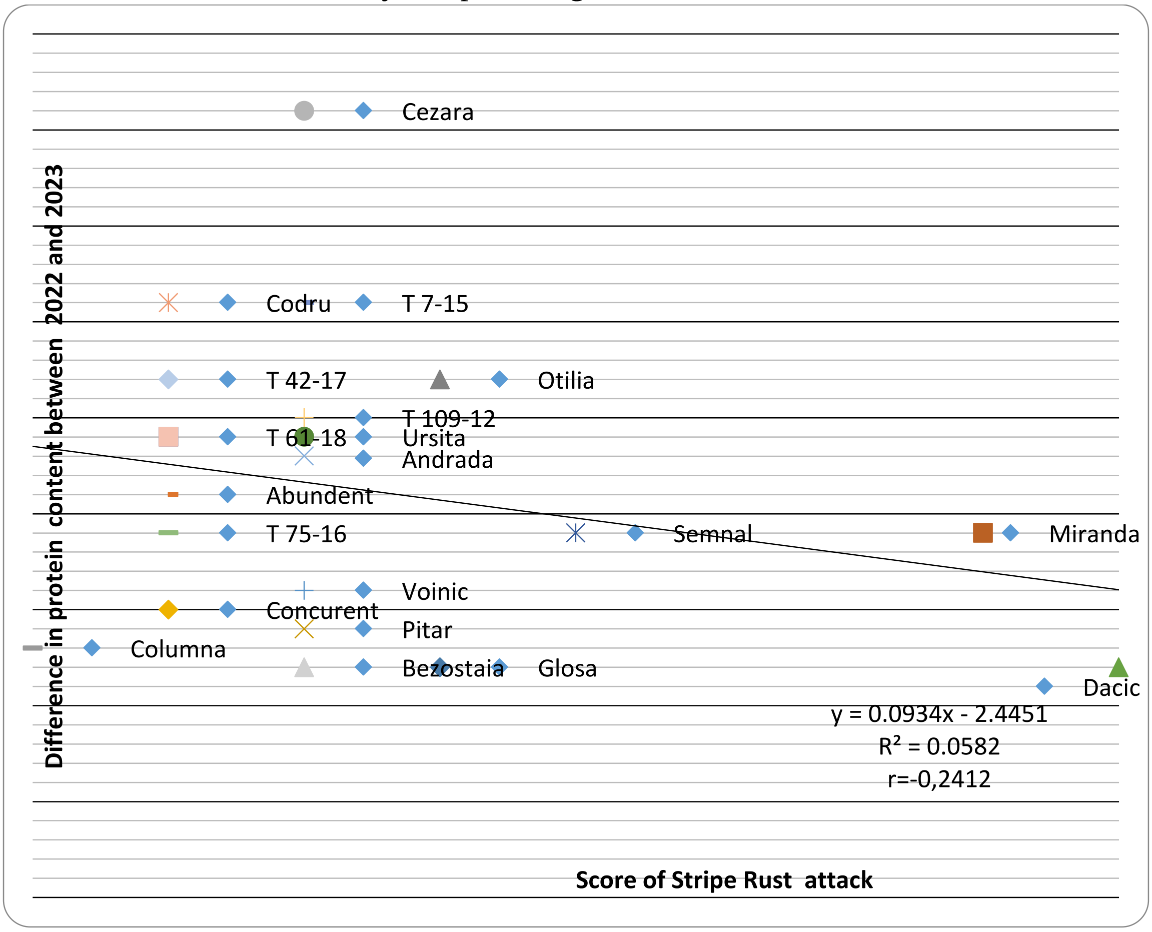

Figure 6. Correlation analysis between the difference in protein content 2022-2023 and the score of Stripe Rust attack// Analiza corelației între diferența la conținut de proteină 2022-2023 și nota de atac la Rugina Galbenă

CONCLUSIONS

1. The 2022-2023 agricultural year from a climatic point of view shows an increase in temperature and precipitation compared to 2021-2022, but these changes did not negatively influence the development of Stripe Rust, on the contrary, they favored the development of the degree of attack, which we believe that new and much more virulent races have emerged under conditions of global warming.
2. Based on the observations in 2022-2023 we can conclude that the newly appeared races are more virulent and the attack was stronger.
3. Production losses were higher at Miranda and Dacic varieties reaching 56% respectively 74%, and at triticale it was 99%.
4. For the moment, the only way to control the disease is to carry out at least two treatments with contact products in combination with systemic products.

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PRELIMINARY RESULTS REGARDING THE BIOLOGICAL POTENTIAL OF SOME COWPEA GENOTYPES STUDIED IN DIFFERENT CROPPING SYSTEMS UNDER CLIMATE CHANGE CONDITIONS IN SOUTHERN OLTENIA

REZULTATE PRELIMINARE PRIVIND POTENȚIALUL BIOLOGIC AL UNOR GENOTIPURI DE FASOLIȚĂ STUDIATE ÎN DIFERITE SISTEME DE CULTURĂ ÎN CONDIȚIILE SCHIMBĂRILOR CLIMATICE DIN SUDUL OLTENIEI

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ABSTRACT

The research focused on the behavior of four varieties of cowpea (Vigna unguiculata L. Walpers), genotypes cultivated in different cropping systems under the conditions of the sandy soils in the south of Oltenia. The results showed that for the formation of pods (>85% mature green pods), the tested cowpea varieties needed a temperature of 937,1-1161.92 ^{0}C in the main crop, of 1115.4-1172.2 ^{0}C in successive crop after early potato and of 1118.1-1233.5 ^{0}C in successive crop after rye. The vegetation period for the cowpea to reach the physiological maturity of the pods (>85% pods with ripened grains), was differentiated according to the variety and the culture system, being between 81-88 days, in the main culture system, when accumulated in the air 1509.8-1931.4 ^{0}C and 93-100 days in the successive crop system after the early potato, when they accumulated in the air 2171.7-2269.4 ^{0}C. The statistical analysis of the grain production recorded in the four cowpea varieties shows that by sowing in the main crop they did not significantly differences from the average, instead in the successive crop after the early potato, the genotypes Aura 26 and Doljana differed distinctly significantly and significantly relative to their mean. By sowing in the successional crop after rye, (end of July), none of the cowpea varieties tested reached the physiological maturity of the pods to obtain grain yield.

Keywords: Vigna unguiculata, phenology, thermal resources, leaf index, grain production

REZUMAT

Cercetările au vizat comportarea a patru soiuri de fasoliță (Vigna unguiculata L. Walpers*) cultivate în diferite sisteme de cultură în condițiile solurilor nisipoase din sudul Olteniei. Rezultatele obținute au evidențiat că pentru formarea păstăilor (>85% păstăi verzi mature) soiurile de fasoliță testate au avut nevoie de un necesar de 937,1-1161,92 ^{0}C, în cultură principală, de 1115,4-1172,2 ^{0}C, în cultură succesivă după cartof timpuriu și de 1118,1-1233,5 ^{0}C, în cultură succesivă după secară. Perioada de vegetație pentru ca fasolița să ajungă la maturitate fiziologică a păstăilor (>85% păstăi cu boabe maturate) a fost diferențiată în funcție de soi și de sistemul de cultură, fiind cuprinsă între 81- 88 zile la sistemul de cultură principală, când s-au acumulat în aer 1509,8-1931,4 ^{0}C și 93-100 zile în cadrul sistemului de cultură succesivă după cartoful timpuriu, când s-au acumulat în aer 2171,7-2269,4 ^{0}C. Analiza statistică a producției de boabe înregistrată la cele patru soiuri de fasoliță arată ca prin semănatul în cultură principală acestea nu s-au diferențiat semnificativ față de medie, in schimb in cultură succesivă după cartoful timpuriu, genotipurile Aura 26 și Doljana s-au diferențiat distict semnificativ și semnificativ față de media lor. Prin semănatul în cultură succesivă după secară, (sfârșitul lunii iulie,) niciunul din soiurile de fasoliță expeimentate nu au ajuns la maturitatea fiziologică a păstăilor pentru a obține producție de boabe.*

Cuvinte cheie: Vigna unguiculata, fenologie, resurse termice, index foliar, producție boabe

INTRODUCTION

Originally from Central Africa, the cowpea (*Vigna unguiculata* L. Walpers) is considered a key crop in the effort to achieve food security, being a plant with increased tolerance to drought, adapted to warm climates and sandy soils in semi-arid climate zones, becoming a culture suitable for a climate change scenario (Dadson, 2005; Gerrano et al., 2015; Draghici et al., 2023). Having a deep root system, a waxy layer on the leaves and a good strategy to avoid dehydration of the leaf apparatus by closing the stomata, the cowpea can capitalize on drought conditions with good results (Oumarou et al., 2015). However, prolonged water stress negatively affects cowpea plant growth and development due to reduced stomatal diffusion resistance and increased transpiration rate (Iwuagwu et al. 2017; Saba et al. 2024). In these conditions, stomatal closure, as a water conservation strategy in the plant, positively influences the growth of the species in drought conditions (Gomes et al., 2020; Nunes et al., 2022; Omolayo et al., 2023; Hamidou et al., 2007). A study conducted in Nigeria pointed out that there is a negative correlation between precipitation, relative humidity and cowpea yield and a positive correlation between temperature and cowpea yield (Ibrahim et al., 2021). Having a high protein content, both in the plant and in the cowpea, the bean can be successfully used in human nutrition in the form of green pods or grains (Celac, 2018; Leticia de Aguila Moreno et al., 2022), in improving fertility of the soil, by cultivating the plant in intercropping on sands and sandy soils, or by incorporating it into the soil as a green manure (Ion, 1981), as well as in animal nutrition, by its participation together with sorghum or rye in the constitution of dry and silage fodder (Ajeigbe and colab., 2010; Ciurescu et al., 2022). The protein deficit in less developed areas, as a result of the rapid growth of the human population and the demand for animal protein, results in the use of legumes, including cowpea, as a source of protein in traditional grain-based diets. The cowpea seeds, leaves (fresh and dry) and green pods provide a high level of protein, carbohydrates, lipids, vitamins, dietary fiber, minerals, polyunsaturated fatty acids and other nutrients (Belete & Mulugeta, 2022,). From the point of view of quality, the cowpea is rich in protein and starch, components valued by many authors as being in greater quantities than in the bean obtained under the same conditions (Caresma et al., 2022). The quality of the grains emphasizes a content in protein of 22.9-28.8%, in starch of 47.5-56.5%, in fat of 1.5-1.7% and in cellulose of 2.8-5, 2%, which recommends it, depending on the genotype, in human and animal nutrition (Boukar et al., 2011; Karuwal et al., 2021). Results obtained with the cowpea crop used as a green fertilizer incorporated into the soil, highlighted the positive effect of the plant on the physico-chemical properties of the sandy soil, thus contributing to increasing the content of organic matter and nutrient chemical elements and enriching the microbial flora of the soil (Zăvoi, 1967; Ion, 1988; Draghici et al., 2022). It was revealed that over a period of three years, in the 0-20 cm soil layer, the bean contributed to an organic carbon accumulation of 0.34%, compared to the control, where 0.009% organic carbon was accumulated. The improvement of soil properties by the use of cowpea as a green manure in the successive crop implicitly led to the achievement of very good yields in the wheat and rye crops sown the following year. Encouraging environmentally friendly agricultural practices, including traditional agricultural practices and reducing the use of mechanized machinery, the application of chemical fertilizers and organic fertilizers, contributes to the reduction of greenhouse gas and ammonia emissions from agriculture (Plan-National-Strategic-PAC -2023-2027_v1.2.pdf (madr.ro). In this sense, the expansion of leguminous plants, including the cowpea, which has a high capacity to fix atmospheric nitrogen in the soil, contributes to achieving the objectives of maintaining a reduced level of greenhouse gas concentrations in the atmosphere (Eliade et al., 1975; Souza et al., 2021; Omolayo et al., 2021). Considering the evolution of climate changes in the last period with the registration of an average annual temperature of 12.93 ^{0}C and a positive deviation of 1.2 ^{0}C from the multi-year average, associated with the registration of an amount of precipitation insufficient for plant consumption, solutions should be found optimal utilization of the microclimate in the soil area for as long a period of time as possible. In this sense, a study was initiated regarding the cultivation of some varieties of cowpeas in different cropping systems (main and successive) in order to promote a system of sustainable agriculture and to maintain the land covered with vegetal carpet for a longer time in the area of sandy soils in the south Oltenia.

MATERIAL AND METHOD

The research was carried out in 2023 at the Dabuleni Research Development Station for Plant Culture on Sands on the cowpea culture studied within a bifactorial experience placed in the field according to the method of parcels subdivided with 2 factors.
The study factors were:

A. A. The culture system

a_1- Main crop
a_2- Successive crop after early potato
a_3- Successive crop after rye

B. Genotype

b_1-*Aura 26*
b_2-*Doljana*
b_3-*Ofelia*
b_4-*China T3*

The study was carried out in the conditions of a sandy soil poorly supplied in organic matter (organic carbon=0.35%-0.64%) and in total nitrogen (Nt=0.02-0.04%), well supplied in extractable phosphorus (53.25-70.9 ppm), low to medium supply of exchangeable potassium (52.4-91.2 ppm) and a soil pH that oscillated between 6.57 and 7.1, values showing a moderate reaction acid to neutral. During the vegetation period, observations were made regarding the development of the phenophases of vegetation, determinations of physiology, biometrics and productivity of the cowpea plant. During the flowering phase of the plant, the leaf surface was determined, with the help of the *Area Metter 300* device. The results were calculated and analyzed by the method of analysis of variance (ANOVA) and with the help of mathematical functions.

RESULTS AND DISCUSSION

Analyzing the climatic conditions recorded during the vegetation period of cowpea sown in different crop systems (Table 1), it was highlighted in the May-August period (main crop), the accentuation of the drought phenomenon, by increasing the air temperature by 1.07 ^{0}C and recording an amount of precipitation of 258.9 mm, insufficient for the normal growth and development of the plant, being necessary to carry on the irrigation work, which was achieved by applying 3 waterings with a rate of 250 m^3 water/ha. Despite its ability to thrive in high temperature environments, cowpea productivity can be hampered by heat stress, especially when the night air temperature exceeds 17 °C (Saba et al., 2024).

Table 1. Climatic conditions recorded at the weather station* of SCDCPN Dăbuleni during the cowpea growing season, 2023/ Condițiile climatice înregistrate la stația meteo* a SCDCPN Dăbuleni în timpul sezonului de creștere a fasoliței, 2023

The climatic element	*April*	*May*	*June*	*July*	*August*	*September*	*October*	*May – August*	*July-September*	*August-October*
Average temperature (^{0}C)	11.1	16.8	21.2	25.4	25.4	21.2	14.9	22.20	24.00	20.50
Absolute Maximum (^{0}C)	23.5	29	37.6	42	41.6	36.5	33.3	42.00	42.00	41.60
Absolute Minimum (^{0}C)	0	7.4	11.4	10.2	10.6	9	-0.8	7.40	9.00	-0.80
Rainfall amount (mm)	57.8	81.6	81.4	73.6	22.3	46.8	8.2	258.90	142.70	77.30
Number of days with rain	12	16	13	9	7	3	3	45.00	19.00	13.00
Relative air humidity (%)	67.1	66.9	70.6	61.6	55	58.5	63.7	63.53	58.37	59.07
Multiannual mean temperature (1956-2023) (^{0}C)	11.868	16.947	21.544	23.321	22.700	18	11.56	21.13	21.34	17.42
Multiannual rainfall (1956-2023) (mm)	47.129	62.672	70.008	54.288	36.547	44.95	43	223.52	135.79	124.50
Deviation of the 2023 average temperature from the multiannual average temperature (^{0}C)	***-0.768***	***-0.147***	***-0.344***	***2.079***	***2.7***	***3.2***	***3.34***	**1.07**	**2.66**	**3.08**
Deviation of the 2023 rainfall amount compared to multiannual rainfall	***10.671***	***18.928***	***11.392***	***19.312***	***-14.247***	***1.85***	***-34.8***	**35.39**	**6.91**	**-47.20**

**)AgroExpert from Adcon Telemetry SRL Romania*

The climatic parameters recorded in Dabuleni, namely the air temperature regime and that of precipitation, in interaction with low values of relative air humidity in the range of 55-70.6%, with an average of 63.53%, generated an arid microclimate in area of sandy soils. In these conditions, the cowpea is an alternative to soybean and bean crops for areas with sandy soils, in order to promote sustainable agriculture by including it, along with sorghum and rye, in the crop rotations specific to the area. The specialized literature mentions that as the cowpea is cultivated in an area as similar as possible to the one of origin, the plant develops a larger leaf surface (Dadson et al., 2005; Kamara et al., 2018). Climatic conditions recorded during July-September (average temperature=24.00 ^{0}C; precipitation=142 mm; relative air humidity=58.37%) and August-October (average temperature=20.5 ^{0}C; precipitation=77.3 mm; relative air humidity=59.07%) were favorable for the cultivation of cowpea and in the successive crop with the destination for the production of green pods and even for the production of grains, if it is sown at the beginning of July, in the successive crop after the early potato.

Observations and determinations regarding plant emergence (Table 2), highlighted a good uniformity of the four cowpea genotypes sown in different cropping systems (main and successive after early potato or rye). With the exception of some plants that showed symptoms of attack specific to infection with the *Cowpea Mosaic Virus* and *Cowpea Yellow Mosaic Virus* and some plants that showed a few isolated spots on the leaves, specific to the attack of the pathogen *Colletotrichum lindemuthianum*, which produces cowpea anthracnose, cowpea cultivars tested in different culture systems showed good behavior to natural infection with pathogens, both in the phase of 3-4 true leaves and in the flowering phase. The resistance to pathogen infection, scored according to the FAO scale (Notes 1-9), was between 1.17-1.67, in the phase of 3-4 true leaves and 1-1.42, in the flowering phase, with the best behavior when the cowpea was grown in succession after rye. Among the cowpea genotypes tested, *Aura 26* showed the best resistance (Notes 1.11-1.22).

Table 2. Observations on emergence and resistance to natural infection with pathogens in some cowpea genotypes grown in different cropping systems// Observații privind apariția și rezistența la infecții naturale cu agenți patogeni în unele genotipuri de fasoliță cultivate în diferite sisteme de recoltare

Cowpea genotype	Main crop Sown: May 16, 2023			Successive culture after early potato Sown: 04 July 2023			Successive culture after rye Sown: July 28, 2023			Average resistance of the genotype to pathogen infection	
	Uniformity emergence (Notes 1-9)	Resistance to pathogens (Notes 1-9)		Uniformity emergence (Notes 1-9)	Resistance to pathogens (Notes 1-9)		Uniformity emergence (Notes 1-9)	Resistance to pathogens (Notes 1-9)		3-4 true leaves	Flowering
		3-4 true leaves	flowering		3-4 true leaves	flowering		3-4 true leaves	flowering		
Aura 26	1	1.66	1.33	1	1	1	1	1	1	1.22	1.11
Ofelia	1	2.00	2.00	1	1.66	1.33	1	1.33	1	1.66	1.44
Doljana	1	2.00	1.33	1	1	1	1	1	1	1.33	1.11
China T3	1	1.00	1.00	1	2	2.00	1	1.33	1	1.44	1.33
Average	1.00	1.67	1.42	1.00	1.42	1.33	1.00	1.17	1.00	1.42	1.25

Analyzing the evolution of the vegetation phenophases in the four cowpea genotypes studied in different cropping systems (Table 3), we notice that the emergence of the plants was recorded at 7-8 days after sowing, when the cowpea was grown in the main crop, after 4-5 days from sowing, when the cowpea was sown in succession after early potato and at 6-7 days from sowing in succession after rye. Under the conditions of 2023, the phenophase of the formation of green pods in cowpea was recorded in all three cropping systems, and the phenophase of physiological maturity of the cowpea in the pod was recorded only in the main cropping system and the successive cropping system after the early potato.

The graphical representation of thermal resources and the number of days covered by the four cowpea genotypes sown in different cropping systems shows a shortening of the vegetation period from 49.5 days, the average of the period recorded by sowing in the main crop, to 44.25 -47.75 days, by sowing them in successive culture (Figure 1). For the formation of green pods, a phase that coincides with the maximum development of the leaf apparatus, the cowpea genotypes needed thermal resources of 937.1-1161.92 ^{0}C, in the main crop, 1115.4-1172.2 ^{0}C , in successive crop after early potato and of 1118.1-1233.5 ^{0}C, in successive crop after rye.

Table 3. Development of vegetation phenophases in cowpea genotypes studied in main and successive crop// Dezvoltarea fenofazelor vegetative în genotipurile de fasoliță studiate în cultura principală și succesivă

The experimental variant		**Calendar date**							
The culture system	**Cowpea genotype**	**Sowing**	**Emergence**	**3-4 true leaves**	**Shoot emergence**	**Flowering (85%)**	**>85% mature green pods**	**Beginning of ripening dry pods**	**>85% mature dry pods**
Main crop	*Aura 26*	May 16	May 23	June 8	June 19	July 8	July 12	July 30	August 12
	Ofelia	May 16	May 23	June 7	June 17	July 11	July 16	July 30	August 14
	Doljana	May 16	May 24	June 9	June 18	July 8	July 14	August 1	August 12
	China T3	May 16	May 24	June 11	June 20	July 1	July 6	July 16	July 28
Successive crop after early potato	*Aura 26*	July 4	July 9	July 24	July 26	August 17	August 22	September 4	October 9
	Ofelia	July 4	July 8	July 23	July 26	August 18	August 22	September 1	October 12
	Doljana	July 4	July 9	July 24	July 28	August 17	August 23	September 9	October 10
	China T3	July 4	July 9	July 26	July 31	August 19	August 21	September 11	October 16
Successive crop after rye	*Aura 26*	July 28	August 3	August 22	August 28	Sept. 14	September 19	No mature pods were recorded until 20 October	
	Ofelia	July 28	August 4	August 20	August 25	Sept.15	September 20		
	Doljana	July 28	August 3	August 23	August 30	Sept. 17	September 23		
	China T3	July 28	August 4	August 22	August 29	Sept. 13	September 19		

The specialized literature mentions that from germination to the end of the vegetation period, all vital processes of the cowpea plant take place in high temperature conditions, over 10 ^{0}C (Boukar et al., 2011; Sinclair et al., 2015), conditions that were recorded this year in the southern area of Oltenia. Observations on the physiological maturity of cowpea pods for grain yield, highlighted the recording of this phenophase only when sowing in the main crop and in the successive crop after the early potato. Thus, in the main culture system the ripening of the grains in the pod in a percentage of >85% was recorded after 81-88 days, when 1509.8-1931.4 ^{0}C were accumulated in the air, and in the successive culture system after early potato, the ripening of the grains was recorded after 93-100 days from emergence, when 2171.7-2269.4 ^{0}C accumulated in the air.

Regardless of water availability, temperature is the most limiting climate elemeny for cow pea production (Alves Barros et al., 2023). The results obtained by Ibrahim et al., (2021) show that all climatic parameters namely temperature, rainfall and relative humidity contribute 61% to the development of morphological and physiological processes in cowpea crop and recommend that cowpea farmers in Gombe State, Nigeria to adopt new measures such as early planting, use of resistant varieties, crop rotation for water conservation and supplementary irrigation to cope with the adverse effects of climate change. Considering the increasing drought around the globe, the cowpea can be considered a suitable crop for a climate change scenario, representing a solution in maintaining food security in terms of vegetable protein (Nunes et al., 2022).

The intraspecific competition between plants, which takes place during the development of the leaf system and the root system of the cowpea plant, shows that the greater increases in energy biomass are achieved as the plant is grown in an area as similar as possible to that of origin (Ajeigbe et al., 2010; Ishiyaku & Aliyu, 2013). The results obtained regarding the biometry and productivity of the fenugreek plant showed differentiated values depending on the genotype and the culture system (Table 4).

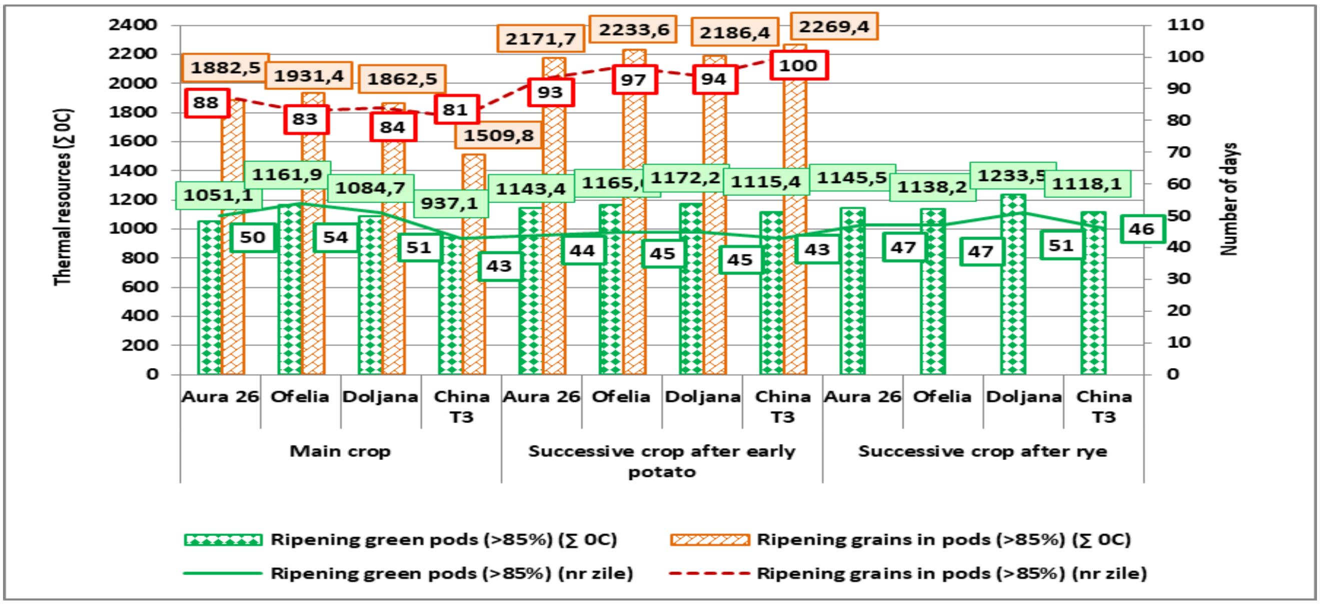

Figure 1. The thermal resources needed by the cowpea genotypes tested in different cropping systems // Resursele termice necesare genotipurilor de fasoliță testate în diferite sisteme de recoltare

Table 4. Biometry and plant productivity determinations in some cowpea genotypes grown in different cropping system// Determinări ale biometriei și productivității plantelor în unele genotipuri de fasoliță cultivate în diferite sisteme de recoltare

Experience Factors		Plant Height (cm)	No. pods / plant	[1]LAI	Biomass production (t/ha)	Statistical Analysis of Grain Yield		
						Grain Yield (Kg/ha)	Difference (kg/ha) / Significance to the control	
A.The culture system	B. Cowpea genotype						AxB	A
A1. Main crop	b1. *Aura 26*	70	14.4	6.4	29.92	2341.3	118	a1=2223.3
	b2. *Ofelia*	81.2	12.4	*6.9*	33.44	2166.7	-56.6	
	b3. *Doljana*	87.4	14.2	7.2	30.36	2043.7	-179.6	
	b4. *China T3*	39	14.8	6.3	52.8	2341.3	118	
	Average of A1xB factors	69.4	13.95	6.7	36.63	2223.3	Control	Control
A2. Successive crop after early potato	b1. *Aura 26*	49.6	13.2	5.4	33.25	2065.9	439.1**	a2=1626.8
	b2. *Ofelia*	44.8	13.6	6.7	39.5	1661.1	34.3	
	b3. *Doljana*	53.2	11	6.1	31	1930.2	303.4*	
	b4. *China T3*	38.2	10	6.3	47.5	850.0	-776.8^{000}	
	Average of A2xB factors	46.45	11.95	6.13	37.81	1626.8	Control	-596.5^{0}
A3. Successive crop after rye	b1. *Aura 26*	55.6	18.4	8.9	65	Grain Yield=0 kg The ripening phenophase of the grains in the pod was not recorded		
	b2. *Ofelia*	68.8	20	8.8	66.25			
	b3. *Doljana*	57.2	15.8	8.1	41			
	b4. *China T3*	48	12.4	6.7	52.75			
	Average of A3xB factors	57.4	16.65	8.13	56.25			
[1] Leaf area index						LSD 5%	276.8	522.1
						LSD 1%	388.6	1205.7
						LSD 0.1%	548.6	3836.9

Regarding the influence of the culture system on the development of the cowpea plant, the highest vegetative growths were recorded when cowpea were sown in the main crop in the 2-nd decade of May (69.4 cm) and the lowest growth when the cowpea was sown in the crop successive after the early potato, at the beginning of July (46.45 cm). From the point of view of the fruiting of the plant, the sowing of cowpea in succession after rye (16.65 pods/plant) was separated with the largest number of pods, pods which, however, did not reach the ripeness of consuming grains, followed by sowing in the crop main. The leaf area index (LAI), calculated as a function of the area of a leaf, the number of leaves per plant and the number of plants per square meter, had values between 6.13-8.13, with a maximum when sowing cowpea in succession after rye, the biomass production obtained being 56.25 t/ha. Under the aspect of the interaction of the studied factors on the obtained production results, the largest amount of biomass was recorded for the *Ofelia* cowpea genotype, sown in successive crop after rye (66.25 t/ha). Grain yield recorded a maximum of 2341.3 kg/ha for *Aura 26* and *China T3* genotypes, sown in the main crop. In our experiment, the cowpea reached the physiological maturity for dry grain consumption only by sowing in the main crop and in the successive crop after the early potato. The statistical analysis of the grain yield recorded in the four cowpea varieties shows that by sowing in the main crop, they did not differ significantly from the average, instead when they were sown in successive crop after the early potato, the genotypes *Aura 26* and *Doljana* they differed significantly and significantly against the average of the varieties. None of the four cowpea genotypes reached physiological maturity for grain yield they were sown in succession after rye (late July), and under these conditions it is recommended that the biomass be incorporated as a green manure in the soil for improving the physico-chemical properties of sandy soils.

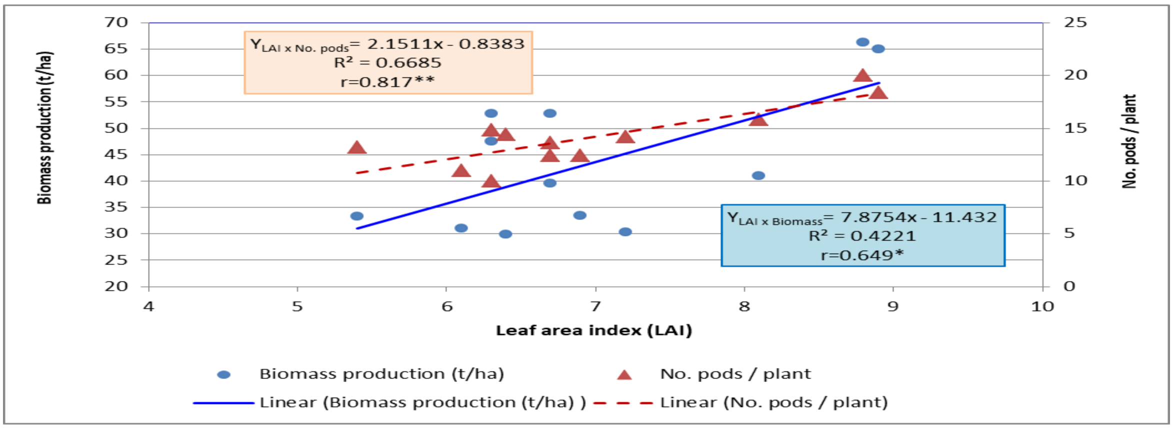

Figure 2. Correlations between leaf area index and biomass production and pod number recorded in cowpea crop// Corelațiile dintre indicele suprafeței frunzelor și producția de biomasă și numărul de păstăi înregistrate în cultura de fasoliță

The analysis of the functional link between the leaf surface and the fruiting development of the plant in the four varieties of cowpea studied in 3 culture systems (Figure 2), revealed significant positive correlations between the leaf index and the amount of biomass (r=0.649*) and distinctly significant between the value of the leaf index and the number of pods (r=0.817**).

CONCLUZII

1. The cowpea capitalizes with good results on the pedoclimatic conditions in the area of sandy soils in the south of Oltenia.
2. Thermal requirement from emergence to the formation of green cowpea pods, the phenophase that coincides with the maximum development of the leaf apparatus, was 937.1-1161.92 ^{0}C, in the main crop, 1115.4-1172.2 ^{0}C, in successive culture after the early potato crop and of 1118.1-1233.5 ^{0}C, in successive culture after the rye crop.
3. The largest amount of biomass was achieved by the *Ofelia* cowpea variety, sown in successive crop after rye (66.25 t/ha), which registered a leaf index equal to 8.8.
4. The vegetation period, for the cowpea to reach maturity for grain yield, was differentiated according to genotype and cropping system, being between 81-88 days in the main cropping system, when they accumulated in air 1509.8-1931.4 ^{0}C and 93-100 days in the successive crop system after the early potato, when 2171.7-2269.4 ^{0}C were accumulated in the air.
5. The highest grain yield, of 2341.3 kg/ha, was recorded in the genotypes *Aura 26* and *China T3* sown in the main crop.

6. None of the four cowpea genotypes, sown in succession after harvesting the rye plant, has not reached the physiological maturity of pods for grain yield.

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ACTUAL PROBLEMS FOR SOIL SCIENCES IN ROMANIA

PROBLEME ACTUALE PENTRU ŞTIINŢELE SOLULUI ÎN ROMÂNIA

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ABSTRACT

The paper presents a synthesis of the current problems faced by soil sciences in Romania. The importance of soil for the maintenance of life on the planet is firstly presented. Then, some concerns of the European Commission for soil protection at the European level, which in future will be considered at the national level are presented: the passport for excavated soil; limiting land occupation and soil sealing; consumption of fertilizers; soil biodiversity protection; soil health; the relationship between soil and healthy waters; the role of soil in mitigating climate change; the soil and the circular economy; organic farming. These are only some of the problems that soil science community must solve in the shortest possible time.

Keywords: soil, fertilizer consumption, biodiversity, circular economy, ecological agriculture

REZUMAT

Lucrarea prezintă o sinteză a problemelor actuale cu care se confruntă științele solului în România. Importanța solului pentru menținerea vieții pe planetă este prezentată în primul rând. Apoi, sunt prezentate unele preocupări ale Comisiei Europene privind protecția solului la nivel european, care în viitor vor fi luate în considerare la nivel național: pașaportul pentru sol excavat; limitarea ocupației terenurilor și a impermeabilizării solului; consumul de îngrășăminte; protecția biodiversității solului; sănătatea solului; relația dintre sol și apele sănătoase; rolul solului în atenuarea schimbărilor climatice; solul și economia circulară; agricultura ecologică. Acestea sunt doar câteva dintre problemele pe care comunitatea științei solului trebuie să le rezolve în cel mai scurt timp posibil.

Cuvinte cheie: sol, consum de fertilizanți, biodiversitate, economie circular, agricultură ecologică

INTRODUCTION

Soil, an essential environmental factor, the main means of production in agriculture and forestry, is defined as a three-dimensional natural body, with a thickness of up to 2-3 m of relatively loose material, made up of mineral, organic compounds and living organisms, permanently in interaction. It is compared to human skin, being highlighted its essential role in sustaining life on the planet.

The soil can be considered as a living organism, it is a permanent source of life, being capable to some extent of self-regeneration. Water, air, organic and inorganic matter - living or dead - all make the soil a factory in which complex transformation processes from mineral to organic matter are produced continuously.

The soil can be considered a link between the inorganic and the organic life, any dysfunction in the normal functioning of the soil having serious repercussions on all living organisms (Oprea and Lupei, 1975).

The soil ensures the production of biomass necessary to support life. It has a high capacity for filtering, buffering and transformation, which compares it to a "giant sewage treatment plant". It is the spatial basis for technical, industrial and socio-economic structures ensuring the development of society, it works as a biological habitat and gene reserve, insufficiently known and exploited, but essential for the protection of life and biodiversity. It also serves as a source of geogenic energy, raw materials and water and houses archaeological and paleontological vestiges.

The soil is considered as one of the most complex natural systems on the surface of the lithosphere, structured, open, polyphasic and with many components, including living entities, multifunctional, self-organizing, capable of continuous substances exchange and energy with the surrounding environment, with an important role in the circuit of substances in nature. Containing living organisms, it not only makes the connection between the inorganic and the living organic world but also has attributes of biological systems conferred on the soil by the living organisms by virtue of the global properties of the systems. Numerous soil constituents (mineral and organic solids, water, air, living organisms) are spatially organized in the soil layer both vertically and horizontally. The vertical organization of a soil can be seen in a section in the soil cover, a section that reveals the sequence of soil (pedogenetic) horizons, known as a soil profile. It reflects the internal organization of the soil which is correlated with the set of environmental conditions and its evolution over time.

Soil forms very slowly, over centuries or millennia, inheriting many of the rocks properties on which it develops. There is no life without soil, but no soil without life, they evolved together. The soil is integrated into the continental geosystems, as it results from the position on which the soil is placed in the zone of interference between the different geospheres. Through this interface position, soil mediates the transfer of substance and energy between the atmosphere, lithosphere and hydrosphere, and particularly between the biosphere and the other abiotic spheres, performing complex functions.

However, even today we do not have a Soil Directive, despite all the efforts made by specialists over the last 20 years, probably because soil has mainly local or regional properties, appears stable and inert at first sight and has a very large resilient capacity.

Only in recent years, concerns on soil protection have begun to appear at European level. We will list some of the concerns of the European Commission in the area, in order to understand our tasks in the future.

PASSPORT FOR EXCAVATED EARTH

A look at a landscape shows that even on small areas a wide variety of soils can be found, depending on the factors that led to their formation: local climate, rock, relief, altitude, exposure, slope, type of vegetation, hydrology, the time period in which the soil was formed and the human influence. Although it has the capacity of self-regeneration, the specific formation conditions make that once destroyed, the soil cannot be restored as it was, because the conditions and the millennial history of its formation cannot be reproduced. At most one body with analog functions can be created. Its creation on the land surface through complex processes of disaggregation, alteration, accumulation, transport, deposition, synthesis and decomposition, makes the soil limited in extent, and once destroyed we permanently lose the respective surface and its specific functions strictly necessary for the protection of the quality of the environment, development of sustainable agriculture and forestry and protection against unwanted climate change.

Considering the soil genesis and evolution, its particular importance, especially of the humus horizon, the European Union recommended in 2021 to protect the fertile horizon, and in the case of land use for construction, mining etc., the humus horizon should be excavated and receive a "passport for the excavated land", in order to follow the way of its protection and exploitation. "This passport should reflect the quantity and quality of excavated soil to ensure that it is transported, treated and reused safely elsewhere (EC EU Soil Strategy 2030)".

LIMITATION OF LAND TAKE AND SOIL SEALING

The soil is a support and living environment for higher plants, and its horizon with humus is the main depository of the living substance of the land and of the potential biotic energy captured through photosynthesis, as well as of the most important vital elements (carbon, nitrogen, calcium, phosphorus, potassium, sulphur, iron, zinc, copper etc.). It is a depository and supplier of nutrients and water on the one hand and a container and transformer of residues and waste on the other, thus having the role of the ecosystem regulator and purifier of the environment. Far from being stable and inert as it seems at first sight, the soil is, on the contrary, a complex, constantly changing environment, subject to its own laws, on the basis of which its genesis, evolution and destruction take place. Being a complex environment that is always changing, it can be very easily affected and even destroyed, either by natural causes or, in a much faster manner, by irrational human interventions.

In order to reduce the pressure of land take for construction and infrastructure, the European Community recommended to apply a "territorial planning hierarchy" and to establish by each member state its "own ambitious national, regional and local objectives for reducing the net land take until 2030 in order to have a quantifiable contribution to the EU's 2050 target and to report on progress". It also requires each member state to “integrate the land use hierarchy into urban greening plans and prioritize the reuse and recycling of qualitative urban land and soils at national, regional and local levels through appropriate regulatory initiatives. The objectives are to reduce land take to zero (EC EU Soil Strategy for 2030)".

FERTILIZER CONSUMPTION

Soil has often been looked, mainly due to its fertility, especially its ability to support plant life, only as the main means of production in agriculture, thus recognizing that the existence and development of human society will also be conditioned in the future by the abundance and quality of plants, which must provide people with food and raw materials for clothing, shelter, medicine and other requirements. Soil differs from other production means by the fact that through rational use it does not depreciate over time, but on the contrary, it can even increase its fertility, its production capacity acquiring new, high qualities, unknown under normal conditions. But, as a production means, it cannot be moved from one place to another, nor multiplied according to the needs, as it happens with the other production means. Furthermore, only on soil can successive investments be made without canceling out the previous investments with the new ones.

The progress of agricultural science and technology led to the appearance of a cultural fertility that overlapped on the natural one. Rational human intervention on the soil increases its productive capacity, but there are also cases when inappropriate intervention leads to a decrease in fertility (Blaga et al., 2005).

Despite the high productivity achieved through fertilization, irrigation, seed ammelioration, erosion and excess water control, mechanization etc., more than one billion people, which means one from seven, are affected by "food insecurity", and their number increases by more than 7.5 million every year. Every year more than 300 million people die due to lack of food. At the same time humanity is fighting with another scourge, obesity, which affects a similar number of people.

It is estimated that fertilization contributed worldwide to the increase of agricultural production by about 40%. In the last time we face with a decrease in the growth rate of fertilizer consumption. Forecasts show that in the future the soils productivity will decrease while the population will continue to grow, leading to increased food deficit. As the food supply decreases, we face with an unprecedented battle for land exceeding the national borders everywhere. "Earth is fast becoming the new gold and right now the rush is on". The most active countries in buying or renting agricultural land abroad include Saudi Arabia, South Korea, China, India, Egypt, Libya, Bahrain, Qatar and the United Arab Emirates (Brown, 2011).

In Romania, it has never been used sufficient organic and mineral fertilizers, because a "mining" agriculture was applied (we extract more nutrients from the soil than we apply).

Analyzing the situation for the period 2012-2019, it was found that in Romanian agriculture, an average of 39 kg N/ha, 13 kg P/ha, 5 kg K/ha and 1543 kg/ha of manure were used. The balance for the same period shows a continuous impoverishment of the soil, on average per hectare with -45 kg of nitrogen, -26.01 kg of phosphorus and -57.83 kg of potassium.

In contrast to Romania, in France, on average, the same doses of nitrogen and phosphorus were found but in addition, not in minus.

Since 2000, the OECD has come to the conclusion that "there is a negative balance in Romanian agriculture, a phenomenon that leads to an irrational use of soil resources and the impossibility of a sustainable soil use".

At this stage the European Commission recommends to reduce the consumption of nutrients from chemical fertilizers by 20% and to reduce nutrient losses by 50%. If there are some recommendations for reducing nutrient losses and it will be a difficult process to apply, we draw attention to the fact that we have not found any solution for reducing the fertilizers consumption together the nutrient deficit in the soil, especially considering that "this objective will become mandatory from legal point of view".

A better use of nutrients from manure is not a solution, due to the small number of animals in Romania. With all the manure produced, we could fertilize 483 thousand hectares, which are usually lands located near animal farms and cultivated with vegetables and fruit trees. All the experiences organized with manure up to now have shown that the application of manure alone in a maximum dose of 170 kg/ha does not ensure sufficient productions if they are not also accompanied by mineral fertilization.

When we are talking about organic fertilization we have to consider the small number of animals compared to other European countries (see table 1). It is very difficult to apply unitary environmental policies in agriculture in these extremely different conditions which our country is faced to, without taking into account the situation in each country.

Table 1. Animal number - EU, 2020// Numărul de animale - UE, 2020

Country position at EU level	Country	Animal number (thousand heads)	Density at 100 ha land (heads)
		Cattle	
19	**Romania**	1910,9	15,1
2	**Belgium**	2334,1	174,3
20	**Bulgary**	588,6	12,1
14	**Czech Republic**	1340,0	38,5
11	**Denmark**	1500,0	57,7
7	**Germany**	11301,9	68,6
3	**Ireland**	6529,4	144,4
18	**Greece**	539,0	13,7
14	**Spain**	6636,4	34,4
8	**France**	17591,3	63,2
15	**Croatia**	423,0	29,6
10	**Italy**	6400,0	59,8
15	**Lithuania**	629,5	21,4
17	**Hungary**	933,0	18,3
1	**Netherland**	3691,0	207,5
6	**Austria**	1855,4	71,8
12	**Poland**	6278,9	44,3
9	**Portugal**	1691,3	60,5
4	**Slovenia**	485,6	107,4
16	**Slovakia**	441,8	23,7
13	**Finland**	835,4	36,8
5	**Sweden**	1391,0	93,7
Total		75327,6	
		Swine	
17	**Romania**	3750,4	43,9
2	**Belgium**	6219,2	720,2
20	**Bulgary**	592,1	17,1
16	**Czech Republic**	1546,0	62,1
3	**Denmark**	13391,0	559,3
6	**Germany**	26069,9	222,6
4	**Ireland**	1678,6	380,0
18	**Greece**	743,0	40,9
5	**Spain**	32676,7	271,8
12	**France**	13872,0	76,2
9	**Croatia**	1035,0	125,8
10	**Italy**	8543,0	123,6
19	**Lithuania**	555,2	25,1
13	**Hungary**	2850,0	66,1
1	**Netherland**	11541,0	1141,4

Country position at EU level	Country	Animal number (thousand heads)	Density at 100 ha land (heads)
7	**Austria**	2806,5	211,7
11	**Poland**	11727,4	106,1
6	**Portugal**	2259,2	245,8
8	**Slovenia**	229,5	131,7
19	**Slovakia**	538,1	39,9
15	**Finland**	1103,9	49,2
14	**Sweden**	1383,2	54,5
Total		**145110,8**	
Sheep and goats			
2	**Romania**	12094,8	95,7
8	**Bulgary**	1561,6	32,1
7	**Germany**	1644,7	10,0
3	**Greece**	11828,0	299,6
1	**Spain**	18090,3	93,8
4	**France**	8696,0	31,3
11	**Croatia**	776,0	54,3
5	**Italy**	8099,9	75,7
14	**Lithuania**	155,3	5,3
10	**Hungary**	991,0	19,4
9	**Netherland**	1267,0	71,2
12	**Austria**	486,5	18,8
6	**Portugal**	2482,2	88,8
13	**Slovakia**	356,2	19,1
Total		**68529,4**	

The economic use of industrially produced fertilizers can only be ensured if the following aspects are respected (Borlan et al. 1994):

- Optimizing soil reaction by neutralizing harmful acidity and removing exchangeable sodium and soluble alkalinity from the plowed layer
- The reuse of nutrients and the complex physical, chemical and biological improvement of the soil by collection, preparation and integral application in soil of all organic (natural) fertilizers and plant residues which cannot be used in animal feed, as raw material in industry or as litter in animal shelters;
- Use of nitrogen left in the soil by leguminous crops;
- Physiologically optimizing the content of the nutrients in seed and planting material;
- Optimizing the physical status of the soil by loosening, drainage-irrigation, erosion control, structure improving etc.;
- The correct application and at the optimum time of the components from the plant cultivation technologies.

In order to reduce the losses in the environment, it necessary to increase the degree of applied fertilizers use in production. Among the measures that should be taken for this are:

- to establish the type and doses of the fertilizers by performing large-scale agrochemical studies at an interval of 4-5 years;
- to correlate the fertilizers doses with the soil nutrients content and plant’s needs;
- to take into account the climatic conditions, to increase the application precision, to choose the appropriate time and method of application;
- to improve continuously the equipment’s for administration and to correlate with other technological components, etc.

The main concern of soil scientists is to increase the soils productivity in order to maintain and enhance food quantity and its quality and to provide economically sustainable soil management techniques.

Unfortunately, in the last 30 years, large-scale agrochemical studies have not been carried out, the methodologies for carrying out these studies have not been renewed, and no specialists training sessions were organized. It was estimated, in our opinion wrongly, that the units that sell fertilizers will also provide the necessary agrochemical services. This led to superficiality, ignorance, fertilization efficiency decrease, narrowing the studies by referring only to reaction and NPK, ignoring microelements, reducing the type of fertilizers applied, etc. No more financial resources have been allocated for the amendments. Instead of progress, we assisted to a large-scale regression.

The European Union proposes "free soil testing", (EC EU Soil Strategy for 2030)" when presently, in Romania, the number of specialists, analysis capabilities and the range of analyzes have largely decreased.

PROTECTION OF SOIL BIODIVERSITY

Soil hosts more than 25% of all biodiversity on the planet (EC EU Soil Strategy 2030) and is at the base of the food chains that feed humans and above all the biodiversity. This fragile layer is expected to provide food and filter drinking water suitable for consumption, to be a continuously major source of genes and chemical resources, to improve atmospheric quality, to regulate ecosystem services, to increase soil resilience to diseases and pests, it will ensure the soil and the integration of various residues into environment (EC A Soil Deal for Europe, 2021).

The EU Biodiversity Strategy for 2030 shows that the adoption of sustainable soil management practices is essential in the efforts to protect soil fertility, reduce soil erosion and increase soil organic matter content (CE Soil Monitoring Law, 2023).

Soil biodiversity contributes greatly to human health. Antibiotics produced by soil microorganisms saved millions of lives. Many soil microorganisms fight against pollution because they are able to break down complex contaminants, performing a free bioremediation. The healthier and cleaner a soil is, the cleaner our water resources and the air are (EU 2030 Soil Strategy).

The biodiversity strategy includes the establishment of a wide network of protected areas on land and in the sea. About 30% of land and 30% of seas will be protected. The Nature Restoration Plan envisages the restoration of degraded ecosystems in Europe by 2030 and emphasizes the need for their sustainable management. The Commission's plans have taken a global leadership role and demonstrate their ability to improve biodiversity. The EU has set ambitious targets for biodiversity at the International Convention on Biological Diversity (The European Green Deal, 2020).

Unfortunately, in Romania, the teams that carry out soil science studies are no longer accompanied in the field by geobotanists, who would evaluate the biological diversity, the functionality of the ecosystems and be able to make recommendations for its protection. Despite all the importance for the environment and human health, for ensuring ecosystem services, studies on soil biodiversity are increasingly rare. We will have to train biodiversity specialists.

SOIL HEALTH

Until last years, the soil was treated only as a support for plant growth, forgetting that it is an environmental factor, it is the main means of production in agriculture and forestry, a very large resource of genes, an almost universal depollutant, a resource of water and raw materials, etc. Highlighting the special value of the 24 existing soil classes on the EU territory was neglected, and instead of being protected and conserved for future generations, it ended up being affected by degradation processes in various degrees. 60-70% of EU soils are unhealthy (EU Soil Strategy 2030, 2021). Land and soil are subject to severe degradation processes such as: erosion, compaction, organic matter decline, pollution, loss of biodiversity, salinization and sealing.

By 2050 all soils will be healthy (EC Soil Monitoring Law, 2023), by ensuring the protection, sustainable use and restoration of soils, they will be more resilient, but for this, very firm changes are needed during this decade. Healthy soils contribute to addressing the big challenges of achieving climate neutrality and resilience to climate change, developing a clean and circular bioeconomy, reversing biodiversity decline, protecting human health, halting desertification and reversing land degradation.

Kibblewhite et al. (2012) appreciate that soil health is dependent on the maintenance of four major functions: carbon cycling, nutrient cycles, maintaining soil structure and counteracting pest and disease activity. Each of these functions behaves as an aggregate of a biological processes diversity sustained by a diversity of soil organisms that are interacting under the influence of the soil abiotic environment. Measuring individual groups of organisms, processes or soil properties is not sufficient to show the status of soil health.

The EU Soil Strategy 2030 (2021) shows that soils are healthy when they are in a good chemical, biological and physical state and are therefore able to continuously provide as many of the following ecosystem services as possible, namely:

- to provide food and produce biomass, including in agriculture and forestry;
- to absorb, store and filter water, as well as transform nutrients and substances, thus protecting groundwater bodies;
- to provide the framework for life and biodiversity, including habitats, species and genes;
- to act as a carbon reservoir;
- to provide a physical platform and cultural services for people and their activities;
- to act as a source of raw materials;
- to represent a depository of the geological, geomorphological and archaeological heritage.

The European Mission on the Soil Deal for Europe (A Soil Deal for Europe, 2021) chose a set of eight indicators to highlight soil health:

1. The presence of pollutants, excess salts and nutrients;
2. The stock of organic carbon in the soil;
3. Soil structure including bulk soil density and absence of erosion and soil sealing;
4. Soil biodiversity;
5. Soil acidity and nutrients;
6. Crop cover;
7. The heterogeneity of the landscape;
8. The forestry cover.

There is a growing interest in an accurate index of soil quality, for example in the financial and industrial sectors. Some Member States have developed soil health certificates, which must be provided during land transactions in order to properly inform the buyer.

The close relationship between the soil health and food one’s allowed the EU to propose the implementation of the "farm to plate" program.

However, the farmer's organization COPA COGECA requests the removal of soil health certificates from the proposed Soil Directive because they do not bring added value for land managers and society, being only an additional burden, considering that Member States already have rules for the protection public health and the environment in relation to soils.

SOIL – HEALTHY WATER RELATIONSHIP

There is a close relationship between soils, sediments and water. Soils filter, absorb and retain water, but they can erode and become polluted. When the soil is sealed, water not being able to infiltrate into the soil, circulates on these surfaces increasing the risk of flooding.

There is a concern related to the better soil management for a better water management in order to ensure a smarter use of decreasing water reserves. We need to increase water use efficiency on farm level through better management of soil, crop and nutrient sources. Through a better knowledge of the soil-plant system we must obtain species and varieties with better water use efficiency. Better management of soil and agricultural inputs will lead to water quality preservation.

The Water Framework Directive (Directive 2000/60/EC) provides the achievement of good ecological and chemical status of surface waters and good chemical and quantitative status of groundwater by 2027.

ROLE OF SOIL IN CLIMATE CHANGE MITIGATION

A conerning trend is observed in the net carbon sinks absorbtion of the land use, land-use change and forestry sector. Between 2013 and 2018, net annual carbon sinks were reduced by 20% (EU 2030 Soil Strategy).

The conversion of peatlands and their use is of particular concern. For example, although only 8% of farm land in Germany is peatland, it is responsible for 30% of the total greenhouse gas emissions of the entire agricultural farm sector. Apart from peatlands, special attention should be paid to the preservation of permanent pastures and the management of forestry soils (CE Soil Thematic Strategy, 2012).

The EC highlighted carbon losses from cultivated soils at a rate of 0.5% per year, and from drained peatlands at 50%. It is estimated that 25% of land is at high risk of desertification in Southern, Central and Eastern Europe (A Soil Deal for Europe, 2023).

The European Green Deal (Fetting, 2020) has a very ambitious roadmap to transform the Union into a prosperous and attractive society with a modern, resource-efficient, competitive economy, seeking to protect, conserve and enhance the Union's natural capital and to protect the health and welfare of citizens.

The EC proposed in the context of the law on restoring nature, to limit the drainage of wetlands and organic soils and to restore managed and drained peatlands, with the aim of maintaining and increasing soil carbon stocks, minimizing flood and drought risks and to increase biodiversity.

The Commission will join the international initiative "4 to 1000" in order to increase the level of carbon in the soil of agricultural land (EC, 2021, Soil health and food).

Greater and more financial incentives are needed for the continuous improvement of on-farm carbon management in full agreement with on-farm results.

SOIL AND THE CIRCULAR ECONOMY

The Circular Economy Action Plan emphasizes that the main objective is to decouple economic growth from resource use. The EC estimates that by applying the principles of the circular economy, the conditions are created for a 0.55% increase in GDP and more than 700,000 new jobs will be created (The European Green Deal).

The residual organic materials, after treatment and transformation, will be used as fertilizers in agriculture with the role of preserving and increasing the level of organic carbon in the soil. When organic waste products are applied, the soil acts by biological oxidation processes, ion exchange, chemical precipitation, adsorption, absorption and assimilation by plants and living organisms, thus it can be considered that the soil represents a biological station with all treatment steps, and its ability to process the complex organic substances depends on its properties, climatic conditions and soil management. However, the treatment capacity of the soil is not unlimited and it is necessary to avoid soil degradation. The treatment capacity is related to the soil properties, the environmental conditions, the crops to be grown and the characteristics of the products which have to be treated and used.

Soil scientists have to answer the following questions:

- How can we better use soils as biogeochemical reactors, preventing contamination and maintaining soil productivity?

- What is the capacity of the soils to process the waste without affecting the quality of the soil or related aquatic systems?

- What is the evolution of soil toxins and substances with biohazard potential which can be applied through organic amendments?

ECOLOGICAL AGRICULTURE

The EC developed the European Action Plan for the Development of Organic Agriculture, published on 25 March 2021. The EC committed that 25% of the EU's agricultural land will be converted to organic agriculture by 2030, as well as a significant development of organic aquaculture.

Once the Member States implement the action plan, conditions will be created to achieve the "farm to plate" and "biodiversity" strategies. It is appreciated that organic agriculture tends to have a limited impact on the environment, as it encourages the responsible use of energy and natural resources, the maintenance of biodiversity, the preservation of regional ecological balances, the improvement of soil fertility and the maintenance of water quality (Romania's Action Plan).

Since no pesticides and synthetic fertilizers are allowed in organic farming, the level of production is lower. Table 2 shows the differences in productivity between conventional and organic farming.

Table 2. Average yields of organic crops (after Niggli and others., 2008) q/h
// Randamentele medii ale culturilor ecologice (după Niggli și alții., 2008) q/h

Crop	Switzerland	Austria	Germany	Italy	France
Wheat	64 - 75	62 – 67	58 – 63	78 – 98	44 – 55
Barley	65 – 84	58 – 70	62 – 68	55 – 94	70 – 80
Oat	73 – 94	56 – 75		88	
Corn	85 – 88		70	55 – 93	66 – 80
Oil crops	83	78 – 88	60 – 67	48 – 50	67 – 80
Potatoes	62 – 68	39 – 54	54 – 69	62 – 99	68 – 79
Leguminous crops	88	83 - 85	49 - 73	73 - 100	83

CONCLUSIONS

If there are production gaps in the developed countries, in Romania the situation will possibly be even worse because:

1. The reserve of weed seeds in the soil is much higher due to the lower degree of the soil cover with cultivated plants, using much less amounts of herbicides;
2. The diversity and number of insects and fungi is greater because we used very few insecto-fungicides;
3. We have many small and very small farms that allow an increased attack of pests and make it much more difficult to carry out treatments;
4. We have a large labor deficit in agriculture due to the lower salary level, and ecological agriculture requires an increase in the labor;
5. A very low degree of mechanization in small farms;
6. We have the lowest incomes in the EU, so a reduced purchasing power;
7. Nothing was invested in research to find appropriate technical solutions;
8. We have a very small number of animals, so we do not have the manure required for organic/ecological farms;
9. We have a low speed of implementation of European and national legislation (for example: the soil law, the compost law, Regulation 1009/2019 on fertilizers, Regulation 834/2018 on organic production, the EU Strategy on healthy soils, etc. have no application rules).

All presented are only a part of the problems in which the members of the soil science society must solve them in the shortest possible period of time.

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STUDY ON THE BEHAVIOR OF SOME SUNFLOWER HYBRIDS IN PEDOCLIMATE CONDITIONS AT ARDS ŞIMNIC

STUDIUL PRIVIND COMPORTAREA UNOR HIBRIZI DE FLOAREA SOARELUI ÎN CONDIȚIILE PEDOCLIMATICE DE LA SCDA ŞIMNIC

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ABSTRACT
This paper presents the results obtained at SCDA Șimnic for a period of 3 years (2021-2023) regarding the behavior of 10 sunflower hybrids following multi-year tests to identify the most suitable hybrids for the study area. The studied hybrids behaved differently from year to year. The best results were obtained in 2021, followed by 2023, and in 2022 the lowest productions were recorded due to the lack of precipitation and high temperatures in June and July that created unfavorable conditions during the flowering and seed formation period. Average yields of the studied hybrids ranged from 1071 kg/ha (FD15CL440) to 1381 kg/ha (HS8232). Hybrid HS8232 was the only hybrid that significantly exceeded control (media) production. Hybrids HS8232, HS5440 and HS8566 had the lowest coefficients of variation. The evaluated productivity elements had low values as a result of the climatic conditions recorded during the experimentation period.

Keywords: sunflower, head diameter, hectoliter weight, seed yield

REZUMAT
În această lucrare se prezintă rezultatele obținute la SCDA Șimnic pentru o perioadă de 3 ani (2021-2023) cu privire la comportamentul a 10 hibrizi de floarea soarelui în urma testelor multianuale pentru identificarea celor mai potriviți hibrizi pentru zona de studiu. Hibrizii studiați au avut un comportament diferit de la un an la altul. Cele mai bune rezultate s-au obținut în anul 2021, urmat de anul 2023, iar în 2022 s-au înregistrat cele mai mici producții din cauza deficitului de precipitații și a temperaturilor ridicate din lunile iunie și iulie care au creat condiții nefavorabile în perioada înfloritului și formării semințelor. Producțiile medii ale hibrizilor studiați au variat de la 1071 kg/ha (FD15CL440) la 1381 kg/ha (HS8232). Hibridul HS8232 a fost singurul hibrid care a depășit semnificativ producția martor(media). Hibrizii HS8232, HS5440 și HS8566 au avut cei mai mici coeficienți de variație. Elementele de productivitate evaluate au avut valori scăzute ca urmare a condițiilor climatice înregistrate în perioada de experimentare.

Cuvinte cheie: floarea-soarelui, diametru capitul, masa hectolitrică, producția

INTRODUCTION

Sunflower (*Helianthus annuus L.*) is one of the important oilseed crops cultivated in the world, occupying the 3rd place after soybean and rapeseed. There is a wide range of sunflower hybrids, and in order to choose the most suitable ones for each growing region, it is necessary to research their behavior. One of the most important agricultural practices and the key to a high and stable production is the use of genotypes with a good adaptation to the meteorological conditions specific to each crop area (Yeremenko et al., 2020). The choice of the most suitable sunflower hybrids for each area offers the possibility of obtaining high yields and high quality because the soil and climate factors of the area where they are grown are factors with great influence in determining seed production (Gul and Coban), 2020. The creation of new sunflower hybrids with improved tolerance to drought and extreme temperatures is more than necessary in the current climatic conditions around the world. Previous studies on sunflower have shown that it can easily adapt and perform well in a variety of climatic and soil conditions (Anjum et al., 2012; Canavar et al., 2010, Borleanu and Bonea, 2020).

In last years, sunflower production has marked growth trends with fluctuations from one year to the next, depending on the climatic favorability and the level of technology applied, and a spectacular increase in the areas cultivated for consumption due to both the increase in the demand for grains for the industry processing in the country, as well as export to the European market.

Among the most important sunflower-growing countries are Argentina, with 1,958,686 ha, Ukraine with 2,5238,000 ha, Spain with 876,670 ha, Romania with 1,093,270 ha, France with 793,000 ha, the U.S. 1,407,000 ha, (FAO 2022).

Due to its multiple advantages, sunflower has been proposed as a potential crop model for adapting to a changing environment; therefore, it is essential to evaluate hybrids in various environments (Jockovic et al., 2019).

The use of the most adapted genotypes represents a low-cost input to the production system and is thus easily adopted by farmers (Arshad et al., 2013).

Determining the most appropriate breeding strategies for obtaining high-yielding and high-quality genotypes depends on understanding the effects of Genotype × Environment interaction. To determine the agronomic performance and adaptation of genotypes to different local environmental conditions, they must be constantly evaluated, taking into account, in particular, the existence of Genotype × Environment interaction (Shigaki et al., 2019).

Drought is an abiotic factor that limits the production level of cultivated plants worldwide. In Romania, the most affected areas are the south, south west and south east. Therefore, the development of drought-tolerant genotypes is an important improvement objective (Dunăreanu et al., 2020; Dunăreanu and Bonea, 2022).

Due to its low inputs (water, fertilizers and pesticides), drought tolerance and good plasticity, the sunflower is considered a model crop for adapting to new climate changes. Thus, Romanian farmers prefer this culture compared to other alternatives, but the future of this culture depends on the choice of the most suitable hybrids as well as on the attractiveness potential for farmers (price, demand on the foreign and local market) Constantinescu et al., 2024.

The objective of the study was to evaluate the behavior of some sunflower hybrids under ARDS conditions Simnic, Dolj.

MATERIAL AND METHOD

Ten sunflower hybrids obtained at the Fundulea National Institute of Agricultural Research and Development, Romania, were evaluated during 2021-2023 at the Agricultural Development Research Station-Şimnic (44°19' N, 23°48' E, 182 m a.s.l.; Oltenia area) characterized by semi-arid conditions. The soil was mostly reddish. The main properties of this soil at the surface horizons Ap (0-29 cm) and Apt (29-43 cm) are the following: humus content 2.68%-2.33%; N content 0.072-0.071 mg kg-1, P and K content 52.2-32.3, respectively 125-104 mg kg-1, mobile P 52.2-32.3 mg kg-1, mobile K 125- 104 mg kg-1 and pH (1: 2.5 H2O) 5.08-5.33 (Radu et al., 2019).

The studied hybrids come from a comparative culture of 30 hybrids. This was placed according to the Latin rectangle method with 20 variants in three repetitions. The layout of the experience was made in accordance with the methodological instructions for carrying out comparative cultures, with strict observance of the principle of randomization.

Each variant was sown in 4 rows, each row having a length of 7 m. The distance between the rows was 70 cm, and between plants per row 25 cm, corresponding to a theoretically calculated decimation of 57,000 plants/ha. The preceding crop was wheat (*Triticum aestivum L.*), every year. The experimental field was plowed in the fall to a depth of 28 cm, and in the spring the disc harrow and combiner (8-10 cm) were used. The NPK 20-20-0 complex fertilizer was applied before sowing with a dose of 250 kg ha-1, to which 150 kg ha-1 of ammonium nitrate (NH4NO3) was added during the vegetation period (BBCH 16- BBCH 18).

Sowing was carried out on April 9, 2021, April 5, 2022 and April 28, 2023. Before sowing, the herbicide S-metolachlor 960 g L-1 was applied at a dose of 1.2 L ha-1. At BBCH 14-BBCH 16 stages, the herbicide quizalofop-p-tefuryl 40 g L-1 at 1 L ha-1 was applied to control annual and perennial monocot weeds (when weeds reached 15-20 cm height). Two mechanical sweeps and one manual sweep were performed. Harvesting was carried out mechanized with a combine for experimental plots, on September 8, 2021, August 30, 2022, September 22, 2023.

The main data collected included plant height, calathidium/head diameter, hectoliter mass, 1000 seed mass and seed production. Plant height determined in BBCH 69 and head diameter (in BBGH 87) were measured in the field on 10 plants from each plot. The mass of 1000 seeds was determined by counting and weighing 1000 seeds for each plot. Grain Analyzer (AM 5200-A, Perten Instruments, Stockholm, Sweden) was used to determine hectoliter mass and seed moisture. Seed production was determined by harvesting whole plots, weighing, reporting per hectare and adjusting to 9% moisture.

The amount of precipitation recorded in each year of experimentation was below the multiannual average (663.7 mm), except for the year 2023 when, due to the precipitation that fell in June, the amount of annual precipitation was higher than the multiannual average of the area by 111 mm. The temperature recorded in the years of experimentation was above the multiannual average (12.4o), with the exception of 2021 when the temperature of the year of experimentation was lower than the multiannual average of the area. Climatic conditions showed quite high variability during the 3-year experiment, due to transitions from severe drought in June (2022) and July (2021), to excess precipitation in June (2023), which had significant effects on the behavior hybrids evaluated.

Table 1. Sum of accumulated precipitation and average monthly temperatures from the years of experimentation at the Agricultural Research and Development Station – Șimnic// Suma precipitaţiilor acumulate şi a temperaturilor medii lunare din anii de experimentare la SCDA Șimnic

Parameter	Year	Oct-dec	Ian-Mar	Apr	Mai	Iun	Iul	Aug	Sept	Sum / average
Precipitații (mm)	2021	193.0	191.6	31.0	83.0	83.0	20.0	13.0	5.5	620.1
	2022	114.0	26.9	65.0	76.0	10.0	54.0	54.0	102.0	501.9
	2023	118.0	177.0	56.0	61.0	198.0	90.0	33.0	42.0	775,0
	Multi-annual average	154.0	136,3	47.2	79.3	85.5	70.1	41.6	49.7	663,7
Temperature (ºC)	2021	7.1	3.7	12.3	16.4	21.2	25.5	24.7	12.6	12.1
	2022	8.9	4.0	11.5	17.7	22.8	24.7	25.1	17.4	13.2
	2023	8.9	5.4	10.6	16.1	20.7	25.0	25.4	21.7	16.7
	Multi-annual average	2.9	17.4	12,9	17.4	21.9	24.0	24.2	18.9	12,4

RESULTS AND DISCUSSION

The results obtained from the analysis of variance (ANOVA) for each year of experimentation highlighted that only in two of the three years there were distinctly significant differences in production between the ten sunflower hybrids studied (Table 2).

Table 3 presents the analysis of variance (ANOVA) for seed yields for the three-year series, 2021-2023, showing distinctly significant effects of both genotypes and years and the genotype x year interaction. Therefore, the studied hybrids behaved differently from year to year.

Table2. Analysis of Variance (ANOVA) and F-test for each crop year// Analiza Varianței (ANOVA) și testul F pentru fiecare an de cultură

The cause of variability	SP	GL	s^2	Sample F
2021				
Genotypes (G)	448436	9	49826.23	5.30 (2.39-3.46)**
Error	187950.7	20	9397.533	
Total	636386.7	29		
2022				
Genotypes (G)	1012683	9	112520.4	2.33 (2.39-3.46)^{ns}
Error	962572	20	48128.6	
Total	1975255	29		
2023				
Genotypes (G)	909124.7	9	101013.9	6.11 (2.39-3.46)**
Error	330550	20	16527.5	
Total	**1239675**	**29**		

Analyzing the production dynamics of sunflower hybrids by year, presented in Tables 2 and 3, a fluctuation was observed which was mainly determined by the years of experimentation and to a lesser extent by the genotype.

Table 3. Analysis of Variance (ANOVA) and F-test for the three-year series// Analiza varianței (ANOVA) și testul F pentru seria de trei ani

The cause of variability	SP	GL	s^2	Sample F
Genotypes (G)	849568.4	9	94396.49	3.82 (2.04-2.72)**

The cause of variability	SP	GL	s^2	Sample F
Years (A)	1298827	2	649413.7	26.30 (3.15-4.98)**
G x A	1520676	18	84481.99	3.42 (1.81-2.32)**
Error	1481073	60	24684.54	
Total	5150144	89		

The best results were obtained in 2021, followed by 2023, and in 2022 the lowest productions were recorded due to the lack of precipitation and high temperatures in June and July that created unfavorable conditions during the flowering period and seed formation, decisively determining the level of this year's productions.

In 2021, the highest seed productions were recorded, the values being between 1101 kg/ha (HS8566) and 1511 kg/ha (HS8232), and the average of 1365 kg/ha. The maximum productions were achieved by hybrids HS8232 (1511 kg/ha) and HS8840 (1509 kg/ha), but they were statistically insignificant compared to the average production (control). The lowest seed production was achieved by the hybrid HS8566 (1101 kg/ha), the difference compared to the control being distinctly significantly negative. The other hybrids achieved yields close to the control (statistically insignificant).

In 2022, the level of production was lower than in the other years, varying between 881 kg/ha and 1356 kg/ha, the differences between the hybrids not being statistically ensured. The maximum production was obtained by the hybrid HS8232 (1356 kg/ha).

In the year 2023, the productions varied between 930 kg/ha (FD15E27) and 1507 (fD18E41. The FD19E42 hybrid achieved a distinctly significantly higher production compared to the control (1507), followed by the HS8840 hybrid with a significantly higher production (1441 kg/ha).

Table 4. Production of sunflower hybrids obtained at ARDS Șimnic in 2021, 2022 and 2023// Producțiile hibrizilor de floarea soarelui obţinuţi la ARDS Șimnic în 2021, 2022 şi 2023/

Hybrid	2021		2022		2023	
	Kg/ha	The difference from the control	Kg/ha	The difference from the control	Kg/ha	The difference from the control
FD15CL44	1252	-113	967	-104	995	-213
FD15E27	1343	-22	990	-81	930	-278^{0}
FD18E41	1272	-93	1383	+312	1147	-61
FD19E42	1370	+5	902	-169	1507	+299**
HS8840	1509	+144	925	-146	1441	+233*
HS 7083	1405	+40	881	-190	1104	-104
HS 8566	1101	-264^{00}	1165	+94	1260	+52
HS 6877	1475	+110	917	-154	1124	-84
HS 8232	1511	+146	1356	+285	1275	+67
HS5440	1410	+45	1222	+151	1296	+88
Average (control)	1365		1071		1208	
DL 5%	165		374		219	
DL 1%	224		508		298	
DL 0,1%	304		689		404	

On average over the three years of experimentation, the level of seed production in the studied hybrids varied between 1071 kg/ha for the FD15CL44 hybrid and 1381 kg/ha for the HS8232 hybrid, the average being 1215 kg/ha (Table 5). These results are consistent with those obtained by Bonea et al (2010) in the dry conditions of central Oltenia.

The maximum seed production was achieved by the hybrid HS8232 which exceeded the average of the hybrids by a significant difference of +166 kg/ha. The rest of the hybrids achieved yields close to the average, the differences being statistically insignificant.

Table 5. Average production of sunflower hybrids obtained at ARDS Șimnic in the period 2021-2023// Producţia medie de hibrizi de floarea-soarelui obţinută la ARDS Șimnic în perioada 2021-2023

Hybrid	Kg/ha	The difference from the average	The meaning
FD15CL44	1071	-144	
FD15E27	1088	-127	
FD18E41	1267	+52	
FD19E42	1260	+45	
HS8840	1292	+77	
HS 7083	1130	-85	

Hybrid	Kg/ha	The difference from the average	The meaning
HS 8566	1175	-40	
HS 6877	1172	-43	
HS 8232	1381	+166	***
HS5440	1309	+94	
Average	1215		
DL 5%			148
DL1%			197
DL0,5%			256

Regarding the coefficients of variation, it was observed that only three of the studied hybrids (HS8566, HS8232 and HS5440) can be characterized as having a small variation in seed yields (CV<10). Only one hybrid, namely FD18E41, recorded a medium coefficient of variation (CV <20), and the rest of the hybrids had high coefficients of variation (CV>20), determined by large variations from one year to another (Figure 1).

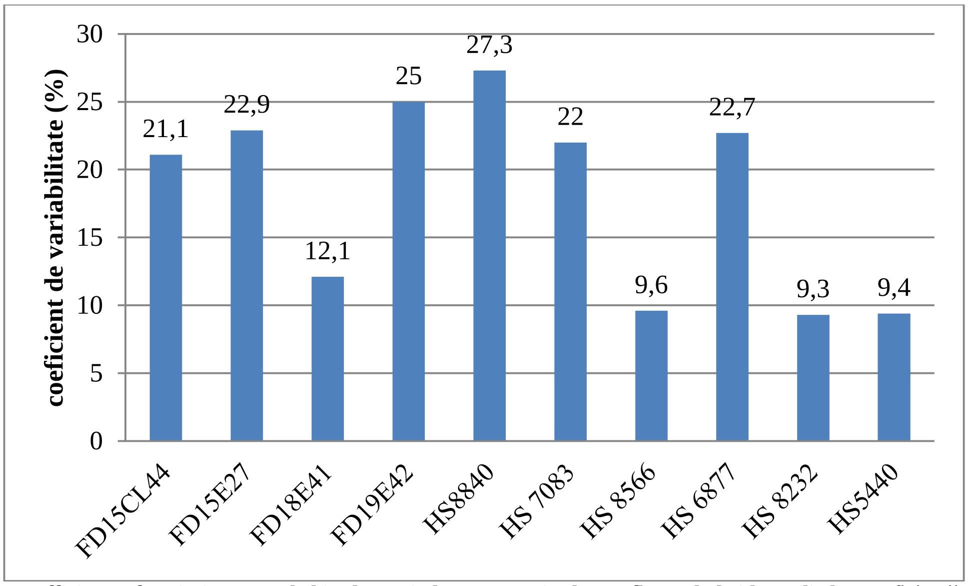

Fig. 1. The coefficients of variation recorded in the period 2021-2023 in the sunflower hybrids studied // Coeficienții de variație înregistrați în perioada 2021-2023 la hibrizii de floarea-soarelui studiați

Regarding the determinations of height, calathidium diameter, hectoliter mass and MMB, these are presented in Table 6.

Plant height is an important trait for sunflower breeding, with shorter height genotypes being better adapted to mechanized harvesting. In this study, the average height of the studied hybrids was 144 cm, around this value most of the hybrids were located. The highest height was recorded by the hybrid HS8566 (155 cm), and the smallest by the hybrid HS6877 (132 cm).

The diameter of the calathidius is an important productivity element because it influences the number of flowers and seeds obtained. In a previous study Borleanu and Bonea (2020) found a significant positive correlation between seed production and calathidium diameter. On average, the studied hybrids had a diameter of 20 cm, the largest being achieved by the FD15CL44 hybrid (22 cm), and the smallest by the hybrids (FD19E42, HS8566 and HS6877 (18 cm).

Regarding the hectoliter mass, considering that a quality seed must have a hectoliter mass of over 40 kg/hl, we can say that no hybrid had such values, the average being 35.3 kg/hl. The maximum value for MH was obtained by the FD15E27 hybrid (36.9 kg/hl) and the minimum value by the FD19E42 hybrid (34.1 kg/hl).

The low values recorded for the mass of 1000 seeds indicate insufficient seed filling and the negative effects of unfavorable environmental conditions during the grain filling period. The mass of 1000 seeds has an indirect effect on the quality of the seeds used for sowing. Thus, the average MMB for the studied hybrids was 43.1 g, the highest value being recorded for the FD19E42 hybrid (47.3 g).

Table 6. Average values of some productivity elements (2021-2023)// Valorile medii ale unor elemente de productivitate (2021-2023)

Hybrid	Height	Calatidium diameter	MH	MMB
FD15CL44	147	22	36.1	47.0

Hybrid	Height	Calatidium diameter	MH	MMB
FD15E27	150	21	36.9	45.5
FD18E41	139	20	34.2	41.6
FD19E42	144	18	34.1	47.3
HS8840	145	19	35.6	41.5
HS 7083	147	21	35.0	39.7
HS 8566	155	18	36.3	39.9
HS 6877	132	18	35.7	42.3
HS 8232	140	21	35.0	42.0
HS5440	138	18	34.4	44.5
Media	144	20	35.3	43.1

CONCLUSIONS

The 2021-2023 experimentation period was characterized by large fluctuations in precipitation and temperatures from one year to another, but especially by their non-uniformity throughout the vegetation periods, negatively influencing the level of productions obtained

The average yields obtained by the sunflower hybrids studied were low, ranging from 1071 kg/ha to 1381 kg/ha. Hybrid HS8232 kg/ha (1381 kg/ha) was the only hybrid that significantly exceeded the yield of the control.

The evaluated productivity elements had low values as a result of the climatic conditions recorded during the experimentation period.

The hybrids HS8232, HS5440 and HS8566 showed the best adaptability to the pedo-climatic conditions in the study area, which had low coefficients of variation.

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THE EFFECT OF SOME HERBICIDES ON THE EDAFIC MESOFAUNA IN BROAD BEAN CULTURE, IN THE ECOLOGICAL CONDITIONS OF THE NORTH OF THE COUNTRY

EFECTUL UNOR ERBICIDE ASUPRA MEZOFAUNEI EDAFICE LA CULTURA BOBULUI ÎN CONDIȚIILE ECOLOGICE DIN NORDUL ȚĂRII

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ABSTRACT

The research was carried out at SCDA Suceava, in the pedoclimatic conditions of the Pojorâta Center during 2020-2021, on a lithic alluvial soil, located on the first terrace of the Moldova River, at an altitude of 700 m. One of the main factors in this experience was the use of a xenobiotic product, called Dual Gold 960 EC, herbicide from the IV th toxicity group and its implications on the microbiological activity of the soil. Regarding the edaphic micro arthropod communities, no significant quantitative differences were observed between the studied variants. The only changes found refer to the trophic structure of the edaphic micro arthropod community, both through the disappearance of phytophagous groups, whose sources have been reduced as a result of the removal of weeds, and through the decrease in the percentage of participation of predators, until their total disappearance, groups with increased sensitivity to chemicals. From the analysis of the numerical ratio between the two groups of microarthropod mesofauna analyzed, an increased numerical dominance of detritomicrophytophages emerges in all variants studied compared to the group of zoophagous, which suggests a negative influence of the herbicide on zoophagous where in the variant treated with the maximum herbicide dose, applied after the emergence of broad bean plants, zoophagous are completely absent.

Keywords: edaphic mesofauna, Vicia faba

REZUMAT

Cercetările au fost efectuate la SCDA Suceava, în condiţiile pedoclimatice de la Centrul Pojorâta în perioada 2020-2021, pe un sol aluvial litic, situat pe prima terasă a râului Moldova, la altitudinea de 700 m. Unul din principalii factori în această experienţă, l-a constituit utilizarea unui produs xenobiotic, numit Dual Gold 960 EC, erbicid din grupa a IV-a de toxicitate şi implicaţiile lui asupra activităţii microbiologice ale solului. În privinţa comunităţilor de microartropode edafice, nu s-au observat diferenţe cantitative semnificative între variantele luate în studiu. Singurele modificări constatate se referă la structura trofică a comunităţii de microartropode edafice, atât prin dispariţia grupelor fitofage, ale căror surse s-au redus ca urmare a înlăturării buruienilor, cât şi prin micşorarea procentului de participare a prădătorilor, până la totala lor dispariţie, grupe cu sensibilitate crescută faţă de substanţele chimice.Din analiza raportului numeric dintre cele două grupe ale mezofaunei microartropodelor analizate, reiese o dominanţă numerică crescută a detritomicrofitofagilor în toate variantele luate în studiu comparativ cu grupa zoofagilor, ceea ce sugerează o influenţă negativă a erbicidului asupra zoofagilor, unde, în varianta tratată cu erbicid în doză maximă, aplicat după răsărirea plantelor de bob, zoofagii lipsesc în totalitate.

Cuvinte cheie : mezofauna edafică, Vicia faba

INTRODUCTION

The vast majority of soil fauna (80%) is located in the first 10 20 cm of soils, which represent the organic horizon. Edaphic animals occupy various links in the trophic chains of the soil (primary, secondary, tertiary consumers), which contribute to changing the physical and chemical characteristics of the soil.

Fauna maintains the juvenile stage of bacterial populations, contributing to the dissemination of bacteria and fungal spores. Through the selective consumption of microflora, the edaphic fauna causes important quantitative and qualitative changes in the fungal and bacterial communities, modifying their structure and thus influencing, indirectly, the rate of decomposition of the organic remains in the soil. In turn, fungi and bacteria, as sources of food for a large part of the edaphic fauna, through their quantity and quality, can influence the structure and dynamics of edaphic animal populations, determining both their fecundity and survival rate, as well as their horizontal or vertical distribution (Mitchel and Parkinson, 1976).

These close interrelationships between fauna and edaphic microflora have led some researchers to consider that, in the processes of biodegradation of organic residues, the fauna especially has the role of regulator (accelerating or moderating them), through its influence on the main primary decomposers- fungi and bacteria.

The pedoclimatic factors that influence the quantitative and qualitative distribution of edaphic organisms are: humus and water content, aeration and temperature, porosity, pH and litter quality. Of these, in natural field conditions, they vary at relatively short time intervals, especially temperature, humidity and soil aeration. The biological efficiency of seasonal factors is characterized by minimum, optimal and maximum values, specific for each organism. Among the stationary factors that act simultaneously, the determinant for the biological phenomena in the soil will be the one that is found at extreme values, the modification of one of the factors brings with it the modification of the others, because there is an interdependence relationship between them.

The researches carried out so far have highlighted the characteristics of some edaphic coenoses depending on the type of soil, the type of vegetation, the way of managing the land, as well as the changes in the structure of the edaphic micro arthropod communities due to the influence of disturbing factors including herbicides. Their effect is manifested either by the substantial reduction of all detritivores, or by changing the ratio between the groups involved in the detritus food chain. The extent of these changes depends on the intensity and duration of the action of the disturbing factors.

In-depth research on how edaphic animals react to the use of herbicides in weed control has been carried out by many researchers, on many crops and over certain periods of time, less so in the broad bean crop.

Dual Gold 960 EC in the fight against weeds in the broad bean crop is analyzed , on the edaphic microarthropods in the researched agro system. Among these, the main trophic groups of the detrital chain were analyzed:

- the group of detritomicrophytophagous species: collembola (insects), other orders of insects represented by their first stages of development; oribatids, mites, tarsonemids, pygmephorids, cutacarids, (mites), which intervene in the natural restoration of soil fertility and the dissemination of its microflora;

- group of zoophagous species; gamasids, ereinetids, cunaxids, ragidiids, eupodids, thydeids, raffignatids, pentalodids, erythreids, (mites), which contribute to the numerical regulation of the edaphic fauna.

MATERIAL AND METHOD

The research was carried out at SCDA Suceava, in the pedoclimatic conditions of the Pojorâta Center during 2020-2021, on a lithic alluvial soil, located on the first terrace of the Moldova River, at an altitude of 700 m. One of the main factors in this experience was the use of a xenobiotic product, called Dual Gold 960 EC, herbicide from the IVth toxicity group and its implications on the edaphic soil mesofauna.

The following research options were followed: V_1 - untreated unhood; V_2 - manually hoeing; V_3 – treated 1 l/ ha before sowing; V_4 – 1,5 l/ ha before sowing; V_5 – 1 lg/ ha before the plants emerge; V_6 – 1.5 l / ha before the plants emerge; V_7 – 1 l / ha after the plants emerge; V_8 – 1.5 l / ha after emergence, sown 50 cm between the rows and V_9 – untreated unhood; V_{10} – manually hoeing; V_{11} - 1.5 l / ha before emergence, sown 30 cm between rows.

The soil samples, equal in size, in the number of 5 samples for each variant, were taken from the 11 variants taken in the research, The extraction of the animals from the samples was done by the Tullgren-Berlese method: The material obtained was determined up to the level of the basic taxonomic groups, simultaneously establishing the numerical abundance in individuals and the belonging to the trophic group. The numerical productivity of the investigated taxonomic groups was assessed based on the abundance in individuals, which was used to calculate the percentage ratio between the groups.

From a meteorological point of view, the multiannual average temperature in this area is 6,4°C12.7°C for the entire year and 12.7°C during the growing season, and the multiannual average precipitation records values of 726.2 for the entire year and 531.0 for the growing season (tab. 1). From the point of view of precipitation, the year 20 20 was, insignificantly, below the multi-year average for 26,7 mm the whole year and significantly exceeded the vegetation period with 106.9 mm. The temperatures recorded values equal to the normal for the whole year and exceeded the normal for the vegetation period by 0.8 ^{0}C. The year 2021 was normal in terms of precipitation both for the whole year and for the vegetation period, but the temperatures were significantly above normal, by 2.5°C for the whole year and by 3.4°C during the growing season.

Table 1. Climatic conditions during the experiment period // Condiţiile climatice din perioada de experimentare

Specification	Precipitation (mm)		Temperatures (°C)	
	annual	IV-IX	annual	IV – IX
2020	699.5	637.9	6.4	13.5
2021	757.7	520.8	8,9	16.1
Multiannual average	726.2	531.0	6.4	12.7

RESULTS AND DISCUSSION

From the data obtained (table 2,3,4), it appears that neither the different way of organizing the experiment (distance between rows, technologies used) nor the dose or method of application of the herbicide significantly influenced the structure of the edaphic microarthropod community, in especially in terms of quantity. This fact is clearly highlighted by the average total densities of these animals, which show very close values in all the variants analyzed. This is explained by the fact that the experiment was located on a soil lower in organic substances, which limits the possibilities of numerical development of microarthropods. It is known that most of them are saprophages, and the sine qua non condition of saprophagy is the existence of rich sources of organic matter.

The only noticeable changes in the conducted study refer to the trophic structure of the microarthropod community. Within it, a low density of phytophagous forms is especially noticeable, that is, of organisms that usually feed on the living underground parts of plants. The very low density of phytophagous is explained by the use of the herbicide, which, by eliminating weeds, drastically reduces the food sources of these edaphic animals.
The other two basic trophic groups of the detrital network (*Oribatida*, *Collembola*) are represented by the secondary consumers (detritomicrophytophages), which feed on organic remains "prepared" by the primary consumers (nematodes, bacteria, fungi) and by the tertiary consumers (zoophagous). , whose food sources are, as a rule, the secondary consumers, but also the primary ones (in the case of nematophagous species).

Analyzing the numerical ratio between these two groups, linked by trophic relations, reveals an increased numerical dominance of detritomicrophytophages in all the variants studied. The finding suggests a negative influence of the herbicide on zoophagous. The effect is more blurred in the case of applying the herbicide before sowing, at the distance 30 cm between the rows (table 2,4), but it is devastating in the version with the maximum dose of herbicide, applied after the sprouting of the broad bean plants, 50 cm between the rows (table 3&4), where zoophagous are completely absent.

The reduction of zoophagous populations is, as a rule, the consequence of the cumulative effect of the decrease in food sources, but also of an increased sensitivity of many predatory groups to extrinsic substances. This sensitivity is explained (Karg W., 1961, 1963, 1965), as the result of the gradual accumulation in the predatory animals of some toxins originating from the partial or total

Table 2 The values of some ecological parameters of the edaphic micro arthropod communities from the organic horizon of the analyzed variants sown 30 cm between the rows // Valorile unor parametri ecologici ai comunităților de microartropode edafice din orizontul organic al variantelor analizate semănate la 30 cm între rânduri

Trophic groups	**Systematic groups**	**30 cmbetween the lines**					
		BLANK				**before sunrise 1,5 Kg/ ha**	
		unbroken		**hoeing**		**1 l/ha**	**1.5 l/ha**
		x	**dr %**	**x**	**dr %**	**x**	**dr %**
Detritomicro-phytophagus	*Oribatida*	6.6	31.4	2.4	12.1	7.2	52.2
	Collembola	2.1	10.0	1.8	9.1	1,2	8.7
	Other insects	5.7	27.1	10.2	51.6	4.8	34.8
	The mite	0.3	1.5	-	-	-	-
	Tarsonemidae	0.6	2.8	0.3	1.5	-	-
	Pygmephoridae	0.3	1.5	1.8	9.1	-	-
	Scutacaridae	-	-	-	-	-	-
	TOTAL 1	15.6	74.3	16.5	83.4	13.2	95.7
Zoophages	*Gamasida*	4.8	22.7	2.4	12.1	-	-
	Ereynetidae	-	-	-	-	-	-
	Cunaxidae	-	-	-	-	0.6	4.3
	Rhagidiidae	0.3	1.4	-	-	-	-
	Eupodidae	0.3	1.5	0.9	4.5	-	-
	Tydeidae	-	-	-	-	-	-
	Raphignatidae	-	-	-	-	-	-
	Penthalodidae	-	-	-	-	-	-
	Erytharaeidae	-	-	-	-	-	-
	TOTAL 2	5.4	35.7	3.3	16.6	0.6	4.3
TOTAL (1+2)		21.0	100	19.8	100	13.8	100

x = average density of individuals / 100 cm ^{2}
Dr % = relative density.

metabolism of the respective chemical substances, of which the sarcophagus that serve them as food, through these accumulations, at some point, a lethal threshold is reached, which causes the reduction or disappearance of many zoophagous groups.

Table 4. Mesofauna of microarthropods (on average per trophic group) from the soil depending on the dose an the era of herbicide application. // Mezofauna microartropodelor (în medie pe grupe trofice) din sol în funcție de doza și epoca de aplicare a erbicidului.

Alternative	**Distance between rows (cm)**	**Trophic groups**			
		Detritomicrophytophages		**Zoophagouss**	
		No. individual / 100 cm ^{2} soil	**%**	**No. individual / 100 cm ^{2} soil**	**%**
Unhoed - untreated	50	14.1	82.5	3.0	17.5
Manually hoeing	50	15.9	84.1	3.0	15.9
1 l/ha before sowing	50	26.4	88.0	3.6	12.0
1.5 l/ha before sowing	50	19.2	80.0	4.8	20.0
1l/ha before plants emerge	50	15.9	94.6	0.9	5.4
1.5 l/ha before plants emerge	50	35.4	86.3	5,6	13.7
1 l/ha after plants emerge	50	25.2	91.3	2.4	8.7
1.5 l/ha after plants emerge	50	21.0	100.0	-	-
Unhoed - untreated	30	15.6	74.3	5.4	35.7
Manually hoeing	30	16.5	83.4	3.3	16.6
1.5 l/ha before plants emerge	30	13.2	95.7	0.6	4.3

CONCLUSIONS

1. Regarding the edaphic microarthropod communities, no significant quantitative differences were observed between the variants studied. The only changes found refer to the trophic structure of the edaphic microarthropod community, both through the disappearance of phytophagous groups, whose sources have been reduced as a result of the removal of weeds, and through the decrease in the percentage of participation of predators, until their total disappearance, groups with increased sensitivity to chemicals.

2. From the analysis of the numerical ratio between the two groups, linked by trophic relationships, it reveals an increased numerical dominance of the detritomicrophytophages in all the variants studied compared to the group of zoophagous, which suggests a negative influence of the herbicide on the zoophagous where in the variant treated with herbicide in the maximum dose, applied after the emergence of broad bean plants, zoophagous are completely absent.

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Table 3 The values of some ecological parameters of the edaphic microarthropod communities in the organic horizon of the analyzed variants sown 50 cm between the rows // Valorile unor parametri ecologici ai comunităţilor de microartropode edafice din orizontul organic al variantelor analizate semănate la 50 cm între rânduri

Trophic groups	**Systematic groups**	**Sown 50 cm between the rows**															
		BLANK				**before sowing**				**before sunrise**				**after sunrise**			
		unbroken		**hoeing**		**1 l / ha**		**1.5 l / ha**		**1 l / ha**		**1.5 l / ha**		**1 l/ha**		**1.5 l/ha**	
		x	**dr%**	**x**	**dr%**	**x**	**dr%**	**x**	**dr%**	**x**	**dr%**	**x**	**dr%**	**x**	**dr%**	**X**	**dr%**
Debris-micro-phytophages	***Oribatida***	5.7	33.4	2.4	12.7	6.6	22.0	3.6	15.0	3.9	23.2	7,8	19.0	13.2	47.8	3.0	14.3
	Collembola	2.1	12.3	6.3	33.8	4.8	16.0	3.6	15.0	3.9	23.2	8.4	20.5	3.0	10.9	6.9	32.8
	Other insects	5.1	29.8	6.6	34.9	13.8	46.0	12.0	50.0	8.1	48.2	18.6	45.3	9.0	32.6	11.1	52.9
	The mite	-	-	-	-	0.5	2.0	-	-	-	-	-	-	-	-	-	-
	Tarsonemidae	0.9	5.3	0.3	1.6	0.6	2.0	-	-	-	-	0.6	1.5	-	-	-	-
	Pygmephoridae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Scutacaridae	0.3	1.7	0.3	1.6	-	-	-	-	-	-	-	-	-	-	-	-
	TOTAL 1	14.1	82.5	15.9	84.1	26.4	88.0	19.2	80.0	15.9	94.6	65.4	86.3	25.2	91.3	21.0	100
	Gamasida	2.1	12.3	1,2	6.3	1.8	6.0	3.6	15.0	0.9	5.4	4.2	10.2	1.8	6.5	-	-
	Ereynetidae	-	-	0.3	1.6	-	-	1,2	5.0	-	-	0.6	1.5	-	-	-	-
	Cunaxidae	-	-	0.3	1.6	-	-	-	-	-	-	0.6	1.5	-	-	-	-
	Rhagidiidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Eupodidae	0.3	1.7	0.6	3.2	0.6	2.0	-	-	-	-	0.2	0.5	-	-	-	-
	Tydeidae	0.6	3.5	-	-	1,2	4.0	-	-	-	-	-	-	-	-	-	-
	Raphignatidae	-	-	0.3	1.6	-	--	-	-	-	-	-	-	-	-	-	-
	Penthalodidae	-	-	0.3	1.6	-	--	-	-	-	-	-	-	-	-	-	-
	Erytharaeidae	-	-	-	-	-	--	-	-	-	-	-	-	0.6	2.2	-	-
	TOTAL 2	3.0	17.5	3.0	15.9	3.6	12.0	4.8	20.0	0.9	5.4	5,6	13.7	2.4	8.7	-	-
TOTAL (1+2)		**17.1**	**100**	**18.9**	**100**	**30.0**	**100**	**24.0**	**100**	**16.8**	**100**	**41.0**	**100**	**27.6**	**100**	**21.0**	**100**

X = average density of individuals / 100cm ^{2}
dr % = relative density.

DACTYLIS GLOMERATA L., PROSPECTIVE CULTIVAR CREATED IN THE WESTERN ROMANIA

DACTYLIS GLOMERATA L., SOI DE PERSPECTIVĂ CREAT ÎN VESTUL ROMÂNIEI

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ABSTRACT
The paper analyzes the results of the technical examination for the new cultivar of Dactylis glomerata L., created at Agricultural Research and Development Station Lovrin, SCDA Lovrin, examination that was carried out with the purpose of enrolling the new cultivar in the The Official Catalog of cultivated plant varieties from Romania. Two genotypes of Dactylis glomerata L., the synthetic LVDG1 cultivar as a tester and the homologated Magda cultivar as control were used as biological material. The tests were carried out in the 2021-2023 period, on the territories of six administrative-territorial units, distributed in different geographical areas of our country: Șimleu Silvanei, Dej, Satu Mare, Sibiu, Negrești și Rădăuți. The tests followed the main quantitative characteristics (production of dry matter and fresh fodder) but also features such as spring growth vigour, regeneration capacity, drought resistance, resistance to falling and resistance to disease. From the tests carried out in the ISTIS network, it follows that the LVDG1 cultivar met the criteria for homologation, being approved in 2024 with the final name of Theodor. The maximum dry matter yields for the new cultivar were on average 21.5 t/ha D.M., with a suitable quality in nutritional elements, good regeneration capacity, and, good resistance to climatic factors, falling and disease. Dactylis glomerata L. is a perennial grass that also grows spontaneously in the meadows of Romania. It is an important species in the composition of simple and complex feed mixtures, therefore it is of great importance in breeding and conservation programmes.

Keywords: Dactylis glomerata L., synthetic cultivar, homologation, biological yields and characteristics.

REZUMAT
Lucrarea analizează rezultatele examinării tehnice pentru noul soi de Dactylis glomerata L., creat la SCDA Lovrin, examinare care s-a realizat cu scopul înscrierii noului soi în Catalogul oficial al soiurilor de plante de cultură din România. Ca material biologic au fost folosite două genotipuri de Dactylis glomerata L., soiul sintetic LVDG1 ca tester și soiul omologat Magda ca martor. Testările au fost efectuate în perioada 2021-2023, pe teritorile a șase unităţi administrativ-teritoriale, repartizate în diferite zone geografice ale țării noastre: Şimleu Silvanei, Dej, Satu Mare, Sibiu, Negrești și Rădăuți. Testările au urmărit principalele caractere cantitative (producţia de substanță uscată și de masă verde), dar și însușiri precum vigoarea de creștere în primăvară, capacitatea de regenerare, rezistența la secetă, rezistența la cădere și rezistența la boli. Din testele efectuate în rețeaua ISTIS, rezultă că soiul LVDG1 a întrunit criteriile pentru omolagare, fiind omologat în anul 2024 cu denumirea definitivă de Theodor. Producțiile maxime de substanță uscată pentru noul soi au fost în medie de 21,5 t/ha s.u., cu o calitate corespunzătoare în elemente nutritive, o capacitate de regenerare bună, rezistență bună la factorii climatici, cădere și boli. Dactylis glomerata L. este o graminee perenă care creşte spontan și în pajiștile din România. Este o specie importantă în alcătuirea amestecurilor furajere simple şi complexe, de aceea reprezintă o importanță deosebită în programele de ameliorare și conservare.

Cuvinte cheie**: **Dactylis glomerata L., soi sintetic, omologare, producții și însușiri biologice.

INTRODUCTION

Dactylis glomerata L. it belongs to the genus *Dactylis*, a taxonomic group in the Festuceae tribe, which has several subspecies with varying degrees of ploidy. *Dactylis glomerata* ssp. *glomerata* is a perennial, autotetraploid fodder plant (2n = 4x = 28), characterized by high ecological plasticity and high variability. Present in North Africa, Europe, some temperate areas of Asia (Varga et al., 1998), it is also found in a spontaneous condition in the Romanian meadows (Moisuc et al., 1997, Moisuc et al., 2000; Maruşca et al., 2019). Within this species there are various diploid, tetraploid, and hexaploid subspecies, the largest distribution being represented by the tetraploid forms, due to the high degree of heterozygosity also assuring them with high adaptability (Varga et al 1998).

It is a widely appreciated and used species due to its high perenniality, high production potential and fodder quality (Iacob et al., 2015). It can provide 3-6 cycles of harvest per year (Iacob et al., 2000), being cultivated both alone and mixed with various grasses and fodder legumes; it is also used in agrosilvopastoral systems along with alfalfa, clover, birdsfoot trefoil etc. (Iacob et al., 2015). Following a study conducted by A. P. Kyriazopoulos et al. (2012) *Dactylis glomerata* has been found to be one of the most tolerant species of perennial grasses, with the results clearly showing that production continues to be high under direct sun conditions, semi-shadow but also complete shading caused by trees. Rainfall also contributes to a better expression of vegetative parameters, including the production of fresh fodder for scythe I (Rechițean et al., 2021).

From the point of view of the feed quality, the orchard grass feed is devoid of alkaloids and mycotoxins (Barnes et al., 2007), therefore, it does not compete with other grasses due to the fact that it does not contain allelopathic substances that inhibit the growth and development of other species such as *Festuca rubra*, *Lolium perenne* or *Poa pratensis* (Bostan et al., 2012). The content in crude protein can reach up to 20% D.M., the content decreasing with the maturity and beginning of the flowering phenophase, respectively of the fruiting, at which time the content of fibre increases proportionally (Inra, 2007, Edwards et al., 1993).

The feed should be harvested in the flowering phenophase to ensure the maximum nutrient content being administered mainly for increasing lactation in ruminants (Jonker et al., 2002), with high palatability (Diaz, A., 2000.), being consumed with pleasure both in the form of fresh feed and in the form of hay. Of course, even if it is administered predominantly to ruminants, we also emphasize its importance for feeding other animals, both from households and natural fauna. This is why the presence of this species in natural grassland is once again proved to be essential.

This species is part of many breeding programs internationally due to its high tolerance to drought and frost (D. Sokolović, 2016) and due to its high morphological variability (Lindner et al., 2004), which allows to select and breed new genotypes. The breeding objectives for this species are represented by the increase in feed production, tolerance and resistance to diseases (especially to rust – *Puccinia graminis*), and, high drought and low-temperature tolerance (Alderson and Sharp, 1995), but also improved feed quality. Orchard grass is a species with rich genetic diversity, being introduced in breeding and conservation programs, especially due to climate change, but also due to the high need for feed production (O'Mara, 2012).

In Romania, between the years 1982 and 2005, five varieties of *Dactylis glomerata* were authorized: Poiana (1982), Intensiv (1988), Regent (1999), Magda (2004) and Simina (2005), all being bred for use in both hay meadows and pastures (Mocanu and. Ene 2016). Currently, the following varieties of Orchard grass are listed in the The Official Catalog of cultivated plant varieties from Romania: Bardasha, registered in 2021, maintainer – Barenbrug Holland B.V.; Barlargo, registered in 2022, maintainer – Barenbrug Holland B.V.; Barlegro, registered in 2011, maintainer – Barenbrug Holland B.V.; Intensiv, registered in 1988, re-enrolled in 2018, maintainer – Research and Development Institute for Meadows Brașov; Magda, registered in 2004, re-registered in 2017, maintainer - Research and Development Institute for Meadows Brașov.

MATERIAL AND METHODS

The experimental fields were located on the territories of six administrative-territorial units, distributed in different geographical areas of our country: Șimleul Silvanei, Dej, Satu Mare, Sibiu, Negrești and Rădăuți.

The experiments were placed on an identical general agrofund for each test centre and under the same physico-geographical conditions specific to each centre.

Two genotypes of *Dactylis glomerata* L. were used as biological material, line LVDG1 as tester and approved cultivar Magda as control.

LVDG1 is a synthetic cultivar that has as parents clones extracted from local populations from the plain area of Banat (Romania), clones whose overall combinative capacity has been verified by the polycross method.

According to Gallais (1990), a synthetic cultivar is an artificial population resulting from the sexual multiplication over several generations of the offspring by free pollination, of a limited number of constituents (clones, families, lines).

The research/tests looked at the main quantitative characteristics (dry matter and fresh fodder production), but also characteristics such as growth vigor in spring, regeneration capacity, drought resistance, fall resistance and disease resistance. In the studies performed, the LVDG1 line was compared with the Magda control cultivar.

Data interpretation and processing were performed with microsoft excel (Office 365) - Data Analysis, which used descriptive statistics, Box Plot graphs and variance analysis (ANOVA).

RESULTS AND DISCUSSION

In accordance with the provisions of Law nr. 266/2002, on production, processing, quality control and certification, marketing of seeds and planting material, as well as registration of plant varieties, State Institute for Cultivar Testing and Registration (ISTIS) technically examines the Romanian and foreign varieties for which registration is requested in the Official Catalogue of varieties of crop plants in Romania, in order to be marketed on the territory of Romania and the Member States of the European Union (Ivașcu și Ciora, 2008).

Registration of varieties of field crop species are based on the test of distinctiveness, uniformity and stability (DUS) and the Agronomic Value and Use Test (VAU). A cultivar shall be accepted for registration only if it is distinct, stable and sufficiently uniform and has satisfactory value for cultivation and use (Ivașcu și Ciora, 2008).

Yield results expressed in tonnes per ha dry matter were analysed and represented using Box Plot graphs for each year 2021-2023, as well as variance analysis.

In the first year of testing (2021) in ISTIS centers, the control represented by the Magda cultivar recorded an average yield of 8.5 t / ha DM, and the cultivar under test (LVDG1 provisional name) produced on average 9 t/ha D.M. The calculated median is 7,2 t/ha DM for the control and 7,6 t/ha DM for the tested cultivar; 21,1 and 22,6 represent the maximum dry matter yields obtained for the control and the tested cultivar, and 2,2 and 2,1 represent the minimum yield values recorded. The values 13.15 and 13.6 represent the quartile that shows us that below it are 75% of the obtained values and 25% above it, and 2.65 and 2.925 represent another quartile that shows us that above it are 75% of the values and below it 25% of the values (Fig. 1).

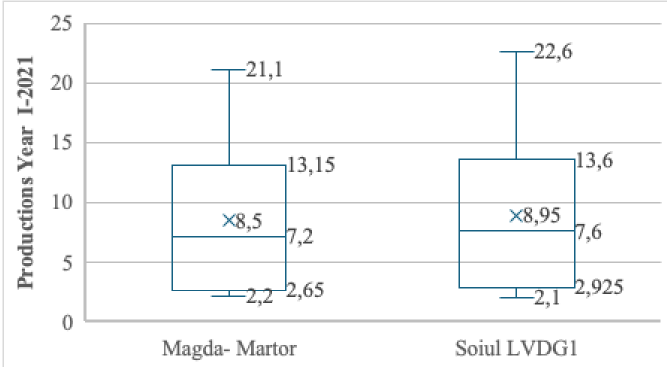

Figure 1. Graphical representation of the yield results recorded in the control cultivar and the tested cultivar, in 2021// Reprezentarea grafică a rezultatelor randamentului înregistrate în cultivarul de control și în cultivarul testat, în 2021

Table 1. Variance analysis table for 2021// Tabelul de analiză a variantelor pentru 2021

SUMMARY	**Magda- Control**	**LVDG1 Cultivar**	**Total**
Year I - 2021			
Count	6	6	12
Sum	51	53,7	104,7
Average	8,5	8,95	8,725
Variance	48,96	55,319	47,45477

Summing up the yields obtained in the 6 test centres, expressed in t/ha, it is noted that the cultivar exceeds the control by 3.7 t/ha DM, the calculated average shows a difference of 0.5 t/ha., in the first year of testing (Table 1).

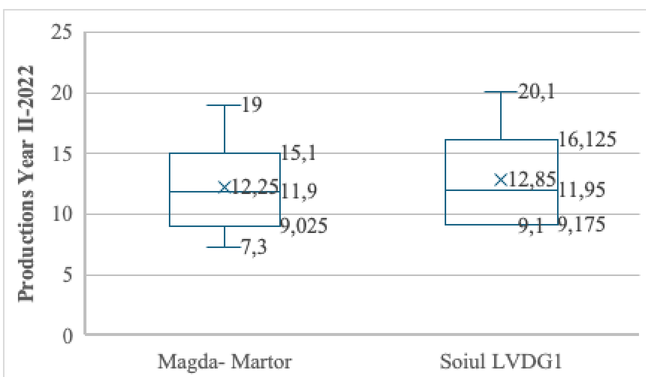

Figure 2. Graphical representation of the yield results recorded in the control cultivar and the tested cultivar, in 2022// Reprezentarea grafică a rezultatelor randamentului înregistrate în cultivarul de control și în cultivarul testat, în 2022

Table 2. Variance analysis table for 2022// Tabelul de analiză a variantelor pentru 2022

SUMMARY	**Magda- Control**	**LVDG1 Cultivar**	**Total**
Year II-2022			
Count	6	6	12
Sum	73,5	77,1	150,6
Average	12,25	12,85	12,55
Variance	16,431	18,163	15,82273

In the second year of testing in ISTIS centers, Box Plot graphs interpreted the results according to the same principle, being observed that the medians are close between the control and the tested cultivar (11.9 and 11.95 t/ha DM), with a maximum of 19 t/ha D.M for the control in the center of Șimleu Silvanei and 20.1 t/ha D.M for the cultivar LVDG1 in the center of Șimleu Silvanei, the minimum values are 7.3 for the control and 9.025 t/ha D.M. for LVDG1 in the Radauti center. In the second year of testing, the Orchard grass cultivar LVDG1 exceeds the control analyzed in culture (Fig. 2).

The sum of yields obtained in all test centres was 77,1 t/ha for the tested cultivar and 73,5 t/ha for the Magda control, the difference of the calculated mean being 0,6 t/ha between the LVDG1 cultivar and the Magda control (Tab. 2).

The third year of testing reveal an increase in dry matter yields for both the tested cultivar and the control, with a maximum yield of 22.6 t/ha for the Magda control in the Dej center and 28.9 t/ha for the LVDG1 cultivar in the Negresti center. The lowest yields were recorded in Radauti, both for the control (12.8 t/ha) and for the LVDG1 cultivar (15.2 t/ha D.M.).

A comparison between the sum of yields obtained on all centres, in year III (2023), shows that the control cultivar Magda obtained 112.5 t / ha D.M. and the cultivar LVDG1 recorded 128.7 t / ha D.M., the difference between the two being 16.2 t / ha D.M.

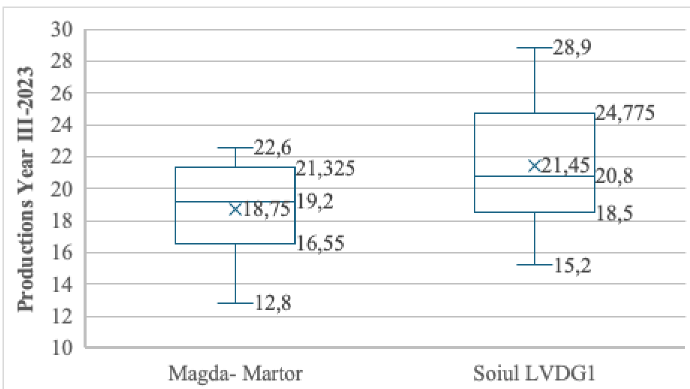

Figure 3. Graphical representation of the yield results recorded in the control cultivar and the tested cultivar, in 2023// Reprezentarea grafică a rezultatelor randamentului înregistrate în cultivarul de control și în cultivarul testat, în 2023

Table 3. Variance analysis table for 2023// Tabel de analiză a variațelor pentru 2023

SUMMARY	**Magda- Control**	**LVDG1 Cultivar**	**Total**
Year III-2023			
Count	6	6	12
Sum	112,5	128,7	241,2
Average	18,75	21,45	20,1
Variance	11,267	20,527	16,44

Table 4. Variance analysis for experimental cycle 2021-2023// Analiza variantelor pentru ciclul experimental 2021-2023

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Sample	804,095	2	402,0475	14,13445	4,73441E-05	3,31583
Columns	14,0625	1	14,0625	0,494384	0,487399423	4,170877
Interaction	9,495	2	4,7475	0,166904	0,84706128	3,31583
Within	853,335	30	28,4445			
Total	**1680,988**	**35**				

The statistical processing of the results obtained between 2021 and 2023, by *the method of Variance Analysis* (ANOVA), between the new cultivar of *Dactylis glomerata* L. and the analyzed control, reveals a very significant difference for the probability of transgression of 0,05 %.

The agricultural year, as a factor, also has a very significant influence on yield. The climatic conditions of the three experimental years reveal the productive potential of the new cultivar. The highest yields were obtained in the 2023 crop year, in all 6 testing centers and also at ARDS Lovrin, the percentage difference between the first and third year of testing for the LVDG1 cultivar is 8.8 percent, and in absolute values of 12.5 t/ha D.M.

In the first year of testing in the ISTIS network, the LVDG1 cultivar recorded an average dry matter yield of 9 t/ha. In the second year of testing in the ISTIS network, the cultivar recorded an average production of 12.9 t / ha dry matter, and in the third year of testing the average yield was 21.5 t / ha dry matter.

The value for cultivation and use of a cultivar shall be considered satisfactory if, compared with other varieties entered in the Official Catalogue, its qualities, taken as a whole, offer, at least in regards of production, in any area concerned, a clear improvement, either in regards of cultivation or in regards of the use made of the crop or products derived from it (Ivașcu și Ciora, 2008).

Description of the *Dactylis glomerata* L. cultivar - LVDG1

The cultivar LVDG1 is a synthetic cultivar, resulting from the sexual multiplication for several generations of the offspring by free pollination, of clones extracted from local populations in the plain area of Banat; The cultivar is created by selection methods and polycross.

It is a tetraploid, uniform and stable cultivar. It has erect stalks, the plant height reaches up to 1.4-1.7 m, the inflorescence is a panicle up to 20-22 cm long.

It is an early cultivar, shows good growth vigor in spring, good and very good regeneration capacity, resistance to drought, falling and diseases, with a good perennity of over 5 years. Nutrient content: in the vegetative stage crude protein 13.5%, crude fiber 22%; spikelet phenophase crude protein 7.7%, crude fiber 33%.

The LVDG1 cultivar has a fresh fodder yield capacity between 50-100 t/ha, and an average seed yield of 600-700 kg/ha, with a MMB (the mass of a thousand grains) = 0.9-1.3 g.

CONCLUSIONS

From the tests carried out in the network of the State Institute for Cultivar Testing and Registration (ISTIS), between 2021 and 2023, the LVDG1 cultivar fulfiled the criteria for homologation and was approved in 2024 with the definitive name of Theodor.

The maximum dry matter yields for the approved cultivar averaged 21.5 t/ha D.M., with adequate nutrient quality, good regeneration capacity, good resistance to climatic factors, falling and diseases, with a good durability of over 5 years.

Currently, in The Official Catalog of cultivated plant varieties from Romania, 5 more varieties of *Dactylis glomerata L* are listed.: Bardasha (2021), Barlargo (2022), Barlegro (2011), and, Intensive (2018, re-enrolled in 2018), Magda (2017), Theodor cultivar (LVDG1) being the latest cultivar registered.

The Theodor cultivar (LVDG1) is being multiplied at ARDS Lovrin. It is recommended for cultivation in all areas meant for Orchard grass culture, for fresh fodder, hay, silo and seeds, both in pure culture and in various simple and complex mixtures, with other fodder grasses and legumes and for the establishment of meadows.

Potential beneficiaries are livestock farms and seed production.

Figure 4. *Dactylis glomerata* –LVDG1 Cultivar (© foto Cristian Bostan)

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VARIABILITY OF FELIX MAIZE COBS MORPHOLOGY IN CONTRASTING CLIMATE CONDITIONS

VARIABILITATEA MORFOLOGICĂ A ȘTIULETELUI HIBRIDULUI DE PORUMB FELIX, ÎN CONDIȚII CLIMATICE CONTRASTANTE

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ABSTRACT

Currently, maize plants know permanent evolutions of productive potential, quality, different resistances, etc. The morphology of the plant in general, but also the cobs express true productive performances. However, the expression of the morphological characters of the cobs is closely related to the natural provision of water. Being a moisture-loving plant, it frequently encounters periods of deficiency, especially during the period of deposition of dry matter in the grains. The intensity of these periods of drought causes some depressions in the expression of the morphology of the stylets and grains respectively. In the present research, the cobs of the Felix hybrid obtained in three different years are compared, namely one with a dry background, one intermediate and another relatively normal, but in all three years there were periods with obvious accents of drought. From the data obtained, the cobs affected by the drought were 2 cm shorter in length and 0.5 cm shorter in thickness. Cob weight was reduced by 70 g, the number of kernels per cob was reduced by 35, and kernel mass was also reduced by 65 g. The kernel yield of cobs was reduced by 1 %. The grain sizes showed decreases of 1 mm in length, the width remained about the same, and the grain thickness was less by 0.4 mm. The mass of one thousand grains decreased by 90 g.

Key words: grains, Felix, maize , cobs, variability

REZUMAT

Actual, plantele de porumb cunosc evoluții permenente ale potențiaului productiv, de calitate, ale diferitelor rezistențe etc. Morfologia plantei în general, dar și știuleții exprimă adevărate performanțe productive. Exprimarea caracterelor morfologice ale știuleților este însă în strânsă legătură cu asigurarea naturală a apei. Fiind o plantă iubitoare și de umiditate, frecvent întâlnește și perioade cu deficit, în special în intervalul depunerii de substanță uscată în boabe. Intensitatea acestor perioade de secetă provoacă unele depresiuni în exprimarea morfologiei știleților și respectv ale boabelor. În cercetarea de față se compară știuleții hibridului Felix obținuți în trei ani diferiți și-anume unul cu fond secetos, unul intermediar și altul relativ normal. Însă în toți cei trei ani s-au înregistrat perioade cu accente evidente de secetă. Din datele obținute știuleții afectați de secetă au avut lungimi mai mici cu 2 cm și grosimi mai reduse cu 0.5 cm. Greutatea știuleților a fost mai redusă cu 70 g, numărul de boabe de pe un știulete a fost mai mic cu 35, iar masa boabelor s-a redus de-asemenea cu 65 g. Randamentul în boabe al știuleților a fost redus cu 1 %. Dimensiunile boabelor au arătat scăderi cu 1 mm la lungime, lățimea s-a menținut aproximativ la același nivel, iar grosimea boabelor a fost mai mică cu 0.4 mm. Masa a o mie de boabe a scăzut cu 90 g.

Cuvinte cheie**: **boabe, Felix, porumb, știuleți, variabilitate

INTRODUCTION

Maize (*Zea mays* L.) is one of the most widely distributed cereals in the world (BYERLEE, 2020). The content of the grains represents an important source of nutrients along with a multitude of compounds such as carotenoids, phenolic components, phytosterols, etc. all with important roles in our existence (DOEBLEY, 2004). Over time, the plant has seen obvious evolutions in desirable characters, including resistance to longer or shorter periods of drought. Maize is now considered an important model for genetics and for biology. At the moment, when the expression of the phenomenon of global warming takes place, new ways must be found (ORT & LONG, 2014) to allow the new genetic creations of maize to be more tolerant, sometimes even resistant to the phenomenon of drought. The researches of the last decade have focused in particular on some changes in plant morphology, but also on new expressions of maize physiology. Thus, some studies were carried out with the aim of proving a certain degree of tolerance to drought (ASHRAF, 2010; ARAÚJO et al., 2015), and others to demonstrate the formation of maize grains in hybrids grown under conditions of water limitation (BOYER & WESTGATE, 2004; DE SOUSA et al., 2013; GARCIA-LARA et al., 2019). Important results were obtained with some modifications of the root system in increasing drought resistance (CAI et al., 2012; POSTMA et al., 2014). New researches have been conducted for some cortical parenchyma tissue changes in maize root (BOURANIS et al., 2006; ZHU et al., 2010; CHIMUNGU et al., 2014a; CHIMUNGU et al., 2014b). At the same time, new results were obtained regarding the finding of new genes with drought tolerance, either in several crop plants (ALTER et al., 2015) or in the case of maize (COOPER et al., 2014). Maize in its diploid form contains 2n = 2x (2x10) = 20 chromosomes, it fixes carbon on the C4 type, also having an increased efficiency of water utilization.

Botanically, the plant is a unisexual monoecious species, with the female flowers grouped in a spike-type inflorescence, with a thickened axis (spadix). The ear of maize has a long stigma with a role in the capture of pollen grains, an ovary from which the specific grains, glumes and blades at the base develop. The mature cob is 3-50 cm long and 1.5-6 cm in diameter, being cylindrical, cylindrical-conical or fusiform. Their weight is between 50 and 500 gr.; 8-20 rows of grains are formed on a cob. The bean is a caryopsis with great variability in shape, size and color. In the literature, maize kernels are shown to be 2.5-22 mm long, 3-18 mm wide and 2.7-8 mm thick, and the weight of one thousand kernels is 30-1200 g. The Felix hybrid studied has large cobs with red spadix and the grains a normal yellow. The hybrid belongs to the *indentata* form (*Zea mays* var. *indentata*, dent maize).

Research carried out to observe the variation of some characters of maize cobs, influenced by periods of drought (Ashraf, 2010) included: total length, diameter in the central zone (at middle of length), absolute weight, total number of kernels, weight of kernels/cob, yield in kernels, grain length, width and thickness, as well as thousand grain mass (MMB).

MATERIALS AND METHODS

The variants were cultivated in the last 3 years (2020-2022) with the Felix hybrid, from the semi-late group, FAO 400-450. The experience was established according to the block method, with variants of 25 m^2 each in 4 repetitions. The technology used was the one recommended by the resort. At full maturity, 25 cobs were randomly chosen from each repetition (100 in total), cut and brought to the laboratory. The 100 cobs were measured and determined: total length, thickness in the central area, weight, total number of grains, total weight of grains, grain yield, grain length, grain width and thickness, mass of one thousand grains. The quality determined in the last year refers to the contents of protein, starch, oil and moisture at harvest. The obtained morphological characters were analyzed by the histogram method (frequency polygons). In expressing them, the class intervals established according to the specific string of values obtained were used. The study highlighted several aspects, namely: a) the mode values (with the highest frequencies), b) the limits of the variability intervals of the studied characters and c) the specificity of each character of the maize ecotype in the analyzed area. Correlations were established between the analyzed characters, with the help of which their trends could also be observed within the studied hybrid. The Excel program was used to express the values. The significance of the correlation coefficients was obtained by comparison with the r_{max} values for the 5%, 1% and 0.1% levels of transgression probabilities. The quality indices were obtained with the help of the Perkin Elmer Inframatic 9500 analyzer. In the statistical calculation of all the values obtained, the analysis of variance (Anova test) was used on the variation strings. Statistical parameters were calculated using the formulas: $\bar{a} = \Sigma x/n$, where $\bar{a}$ = the average of the determinations, and x = the determined values, S^2 (variance) = $1/n-1[\Sigma x^2-(\Sigma x)^2/n]$, S (standard error) = $\sqrt{(S^2)}$ and S% (coefficient of variation) = $s/\bar{a}$ x100.

RESULTS AND DISCUSSION

Climatic characterization from maize vegetation. In general, the cultivation area has a favorable climatic regime from the beginning of vegetation to flowering (table 1). The peak of rains is in May-June, after which the water deficit sets in until harvest. The lack of water thus affects the deposition of nutrients in the grain, closely related to the level of water reserve in the soil. The normal thermal regime was exceeded in the months of July-August in the first two years and starting from May until maturity in the last year. For the maize vegetation, the average temperatures exceeded the multiannual values by 0.78^0 C, 0.66^0 C and 1.44^0C, respectively. The rain regime of the maize vegetation highlights the possibilities that the plant had in the formation of cobs and grains.

Table 1. Evolution of climatic factors in maize vegetation, Felix hybrid
Evoluția factorilor climatici în vegetația porumbului, hibridul Felix

Month	Temperatures, tn^0C				Rainfalls, mm				Potential evapotranspiration PET
	Normal	2020	2021	2022	Normal	2020	2021	2022	mm
Apr.	11,0	11,8	9,0	10,8	56	24	47	**66**	65
May	16,3	15,8	16,0	**17,1**	81	**92**	**95**	**77**	**77**
Iun.	19,5	19,9	19,9	**21,6**	94	**138**	80	14	95
Iul.	21,7	**22,6**	**24,5**	**23,8**	81	10	50	71	152
Aug.	21,3	**23,6**	**23,7**	**23,7**	60	33	47	**105**	111
Mean,/sum	17,96	18,74	18,62	19,40	372	297	319	333	500
	±	**+0,78**	**+0,66**	**+1,44**	±	**-75**	**-53**	**-39**	

PET- potential evapotranspiration

As the volume of precipitation approached the required, consumption, the favorability of that year was more obvious. Of the three years analyzed, the year 2020 came the least close to what was needed, being followed by the other two years with relatively smaller deficits. Potential evapotranspiration shows that much larger amounts of water are needed for maize. Instead, each year the distribution of monthly rainfall was different in the sense that in the first year, although the spring had slightly better rainfall, a 62-day period of very low rainfall followed, and the maize suffered a drought that affected cob and grain formation. In the second year, 2021, the level of rainfall in the growth and development of the plants was more uniform and thus the production formed was affected to a lesser degree. In the last year, the April-May period had relatively normal water, which made the plants grow at normal values. The good water supply from the cold season also contributed to this condition. June followed with little rain, so the period qualified as dry. However, July followed with rains close to normal and especially August with an extra 45 liters above normal, so that the maize plants formed cobs and grains close to the morphological characteristics of the hybrid. From these data it emerged that the Felix hybrid suffered from drought more in the first year, somewhat better in the second year and behaved much better in the last year of culture.

Variability of maize cobs and kernels. The appearance and dimensions of the cob of this maize hybrid exhibited characteristic aspects. Thus, at the level of three years, the length was generally between 14 and 24 cm. Lengths of 17 cm in the first year and 19-20 cm in the other two years dominated (figure 1). The graph shows the influence of the rainfall regime in the formation of the cobs, of which the favorable year 2022 was highlighted. The thickness of the cobs in their central portion was generally between 3 and 5.6 cm (figure 2). Dominant thicknesses were 4.5 cm in the first (2020) year and 4.8 cm in the other two years.

The number of grains/cobs was between 400 and 850, at the level of the three years of cultivation (figure 5). Among them, cobs dominated with 600 grains in all three years. Instead, in recent years with somewhat better favorability, cobs with 800-850 beans have also been determined. Regarding the weight of these grains on a cob, the values ranged from below 100 to 4000 g (figure 6). The grain biomasses of 120 g/cob in the unfavorable climatic year 2020 and 200 g in the other two years whwrw recorded, with the less dry background, 2021 and 2022, were dominant. And in this case, cobs were determined in the last two years with grains weighing 280-300 g.

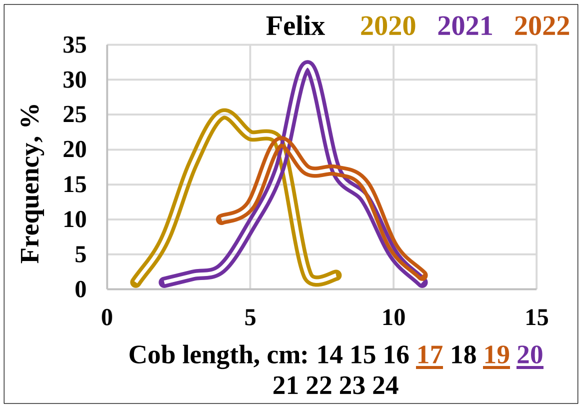

Fig. 1. Frequencies of cob length
Frecvențele lungimii știuletelui

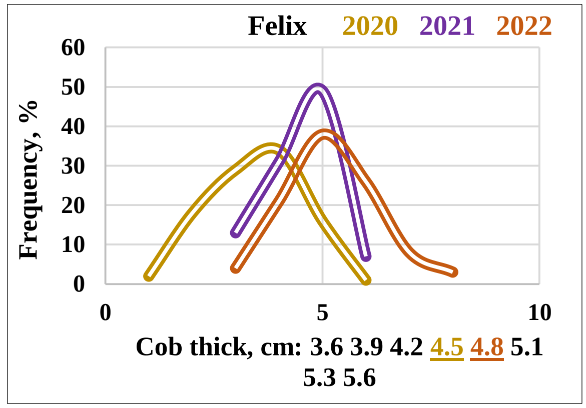

Fig. 2. Frequencies of cob thick
Frecvențele grosimii știuletelui

Cob weight was generally between 100 and 360 g (figure 3). Dominant buds weighed 160 g in the first unfavorable year and 240 g in the following two years. The appearance of the field with Felix hybrid plants in young phases is shown in figure 4.

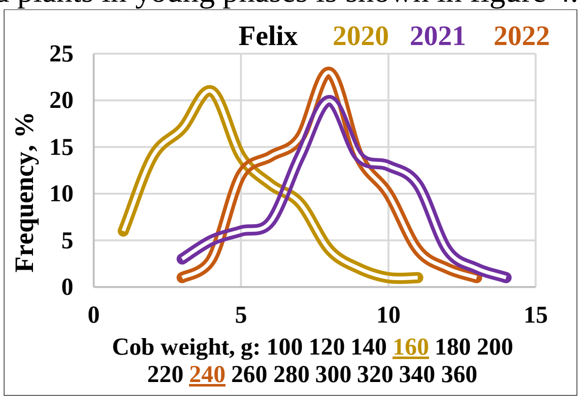

Fig. 3. Frequencies of cob weight
Frecvențele greutății știuletelui

Fig. 4. Felix hybrid, young period
Hibridul Felix, în perioada tânără

The grain yield of cobs fell within a wide range of values: 79% to 88%. Of these, 83% in the first year and 84% in the last years were dominant (figure 7). The absolute grain mass of the Felix hybrid was between 130 g as the lower limit and over 400 g as the upper limit. The dominant values were 220 g in the dry year 2020, 340 g in the second year and 370 g in the favorable year 2022 (figure 8).

The sizes of the grains corresponded to values characteristic of the hybrid and the researched period. Thus, the length (or height) of the grains was generally between 9 and 15 mm (figure 9). The dominant values were 11 mm in the first year and 12 mm in the last years. The width of these grains had as limits 6 mm and 10.5 mm (figure 10). The mode values for the three years were similar, namely 8 mm. The third dimension, grain thickness, was recorded between 3 mm and 6.5 mm (figure 11). The grains with smaller dominant thicknesses were in the first year, namely 4 mm. In the other two years, the grain thickness of 4.5 mm is dominant. Characteristics of the grains of this hybrid are shown in figure 8.

From a qualitative point of view, in the last year the grains of the Felix hybrid contained 9.5% protein, 3.7% oil, 71.3% starch, at a grain moisture of 13.5%.

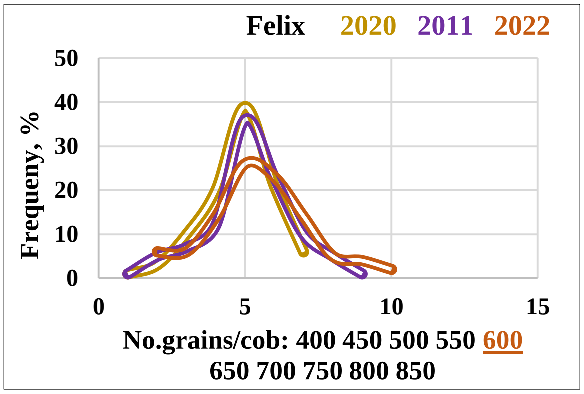

Fig. 5. Frequencies of grains number/cob
Frecvențele numărului de boabe/știulete

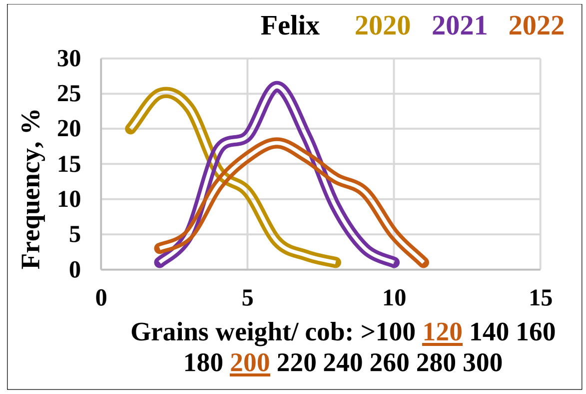

Fig. 6. Frequencies of grain weight/cob
Frecvențele greutății boabelor/știulete

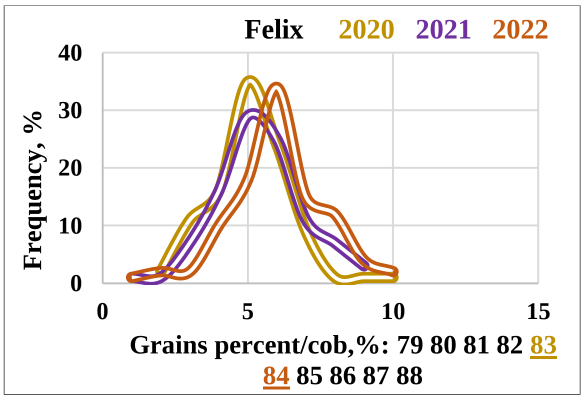

Fig. 7. Frequencies of grains percent/cob
Frecvențele randamentului în boabe

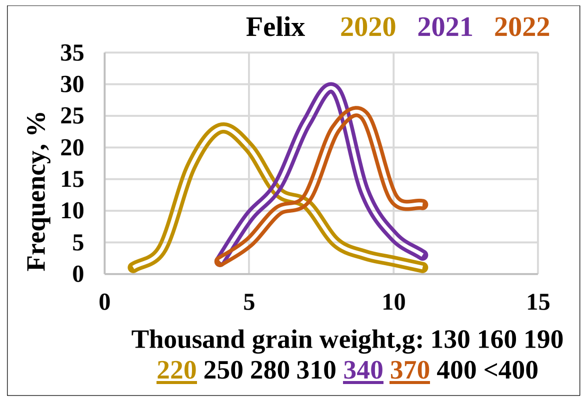

Fig.8. Frequencies of thousand grains weight-TGW
Frecvențele masei a o mie de boabe

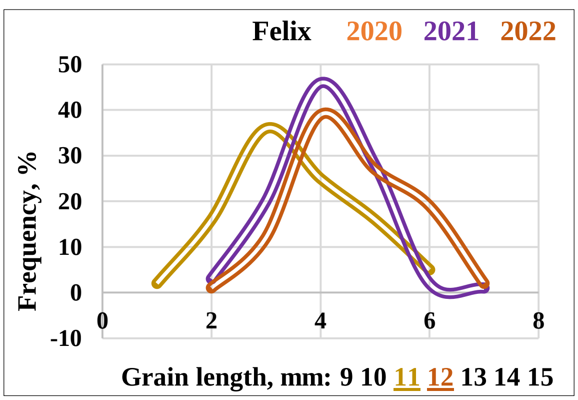

Fig. 9. Frequencies of grain length
Frecvențele lungimii bobului

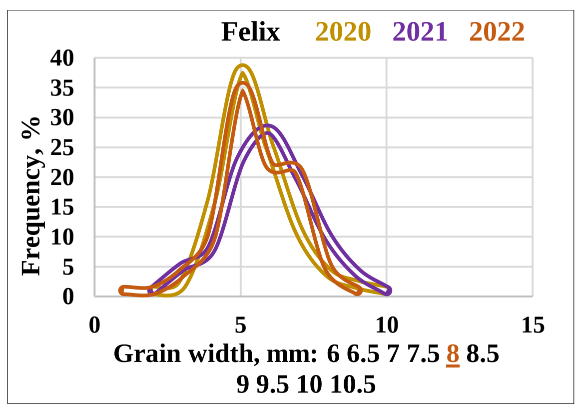

Fig. 10. Frequencies of grain width
Frecvențele lățimii bobului

Correlations between the main characters. If we analyze the entire set of correlations between all determined characters, both positive and negative situations are found. Very obvious positive correlations were observed between the characteristics of the cob: length, thickness, weight, total number of grains, total weight of grains. There were negative correlations in the first year between cob length and grain yield, but also between grain number and grain width (table 2). In the other two years'grain yield was significantly negatively correlated with all elements of cob size and cob weight. In general, the correlations obtained between the characters of this hybrid were under the influence of shorter or longer periods of drought, both during the period of intense growth and during the deposition of reserve substates in the grains.

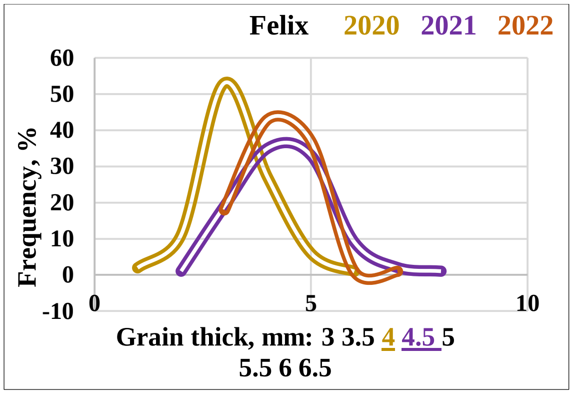

Fig. 11. Frequencies of grain thick
Frecvențele grosimii bobului

Fig. 12. Felix hybrid's cobs
Știuleții hibridului Felix

Statistical analysis of the variability of morphological characters in maize . The results obtained in the morphological analysis of the Felix hybrid characters in the three years showed specific aspects. Thus, the length of the cob was between 17.4 cm in 2020 and 19.9 cm in 2022.

Table 2. Correlations between the morphological characters of Felix maiz cobs// Corelații între caracterele morfologice ale știuleților hibridului Felix

Indices	Thick cob cm	Cob weight g	No. grains	Grain weight g	ŋ,% grains	Grain length mm	Grain width mm	Grain thick mm	TGW, g
	2020								
Cob length, cm	.703	.855	.510	.843	-.105	.617	.403	.382	.720
Cob thick, cm	1	.855	.598	.852	.081	.738	.205	.291	.652
Cob weight, g		1	.457	.998	.134	.780	.414	.374	,877
No.grains/cob			1	.454	.024	.410	-.255	.124	.108
Grain weight, g				1	.188	.784	.411	.372	,855
Grains%/cob					1	.183	.007	.020	.281
Grain length,mm						1	.299	.081	.694
Grain width,mm							1	.310	.596
Grain thick,mm								1	.364
	2021								
Cob length, cm	.267	.755	.615	.759	-.142	.266	.332	.249	-.006
Cob thick, cm	1	.663	.403	.647	-.352	.415	.524	-.036	.231
Cob weight, g		1	.631	.994	-.312	.530	.536	.194	.138
No.grains/cob			1	.657	.080	-.183	.258	-.184	-.095
Grain weight, g				1	-.219	.516	.552	.186	.140
Grains%/cob					1	-.265	-.197	-.134	-.033
Grain length,mm						1	.093	-.133	.473
Grain width,mm							1	.141	.478
Grain thick,mm								1	.291
	2022								
Cob length, cm	.476	.793	.649	.792	-.267	.397	.370	.105	.163
Cob thick, cm	1	.769	.462	.752	-.417	.437	.610	.176	.212
Cob weight, g		1	.608	.996	-.351	.632	.677	.172	.220
No.grains/cob			1	.628	.033	-.078	.252	-.203	.055
Grain weight, g				1	.271	.621	.672	.156	.220
Grains%/cob					1	-.320	-.259	-.212	-.033
Grain length,mm						1	.562	.423	.195
Grain width,mm							1	.150	-.047
Grain thick,mm								1	.217
	LSD 5 % = .190	LSD 1 % = .250	LSD 0.1 % = .320						

The variability demonstrated small coefficients, below 10%. The thickness of the cob measured 4.24 cm to 4.74 cm, with a variation also reduced, and its weight was between 157.0 g to 233.5 g (with medium to large variation). Average number of kernels per cob was 565.4 and 600.3 (average variability across years), and kernel weight per cob was 130.6 g to 195.9 g, with medium to high variability. Grain yield was between 83.1% in the first year and 84.0% in the first year. The three kernel dimensions, namely length, width and thickness had the lowest values in 2020 and higher in the relatively more favorable years, 2021 and 2022. The absolute kernel weight (MMB) averaged between 235.5 g in 2020, 309.1 g in the second year and 333.0 g in the third year of cultivation. The variability of this character was very high in the first year, medium in the second n and small in the last year. From the average values obtained, differences emerged that explain the influence of drought in the first year of culture and less obviously in the second and third year of culture (table 3).

Table 3. Statistical indices of Felix hybrid cob characters // Indici statistici ai caracterelor știuleților hibridului Felix

Indices	The cobs			Grains						
	Length, cm	Thick, cm	Weight, g	No./ cob	Weight, g	ŋ, %	Length, mm	Width mm	Thick, mm	TGW, g
	2020									
Mean	17.36	4.24	157.0	565.4	130.6	83.1	11.2	8.17	3.96	235.5
s^2	2.34	0.09	1896	3524	1346	1.95	1.20	0.49	0.15	3661
s	1.53	0.30	43,55	59.36	36.69	1.39	1.09	0.70	0.38	60.5
VC, %	8.85	7.08	27.7	10.5	28.1	1.68	9.79	8.55	9.64	25.7
	2021									
Mean	**19.78**	**4.53**	**223.4**	**584.1**	**186.3**	**83.3**	**11.8**	**8.31**	**4.53**	**309.1**
s^2	2.82	0.05	1481	5763	970.4	2.24	0.59	0.54	0.22	2104
s	1.63	0.20	38.44	75.92	31.12	1.44	0.73	0.75	0.51	45.8
VC, %	**8.50**	**5.32**	**17.2**	**12.9**	**16.7**	**1.72**	**6.61**	**8.71**	**11.51**	**14.8**
	2022									
Mean	**19.90**	**4.74**	**233.5**	**600.3**	**195.9**	**84.0**	**12.2**	**8.15**	**4.44**	**333.0**
s^2	3.27	0.09	2363	8097	1583	2.62	0.95	0.43	0.15	3197
s	1.81	0.31	48.61	89.99	39.78	1.62	0.98	0.65	0.39	56.5
VC, %	**9.09**	**6.44**	**20.82**	**15.0**	**20.3**	**1.93**	**8.02**	**8.02**	**8.73**	**8.7**

S^2 - variace, s - standard deviation, VC - coefficient of variation

CONCLUSIONS

1. From a climatic point of view, the multi-year average precipitation maize vegetation compared to potential evapotranspiration (ETP) is about 75% of what maize vegetation needs. In the first duringthe precipitation was below 300 mm compared to 500 mm of the ETP. This year the drought left a very obvious mark on cob and grain production in the Felix hybrid. In the other two years, the rains were over 300 mm, which had somewhat smaller influences through periods of drought.

2. The morphological characters of the cobs obtained in the three years, a drier year - 2020 and the last two years with less evident periods of drought, were specific. Thus, in the dry year the average length of the cobs lost about 2.5 cm, and their thickness was reduced by 0.5 cm. The cobs weighed 40-60 g less and formed 150 fewer grains. The grains on the cobs weighed 76.5 g less and had a mass of 1000 grains reduced by 97.5 g. The grain yield of the cobs was reduced by about 1 %. Maize kernel lengths were reduced by 1.0 mm, width remained constant, and thickness decreased by 0.48 mm.

3. Simple correlations were established between all the characters studied, with some differences. Between the sizes and the biomass of cobs and grains the correlations were positive and highly significant.

4. Negative correlations were observed between cob grain yield and all other characters in all years. Among the three years, drought periods, longer or shorter had the most obvious influence in the first year of cultivation of the Felix hybrid.

5. The statistical indices studied showed that the average values is affected by the drought periods of the respective years, and the variability of the analyzed characters was from low to medium percentages and rarely very high.

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CURRENT PRINCIPLES IN WHEAT CROP WEED CONTROL

PRINCIPII ACTUALE ÎN CONTROLUL BURUIENILOR DIN CULTURA GRÂULUI

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ABSTRACT

Long time considered a relatively simple action, currently weed control in wheat needs some new principles for support. The reason is the appearance of important changes in the wheat cultivation system: i) the spread with the appearance of new segetal species (weeds themselves), ii) the fragmentation of control actions with the help of herbicides, with autumn treatments and spring treatments, iii) the appearance of weeds resistant to herbicides, iv) the need to protect the agricultural environment by reducing the doses of active ingredients, v) accepting and promoting new Green Deal politics. For the practical activity of weed control in wheat culture, 4 applicable principles are recommended at the current stage: 1) competition between weeds and wheat, 2) wheat cultivation systems, 3) herbicides and their use and 4) the possibility of reducing herbicide doses. The paper presents three of these principles, except for wheat cultivation systems, taking into account the specifics of each agricultural area in our country. For the first principle, that of the competitiveness between weeds and wheat plants, the degree to which total biomass and grain losses occur is shown. Along with this aspect, how the accumulation rates of wheat plants evolved, with and without weeds, is presented. From the determinations, it was demonstrated how decreases in the mass of one thousand grains (TGM) and the mass of hectoliters (HM) occurred. The weed x winter wheat competition also refers to wheat grains, through two aspects: a) the evolution of the accumulation of biomass in the grain, highlighting the deposition rates of nutrients from the grain, with and without weeds, and b) the evolution of the content of water from the grains until ripening. For the second principle, the results obtained with the most used herbicides, both in the research field and in the fields of farmers in the area, are presented. For more complete information on the use of herbicides on wheat, the mode of action (MoA) of the active ingredients and the chemical families they belong to are also presented. For the last principle, results obtained with some herbicides under the conditions of reduced doses are presented, as a response to the European requirement for this purpose.

Keywords: biomass, competition, grains, herbicides, weeds, wheat

REZUMAT

Considerat mult timp o acțiune relativ simplă, controlul buruienilor în cultura grâului are nevoie actual de unele principii noi pentru susținere. Motivul îl constituie apariția unor modificări importante în sistemul de cultură al grâului,: i)răspândirea cu apariția de noi specii segetale (buruienile propriu-zise), ii)fregmentarea acțiunilor de control cu ajutorul erbicidelor, cu tratamente de toamnă și tratamente de primăvară, iii)apariția de buruieni rezistente la erbicide, iv)necesitatea protecției mediului agricol prin reducerea dozelor de ingredienți activi, v)acceptarea și promovarea politicilor Green Deal. Pentru activitatea practică de control al buruienilor din cultura grâului se recomandă 4 principii aplicabile în etapa actuală: 1)competiția dintre buruieni și grâu, 2)sistemele de cultură a grâului, 3)erbicidele și utilizarea lor și 4)posibilitatea reducerii dozelor de erbicide. În lucrare se prezintă trei dintre aceste principii, exceptând sistemele de cultură ale grâului, având în vedere specificul din fiecare zonă agricolă de la noi. Pentru primul principiu, cel al competitivității dintre buruieni și plantele de grâu se arată gradul în care au loc pierderi de biomasă totală și de boabe. Alături de acest aspect se prezintă modul cum au evoluat ratele de acumulare ale plantelor de grâu, cu și fără buruieni. Din determinări s-a demonstrat cum au avut loc scăderi ale masei a o mie de boabe (TGM) și ale masei hectolitrice (HM). Competiția buruieni x grâul de toamnă mai face referire și la boabele de grâu, prin două aspecte: -)evoluția acumulării de biomasă în bob, cu evidențierea ratelor de depunere a substanțelor hrănitoare din bob, cu și fără buruieni și --)evoluția conținutului de apă din boabe până la maturare. Pentru al doilea principiu se prezintă rezultatele obținute cu cele mai folosite erbicide, atât în câmpul de cercetare, cât și în câmpurile fermierilor din zonă. Pentru o cât mai completă informare a folosirii erbicidelor la grâu se prezintă și modul de acțiune (MoA) al ingredienților activi și familiile chimice din care fac parte. Pentru ultimul principiu se prezintă rezultate obținute cu unele erbicidel în condițiile reducerii dozelor, ca un răspuns la cerința europeană pentru acest scop.

Cuvinte-cheie: biomasă, boabe, buruieni, competiție, erbicide, grâu

INTRODUCTION

Winter wheat, a crop considered "dense", i.e. with a high degree of soil coverage (Berca, 1996), creates the image of a somewhat reduced annual weeding degree, of course in comparison with grass plants, i.e. "rare". Apparently, things are like this, but if we analyze the state of wheat weeding through its structure, some important aspects can be found, which it is good for every farmer to take into account. The characteristics of wheat weeding (Chirilă, 1988) refer to: a) the species present in the crop, both annual and perennial ones that make up the floristic spectrum and which are characteristic of wheat; b) the relatively long vegetation period of wheat (autumn wheat covers practically all 4 seasons of the year) during which very diverse unwanted species sprout; c) the categories of weeds some are autumn-specific, others are spring-specific or walking, autumn-spring, and others early summer, d) the particularly high virulence of some dicotyledonous species on wheat, e) the partial resistance of some species to some herbicides.

Irrespective of the wheat cultivation area, the appearance of certain weed species can be observed already around the emergence of crop plants (Courtney, 1996). In these autumn conditions, with the gradual decrease in the length of the day and the temperatures, both the installation and the coexistence between the wheat plants and the autumn weeds take place. The degree of infestation in this period of the year with autumn weeds, as well as with walking weeds, can be from a relatively high one (here crop rotation plays an important role) to a very high one (in the case of monoculture). Along with the phenomenon of global warming, it is found every year that in the autumn period, an important spectrum of species appears that become a real danger of affecting the wheat crop. It characterizes a critical first phase. The spring period is considered the most critical for winter wheat (Mortensen., et. Al., 2000), because due to the degree of weeding existing in late spring, the most obvious weed attacks on the physiology and morphology of wheat plants occur.

To highlight the degree of weeding on wheat plants, competition studies were carried out (Auld, 1996; Fisele, 1995; Welden & Slauson, 1996). Such studies demonstrate how inhibition of growth and development of wheat plants occurs in the presence of weed species. In such a competition, several aspects are demonstrated: the level of biomass losses of the wheat plant (Ionescu, 1996; Rusu, 2010), the influence of weeds on the ears density, the ratio between height of weeds and that of wheat, the level of deposition of biomass and growth rates of wheat in the presence of weeds, the mode of deposition of nutrients in grains and their growth rates, the curve of water loss from grain to harvest.

In order to avoid the concrete damage that weeds cause to wheat (ionescu, 2000), the most appropriate herbicides will be chosen and applied. In the course of several decades, a multitude of specific herbicides to the floristic spectrum of the autumn wheat crop have been obtained and used, with specific application periods. Very diverse and complex researches carried out both in other parts and here, have highlighted the best strategies for combining chemical means with the moments of application. Their goal was to reduce the levels of weeding to the lowest possible levels, to increase productivity, to reduce the cost price per unit of product: mainly grains and secondary straw.

In the new conditions for protection of the agricultural environment and ensuring its sustainability (in the recent and long perspective), the application of the new rules, also valid for autumn wheat, is requested. Currently, the idea is accepted that for the concrete development of an appropriate strategy for each agricultural area, experiments as diverse as possible, of an ecological, physiological, morphological nature, are necessary.

This paper presents a series of results obtained through ecology and weed control studies characteristic of the luvosol in the south of the country.

MATERIAL AND METHOD

In one of the multi-year studies, several series of research were carried out, which generally included aspects of winter wheat weeding. Thus, on the one hand, weed species were determined quantitatively, annually, from the categories: annual dicots, perennial dicots, annual monocots. Perennial monocots were present sporadically and mostly in the form of small, dispersed and irregular hearts in the wheat culture. The level of weeding over the course of several years is quantitatively reproduced for the three categories of weeds in an evolving synthetic presentation according to the crop year. Quantitatively, the weeds correlated with the level of precipitation recorded in the respective years. In a separate table, the most widespread weed species from the three botanical categories are shown, highlighting the problem weed species, i. e. the most difficult to control.

In one of the research directions, decadal determinations were made from two variants: weed-free wheat and natural weedy wheat. The period of determinations was between April 1 and July 11. The obtained data were represented in a graph showing the evolution of dry matter deposition in the two categories of wheat plants: with and without weeding. In the same graph, the deposition of dry matter (s. u.) in grains was also represented, which meant the formation of useful wheat production.

Based on the data obtained from the weeds that accompanied the wheat each year, several links were established, as follows: the correlation between the density of wheat plants and the biomass of the weeds, then between the number of ears per surface unit and the biomass of the weeds, between the height of the plants and weed height, as well as between weed biomass and grain yield. Two correlations established are of importance for agricultural practice, namely that between weed biomass and thousand grain mass (TGM) and that between weed biomass and hectoliter grain mass (HM).

Two graphs show the results with the evolution of total wheat biomass accumulation under weeding conditions, along with the evolution rates of biomass deposition in wheat plants, with and without competition.

Other graphs show the accumulation of dry matter in wheat grains, along with the rates at which this deposition occurs, in the two situations: weed-free wheat and weed-infested wheat. Two other graphs show the evolution of water loss during the formation of wheat grains, namely in the two situations: with weeding and clean, un-infested wheat.

Another principle of weed control is the exclusive use of chemical methods - with the help of herbicides, to reduce the degree of weeding, but also to protect the soil and wheat plants. Of course, after a relatively large number of years (around 5-6 decades), permanent improvements were found - both from the companies, but also from the researchers in the field, so that the practitioners/farmers had and have at their disposal the most modern, effective and cheap variants that can be very easily adapted to the concrete situations of own soils cultivated with winter wheat.

In separate experiments, several classic herbicides, as well as newer ones, were studied, with the aim of addressing the new EU problem of reducing herbicide doses, regardless of the active substance, the crop and the European area. In the present case, in wheat, several lower proportions were experienced for three herbicides: 2,4-D acid, chlorsulfuron and metsulfuron + 2,4-D.

The experimental variants were placed in the research field of the resort, according to the Latin rectangle method, in 4 repetitions, with a surface of 25 m^2 each. The plant samples (weeds and wheat) were collected in the different moments of the vegetation, as well as in the maturity phase with the metric frame, from all repetitions. The dry substance was obtained each time by oven drying, according to the common method (Clawson), 6-8 hours at 105^0C. The statistical processing was done by the variance analysis method (Anova test), and the Excel program was used to express the average data. The varieties of wheat used were different, but in their great majority the creations of the resort prevailed, namely: Albota and Trivale.

RESULTS AND DISCUSSION

Considering the specific degree of competition of wheat with weeds, especially in the early phases of the spring vegetation, it was considered appropriate to study its infestation with specific species, in the natural conditions of the clay soil eco-environment. Of the multitude of species present in a crop area, most usually produce obvious damage to wheat. The interaction between the two camps: wheat and the vegetal carpet, can be studied either separately depending on a chosen weed, or a botanically close group of weeds, or for the entire unwanted vegetal carpet. When considering the means of weed control in a crop, it is preferable that the weeding be considered primarily as a whole.

Natural weeding of the wheat crop. From the respective experiences, all the present species, with the metric frame, were collected in the final phase for inventory. After they were all weighed together, a separation was made into three categories: DA- annual dicots, DP- perennial dicots and MA- annual monocots. How the weeds in the untreated control evolved quantitatively is shown in figure 1.

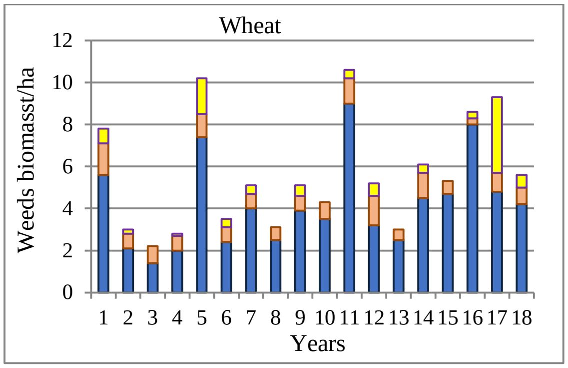

Fig. 1. Weeds biomass structure from wheat crop blue- AD, red- PD, yellow- AM //
Structura biomasei buruienilor din grâu
verde- DA; roșu- DP, galben- MA

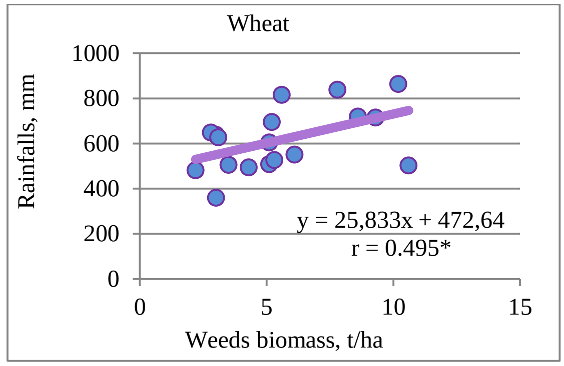

Fig.2. Correlation between weeds biomass and rainfalls//
Corelația dintre biomasa buruienilor x precipitații

The graph shows that, in terms of quantity, the weeds had quite different annual values. The smaller amounts were obtained on the drier climate, while the excessive amounts, over 8-10 t/ha s.u. they were formed in wet, favorable years (figure 2). The annual structure between the three categories of weeds was also different, are fluctuating, demonstrating the variability of appearance, the evolution of their vegetation in relation to the degree of interspecific competitiveness and what resulted in the end. The structure shows the dominance of annual dicotyledouns constantly represented by: *Centaurea cyanus, Fallopia convolvulus, Galeopsis tetrahit, Galium aparine* and *Matricaria inodora*.

Table 1. The main weeds species from wheat crop//Principalele specii de buruieni din cultura de grâu

No.	Perennial dicots	Annual dicots	Annual monocots	Perennial monocots
1.	***Cirsium arvense***	***Centaurea cyanus***	***Apera spica-venti***	*Agropyron repens*
2.	***Convolvulus arvensis***	***Fallopia convolvulus***	***Avena fatua***	
3.	*Lathyrus tuberosus*	***Galeopsis tetrahit***	***Bromus arvensis***	
4.	*Plantago media*	***Galium aparine***	***Bromus secalinus***	
5.	*Sonchus arvensis*	***Matricaria inodora***	*Lolium ssp.*	
6.	*Taraxacum officinale*	*Ambrozia artemisiifolia*	*Poa annua*	
7.		*Hibiscus trionum*	*Vulpia myuros*	
8.		*Lamium purpureum*		
9.		*Polygonum hydropiper*		
10.		*Polygonum persicaria*		
11.		*Raphanus raphanistrum*		
12.		*Scleranthus annuus*		
13.		*Sonchus asper*		
14.		*Veronica ssp.*		

The loss of grain production at wheat was thus important (figure 3). Nutrient deposition rates in grains experienced totally different evolutions. Normally formed wheat grains (in 31-35 days) had a maximum of 14.9 g/m2/day 20 days after the beginning of grain filling. The weedy wheat had a maximum of 9.2 g/m2/day, 20 days after the beginning of the deposition of dry matter (d.m.), in grains, after which it decreased (figure 4). From the graphs, it can be seen that both in the wheat without competition and in the weedy one, the rates of deposition of nutrients in the grains followed approximately the same path, but at different levels.

The quantity of weeds formed influenced wheat production levels very obviously - fig.5. Thus, it can be seen that between 6 and 8 t/ha of unwanted biomass, the wheat production was around 10.0 q/ha. Then, between 1.0-1.5 t/ha of weeds, about 15.0 q/ha of wheat were obtained. Next, with 0.55 t/ha of crop flora, 40.0 q/ha of wheat were formed, and in the absence of weeds, around 60.0 q/ha of wheat were produced. The difference between the ideal weed-free situation with a production of 60.0 q/ha wheat, and the field with the highest weeding, grain production was around 9-10 q/ha. This particularly large loss is due, of course, to other cumulative causes.

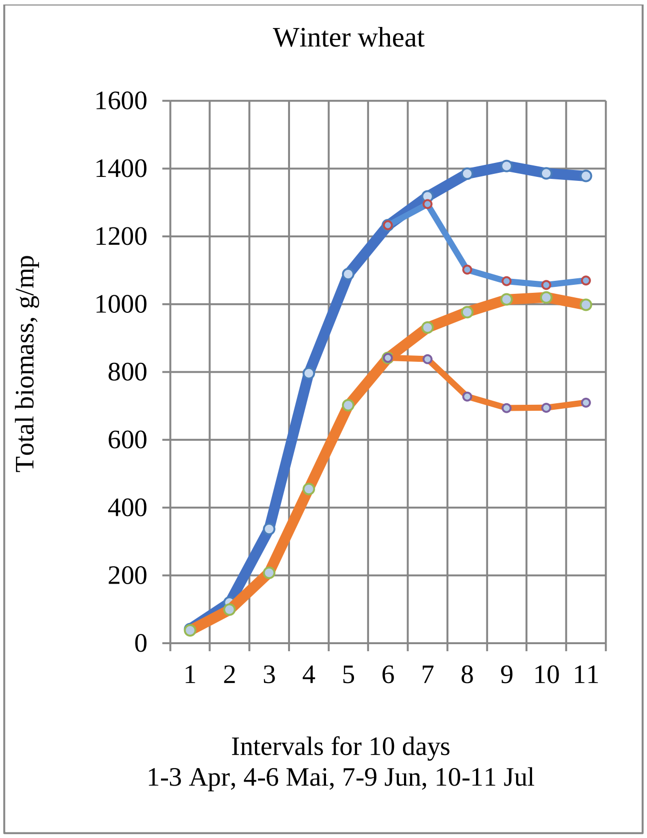

Fig. 3. Evolution of total biomass and grain yield formation//
Evoluția biomasei- biomasa totală

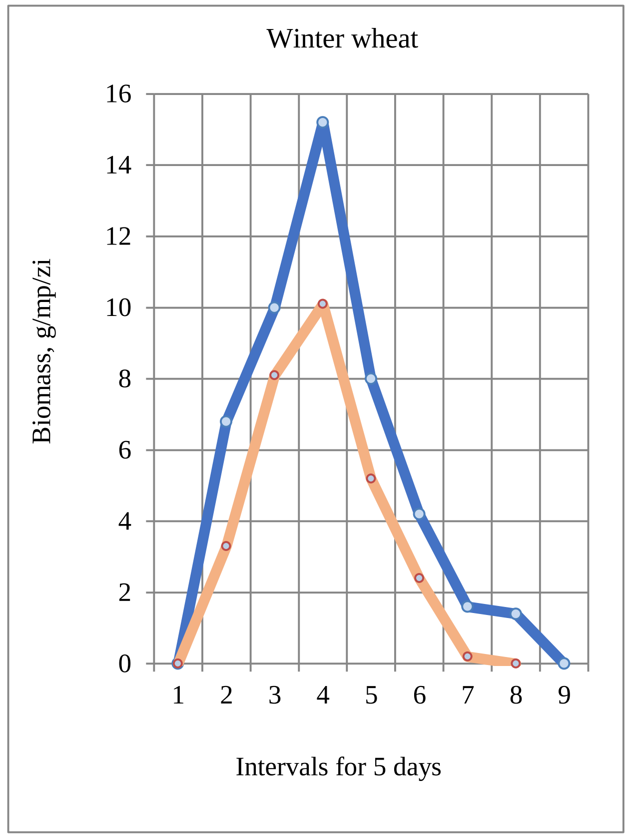

Fig. 4. Grain filling rates, no weeds and with weeds//
Ratele de umplere a boabelor de grâu

The determination in the case of grain production shows very high values (R^2 = 0.7029), which demonstrates the certainty of the competition between weeds and wheat. Through an effective weed control, the particularly damaging effect of weeds can be removed to the greatest extent. One of the causes that could limit the very high degrees of weeding is the density of the wheat field. Depending on the degree of soil coverage by wheat, by the number of plants, the degree of weeding was also influenced (figure 6). The degree of competition between wheat and weeds starts from the density of the field, a competition that can start even in autumn, from the emergence of the species characteristic of this period. From the graph it can be seen that the normal field of wheat had about 400-450 ears/m^2, without weeds, due to the herbicide.

As the density of the meadow was less and less, it allowed the formation of more and more significant amounts of specific weeds. Weed samples were also collected from those areas where no wheat plant remained (wheat density = 0) and they found an average of 21.0 t/ha. The correlation is very significant (correlation index = 0.855 and with a determination of 73.04%). The correlation demonstrates how important it is to achieve an appropriate density when sowing. It is also requested to amend all surfaces with high acidity, to level the land to avoid stagnation of water from precipitation, etc.

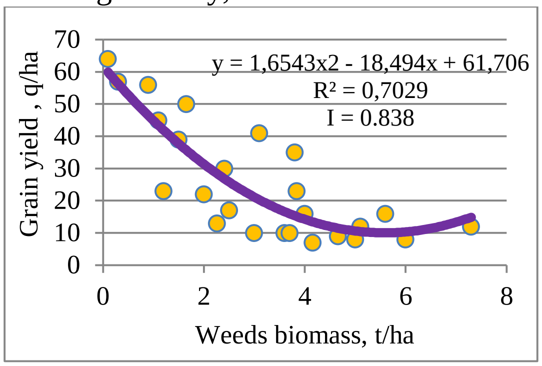

Fig. 5. Correlation between weed biomass and grain yiled // Corelația dintre biomasa buruienilor și producția de grâu

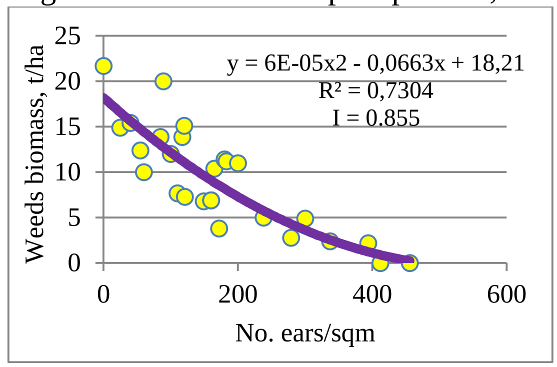

Fig. 6. Corelation abetween ears density and weed biomass// Corelația dintre densitatea spicelor și biomasa buruienilor

From the study of these aspects of competition between weeds and wheat, it was found that there is an inverse correlation in terms of the height of the plants. In no-herbicide soils, weeds grew to a higher height than wheat, increasing production losses. The phenomenon is already known, and because of this aspect, mechanized harvesting is more difficult to perform.

From a qualitative point of view, wheat production differed depending on the degree of weeding. Thus, the weight of wheat grains expressed as the mass of one thousand grains (TGM), experienced a reduction depending on the degree of weeding (figure 7). Thus, through the determinations made, decreases of TGM were found by 7-8 g depending on the weed biomass formed in the weedy control. These decreases were supported by the coefficient of determination, which is 39.9%. Regarding the hectoliter mass (HM), the determinations demonstrated that this particularly important parameter of the wheat grains, was considerably reduced depending on the degree of weeding (figure 8). From the point of view of the utilization of wheat production obtained in weedy conditions, important losses will be found in these conditions.

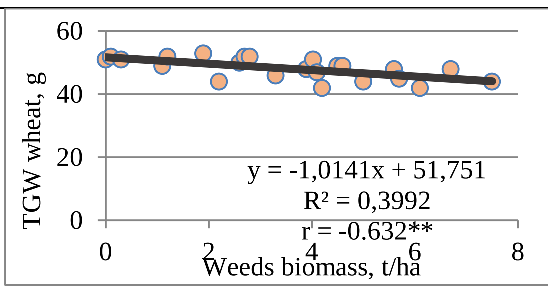

Fig. 7. Correlation between weed biomass x TGM // Corelația biomasă buruieni x MMB

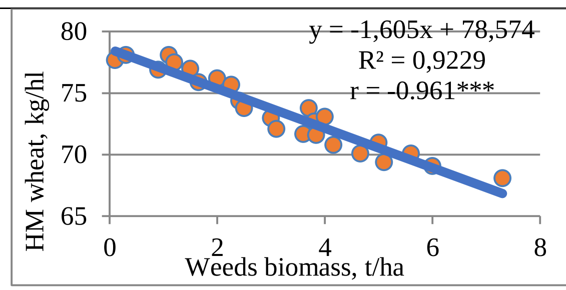

Fig. 8. Correlation between weed biomass x HM// Corelația biomasă buruieni x MH

The biomass of wheat plants accumulated differently, due to the effect of weeding (figure 9). Thus, during the early growth period of the wheat plants, the biomasses, both in the case of weeding and in the case of weed-free wheat, were approximately equal, after which, starting from May 15, differences occurred. These differences were actually decreases in total biomass and they were due to the presence and competition of weeds. Growth rates of wheat biomass showed very different rhythms. Thus, in wheat without weeds there was a high growth rate, namely 66.7 g/m^{-2}/day, after which it suddenly decreased towards maturity. Wheat with weeds had a much lower rate on May 5, namely 48.2 g/m^{-2}/day, after which it decreased on May 15 below that without weeds, after which it was higher than on wheat without weeds, until maturity. The growth of the total mass of wheat with weeds was strongly delayed or transferred towards the end of May and throughout the month of June (figure 10).

After the bladder, spike and flowering stage, the weeds had the highest growth rate, which led to the differentiation of dry matter accumulation in the wheat grains. From the determinations it was found that the differences between the weight of the grains was very different. Thus, on June 5, for wheat without competition, it was 223 g/m^2, on June 15, 428 g/m^2, and on June 25, at 485 g/m^2. In the presence of weeds, the grains had much less weight, namely 96 g/m^2 on June 5, 279 g/m^2 on June 15 and 340 g/m^2 on June 25. From these data, the negative influence of the presence of weed species in the formation of autumn wheat production can be clearly seen (figure 11).

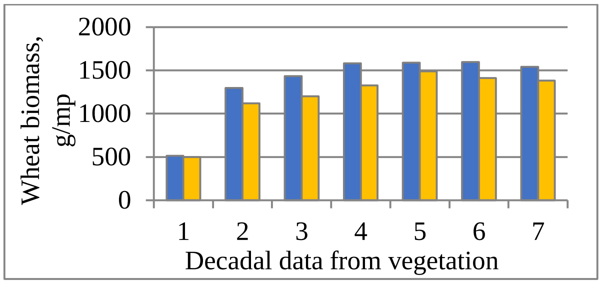

Fig. 9. **The winter wheat biomass acumulation with and whitout weeds**
Evoluţia acumulării masei vegetale
în plantele de grâu, cu și fără buruieni

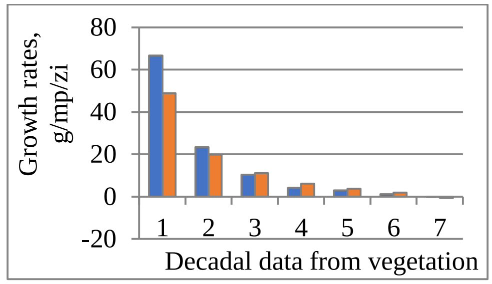

Fig. 10. Growth rates of weat plants with and without weeds
Evoluția a ratelor de creştere ale
plantelor de grâu, cu și fără buruieni

The influence of weeding can also be seen through the rate of accumulation of dry matter in wheat grains (figure 12). In normal conditions, without weeds, the rate of accumulation was high, namely 24.2 g/m^2/day at the beginning of the period (June 5), after which it was reduced until maturity. Due to the presence of weeds, a much lower rate was found, namely only 9.1 g/m^2/day (June 5), after which it increased to 13.2 g/m^2/day (June 15). Next, although this rate decreases, it was still much higher than normal. This aspect actually shows the clear delay in the process of deposition of substances/biomass in the wheat grain.

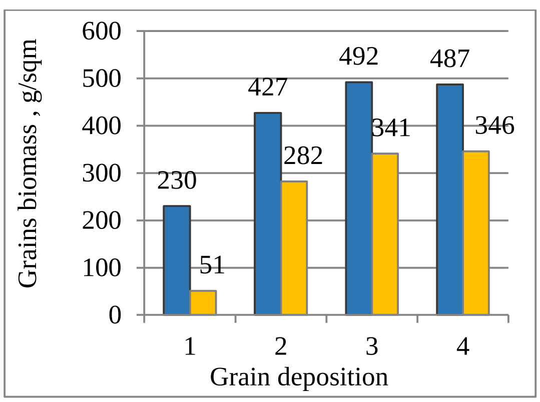

Fig. 11. Wheat grain biomass growing accumulation
Evoluţia acumulării biomasei boabelor de grâu
cu și fără prezența buruienlori

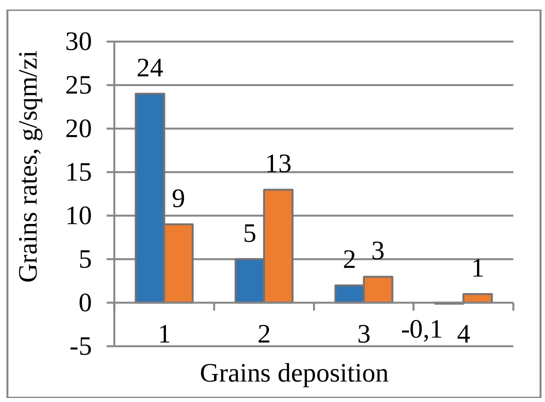

Fig. 12. Wheat grains growing rates evolution
Evoluția ratelor de creştere ale boabelor de grâu
cu și fără prezența buruienilor

In the no-infested wheat grains, the biomass accumulated continuously, in a normal and known rhythm (figure 13). The content of the grains in the water was high and with an increasing tendency until June 29, after which it suddenly decreased (until July 11). In the weedy wheat, the green mass of the grains was about 20 g lower, which means, first of all, that the dry matter was less than normal. The water content of the wheat grains was between 22-23% during June 20-29, after which, for another 6 days, it was at 19.3%, after which, in July (on July 11), it decreased very much. The long maintenance of the water content in the wheat grains was due to the competition of the weeds present in the culture (figure 14).

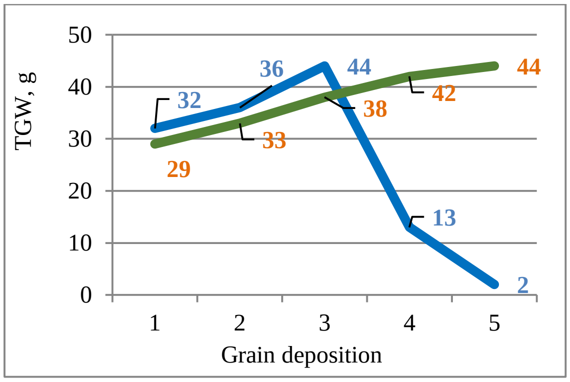

Fig. 13. **Evolution of grain weight and water content, no competition of weeds//**
Evoluția greutății boabelor și a conținutului boabelor în apă fără buruieni, verde- substanța uscată, albastru- apa.

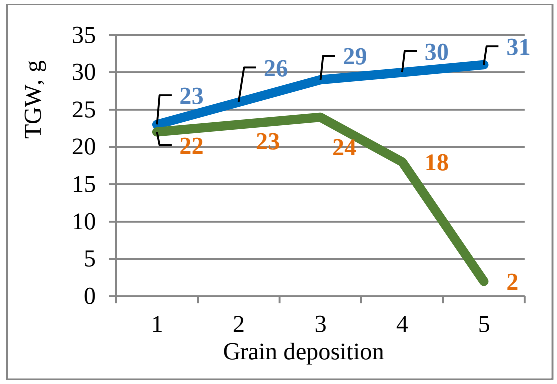

Fig. 14. Evolution of grain weight and water content with weeds competition//
Evoluția greutății boabelor și a conținutului boabelor în apă cu buruieni, verde- substanța uscată, albastru- apa

The use of herbicides in wheat cultivation is one of the most important measures in weed control. Their effectiveness was and is of the utmost importance. Under the conditions in the resort, the effectiveness of all the products used had very good levels of specific weed control. Of course, the spectrum controlled by each active ingredient highlighted the specificity factor (table 2). Most of the products used specifically combated the existing floristic spectrum, namely between 81% (triasulfuron) and 95% (methosulam+2,4-D)- in the season and between 77% (triasulfuron) and 95% (triasulfuron+2,4-D)- in other units (table 3).

Table 2. The herbicides efficacy from wheat crop, research conditions
Eficacitatea diferitelor erbicide aplicate la grâu în condiții de cercetare

Herbicides	**Dose/ha l. kg**	**CD*, %**	**Selectivity (notes)**	**Increase kg/ha**
Rezults from research station				
Acid 2,4-D 330g (SDMA)	2,0	29	1,0	+422
Acid 2,4-D 660g (DMA-6)	1,0	32	1,0	+490
Acid 2,4-D 280g+ **dicamba** 100g (Icedin S)	1,0	11	1,0	+540
Acid 2,4-D 360g+ **metosulam** 5g (Sansac)	1,0	6	1,0	+543
Amidosulfuron 750g (Grodyl)	30g	14	1,0	+367
Bentazon 480g (Basagran)	3,0	13	1,0	+640
Fluroxypyr 250g (Starane)	0,8	20	1,0	+386
Fluroxypyr 250g+ **2,4-D** 330g	0,6+2,0	6	1,0	+433
Mecoprop 337g+ **clopyralid** 17g (Lontrel)	5,0	18	1,0	+600
Metsulfuron-methyl 200g (Laren)	30g	19	1,0	+527
Pinoxaden 50g (Axial)	0,9	23	1,0	+330
Pinoxaden 45g+ **florasulam** 5g (Axial One**)**	1,0	20	1,0	+420
Piroxulam 75g (Pallas)	250g	17	1,0	+398
Piroxulam 70,8g+**floraxulam** 14,2g (Floramix)	260g	9	1,0	+423
Thifensulfuron-methyl 750g (Harmony)	40g	8	1,0	+496
Triasulfuron 750g (Logran)	15g	20	1,0	+315
Tribenuron-methyl 750g (Granstar)	20g	16	1,0	+430
	Mean	**16,5**	**1,0**	**+456**

CD* - covered degrees

Of course, these data refer to the final observations, around the harvest, and actually refer to the condition of the crop after reinfestations have occurred, which, under the conditions of some herbicides, take place. By combating weeds with herbicides, it was thus contributed to the formation of increases in wheat production, which on average stood at 541 kg/ha in the resort and 523 kg/ha in other units. Through a synthesis of the results obtained in all conditions and all years of cultivation, it was found that the degree of coverage (CD, %) of the weeds decreased very significantly by weeding. Thus, in non-threated wheat, with natural weeding, weeds covered the crop in a proportion of 65%. Using the appropriate herbicides, the CD decreased particularly obviously, namely to 15 % coverage. This proves that the use of herbicides on winter wheat is a correct, necessary and mandatory measure.

Tabel 3. The herbicides efficacy from wheat crop, farm conditions//Eficacitatea diferitelor erbicide aplicate la grâu în condiții de fermă

Private farms results				
Herbicides	**Doses l, kg/ha**	**CD**	**Selectivity, notes**	**Increase, kg/ha**
Acid 2,4-D 660g	2,0	33	1,0	+360
Acid 2,4-D 280g+ **dicamba** 100g	1,0	20	1,0	+600
Amidosulfuron 750g	30g	15	1,0	+640
Pinoxaden 45g+ **florasulam** 5g	1,0	20	1,0	+420
Piroxulam 75g	250g	15	1,0	+396
Piroxulam 70,8g+**floraxulam** 14,2g	260g	14	1,0	+440
Triasulfuron 750g	15g	27	1,0	+400
Tribenuron-methyl 750g	20g	17	1,0	+405
	Mean	**20,1**		**+458**

Tabel 4. The main herbicides and the MoA in wheat crop//Erbicidele folosite în cultura grâului și modul lor de acțiune (MoA)

Crt. No.	**Cod group EWRS**	**Cod group WSSA**	**Mode de acțiun, MoA, inhibitors, trget place**	**Chemical family**	**Active ingredients (nr.CP)**
1.	A	1	Acetyl-CoA-carboxilase (**ACC**) (antigraminicid) enzyme It blocks the first step in the synthesis of acyl-lipids, with the formation of fatty acids in the cell	AoPP-aryloxyphenoxy propionate	Clodinafop- propargyl (Sword,1) Fenoxaprop-P-ethyl (Foxtrot,1) Pinoxaden (Axial,2)
2.	B	2	Acetolactat- sintase, **ALS**, or acetohyhidroxyacid sintase, **AHAS** enzyme It blocks the amino acids: Val, Leu, Isoleu and stops DNA formation and cell growth	SU- sulfonylureic	Amidosulfuron+ iodosulfuron- methyl-Na (Sekator P,1) Metsulfuron-methyl (Laren, Rival,5) Thifensulfuron-methyl (Harmony,4) Tribenuron-methyl (Granstar,7) Tritosulfuron (Biathlon,1)
				TRP- triazolopyrimidine	Florasulam (Saracen, Mustang,10) Penoxsulam (Bizon,1) Piroxulam (Pallas,3)
3.	F1	12	Plant bleaching occurs by inhibiting the biosynthesis of carotenoids in the phytoene-desaturase enzyme step (**PDS**)	Nicotinanilides	Diflufenican (Bizon, Alliance, Battle, Saracen,4)
4.	F2	28		Triketone	Mesotrione (Starship,1)
5.	K1	3	It inhibits the assembly of α- and β-tubulin polymers in the formation of the cell division spindle.	Dinitroaniline	Pendimethalin (Stomp,1) preemergent/MA
6.	K3	15	Inhibits cell division: mitosis, meiosis, by stopping protein and nucleic acid synthesis	Oxyacetamide	Flufenacet (Fence, Battle,2)
7.	O	4	Trey are sunthetis auxins with same action as indolylic acetic acid, Herbicides are hormonal products that inhibit auxine activity leading to typical abnormal growth.	Phenoliccarboxilic acid	2,4D Acid (Ceredin F.,3) Aminopyralid (Beflex,1) MCPA (Dicopur M,1)
				Pyridincarboxylic acid	Clopyralid (Lontrel, Cliophar,2) Fluroxypyr (Cerlit, Starane,4)
				Benzoic acid	Dicamba (Dicopur,2)
				Arylpiconilinics	Halauxifen-methyl Arilex® (Pixxaro S,1)

Autumn weeding is an increasingly common practice, against the increasingly obvious background of climate change. From a practical point of view, in order to reduce the degree of autumn weed infestation in grass cereals, a series of particularly important specific rules will have to be taken into account when resorting to "autumn" weed control in crops cereals:

-Autumn herbicide will be carried out only when the plants demonstrate the appearance of the first sibling (usually in approx. 70% of the plants), which also leads to the beginning of the formation of the specific rosette;

-Monitoring climatic elements: rainfall and average daily temperatures, which will have to fall within favorable limits for carrying out the weeding work;

- The use of active ingredients/herbicides, gentle on the culture medium and including the still very young culture plants.

As far as the meteorological phenomena in the autumn period are concerned, it is considered that they influence together with the technological elements, the success of the autumn control of the entire spectrum of weeds that appears regardless of the area of our culture. Mainly soil moisture positively favors the sowing and emergence periods, but also the success of autumn weeding. Drought with its implications distorts the entire agricultural complex from normal, and what can result, could have sometimes undesirable consequences. The thermal regime, on the other hand, has its own characteristics, in the sense that the autumn herbicide will not be carried out below the 50^{o}C threshold, considering some consequences of plant vegetation at lower temperatures. Also, in the warmer autumns, herbicides will not be applied above the 250^{o}C threshold. It is considered that outside this thermal range the metabolism of grass cereal plants is not within normal functional parameters.

In general, for autumn herbicides, active ingredients (herbicides) as mild as possible to the agricultural environment will be used, showing as much residual effect as possible. In table 4, some herbicides are presented whose effectiveness is reflected either for the dicotyledonous spectrum separately, or for the monocotyledonous spectrum separately, or for both categories of weeds together, depending on the existing situations in our grassy grain farms. In table 5, the respective herbicides are grouped by mode of action (MoA), chemical families and the frequency they have in commercial products.

Tabel. 5. The main autumn herbicides and the MoA in wheat crop// Principalele erbicide de toamnă și modul lor de acțiune în cultura grâului

crt. No.	**Code group** EWRS	WSSA	**Mode of actionacțiune, MoA, inhibitors, target place**	**Chemical family**	**Active ingredients (CP)**
1.	A	1	Enzime Acetyl-CoA-carboxilaza (**ACC**) (antigraminicid) It blocks the first step in the synthesis of acyl-lipids, with the formation of fatty acids in the cells	AoPP-aryloxyphenoxy propionați	●Pinoxaden (Axial)
2.	B	2	Acetolactate synthase enzyme, ALS, or acetohydroxyacid synthesize, AHAS It blocks the amino acids: Val, Leu, Isoleu and stops DNA formation and cell growth	SU-sulfonylureic	●Amidosulfuron+ ●●iodosulfuron- methyl-Na (Sekator P) ●Metsulfuron-methyl (Laren, Rival) ●●Thifensulfuron-methyl (Harmony) ●●●Tribenuron-methyl (Granstar) ●Tritosulfuron (Biathlon)
				TRP-triazolopyrimidine	●●●●●Florasulam (Saracen, Mustang) ●Penoxsulam (Bizon) ●●Piroxulam (Pallas)
3.	F1	12	Plant bleaching occurs by inhibiting the biosynthesis of carotenoids in the step of the enzyme phytoene-desaturase (PDS) action	Nicotinanilide	●●Diflufenican (Bizon, Joystick)

A new principle refers to the protection of the agricultural environment by experimenting with the possibility of being able to reduce herbicide doses. This should occur to the extent that control of the weed species is relatively acceptable without economic loss of production. Research has shown that reducing normal herbicide doses can be done with certain precautions. In the course of several years, herbicides with reduced doses were experimented with the wheat crop. The results are shown in figure 15.

The herbicides used were: 2,4-D acid, metosulfam+2,4-D and chlorsulfuron. Normal doses of these herbicides were tested for limits of 80%, 60%, 40% and 20%. The obtained results demonstrate that under certain conditions the normal recommended doses could be reduced by up to 60%. In fact, it is known that any new herbicide authorized to be used in production has a 50% LD limit, which means that through this lower dose limit, the product will have to economically control the degree of infestation in a certain crop.

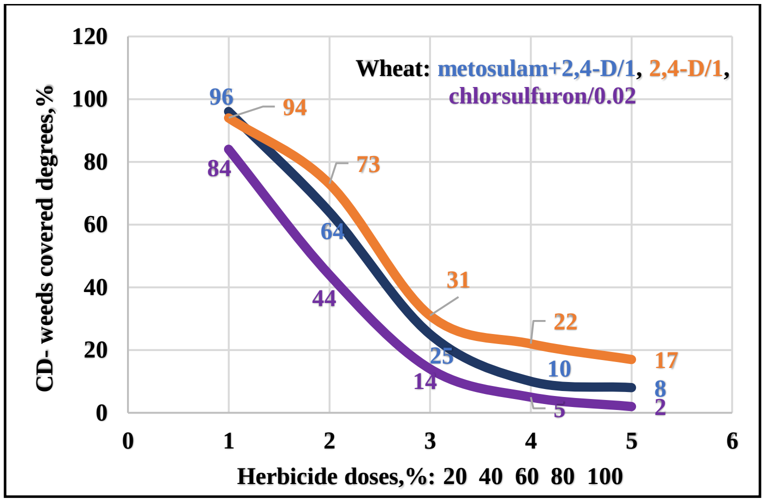

Fig. 15. The efficacy of specific herbicides function of applied doses, in winter wheat crop//
Eficacitatea erbicidelor specifice grâului în funcţie de doza aplicată

CONCLUSIONS

1. In the current conditions, the control of weeds in the winter wheat crop requires a review of all the directions involved in the technical and especially economic support of the use of herbicides in this valuable crop plant. Multi-year research of this kind has brought out much more clearly the complex nature of weed control. Benefiting from such results, cultivated wheat varieties maximized their production potential, and the growing environment was better protected.
2. With the help of the obtained data, the following aspects were highlighted:
   - the average level of weeding expressed quantitatively was 7 t/ha dry weight, with annual fluctuations between 2.3 and 10.3 t/ha;
   - from the entire floristic spectrum, annual dicotyledons - DA, annual monocotyledons - MA and some perennial dicotyledons - DP were dominant. The great concern is represented by the grasses of the *Apera* and *Avena* type, among the classic ones, and *Bromus* together with *Vulpia*, among the newer ones, which together have known and know worrying levels of spread;
   - production losses depending on the weed biomass formed were evident. The contribution of this fact is due to the levels of the density in the field through the number of plants and respectively of ears per surface unit;
   - weeding affects and most of the times distorts the accumulation of biomass, both in the whole wheat plant and in that of the grains;
   - in the presence of weeds, the mass of one thousand grains - TGM decreased significantly by 6-7 g, and the hectoliter mass - HM was drastically reduced by 10 kg/hl, visibly depreciating the commercial character of wheat grains;
   - the loss of water from the wheat grain during weeding was prolonged for a relatively longer period of time.
3. The second principle is the rational use of herbicides in wheat culture. As it is well known, the active substances available to growers are diverse and very effective in controlling weeds. The researches were carried out comparatively both within the research field and among the farmers. The conclusion was unanimous. In both situations, the effectiveness is expressed by the degree

of coverage - GA of the uncontrolled weeds, by the expression of selectivity, but also by the increases in production obtained, demonstrated normal, effective values, without affecting the wheat plants.

To complete the data, the groups of active ingredients, the chemical family to which they belong and their mode of action - MoA in controlling the characteristic weed species are presented.

In another register, reference is made to wheat weeding in the autumn period. The principles are as follows: the wheat must be twined, the growing medium must have air and soil humidity without excesses, with temperature thresholds above 50°C and below 250°C, with the presence of weed species, the use of herbicides as mild as possible for the wheat plants and the soil of culture. And for autumn herbicides, the products currently used, the group to which they belong, the chemical family and the mode of action - MoA are presented.

4. The third principle refers to the possibility of reducing the herbicides rates that are normally applied in the wheat culture. Such results become important for protecting the wheat growing environment. The research results obtained demonstrated that this reduction was successful with herbicides used up to 60% of normal doses. Such investigations will have to be continued in the future.

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PERFORMANCE OF WHEAT CULTIVARS RECENTLY RELEASED FROM N.A.R.D.I. FUNDULEA, TESTED IN THE ADER PROGRAM

COMPORTAREA SOIURILOR DE GRÂU CREATE LA I.N.C.D.A. FUNDULEA, EXPERIMENTATE IN PROGRAMUL ADER

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ABSTRACT

Five winter wheat cultivars released by NARDI Fundulea during 2015-2024 and one pending release in 2025 were tested in fifty-one yield trials all over Romania in remarkably diverse conditions and in special experiments, in 2021-2023. All cultivars released after 2015 were higher yielding than GLOSA, presently the leading cultivar in Romania, best cultivars producing up to 11% more. In very favorable conditions all new cultivars achieved yields over eleven tons/ha, which was more than the highest yield obtained with GLOSA. Yield variation due to environmental conditions in the fifty-one trials was smaller in the new cultivars than in GLOSA. With only one exception, the new cultivars also yielded more than GLOSA

with reduced Nitrogen fertilization. They have suitable freezing tolerance to avoid overwintering losses in most situations and offer better protection against stripe rust and Fusarium head blight. The new cultivars have suitable bread-making quality, being mostly better than GLOSA in grain protein concentration and dough strength. Progress achieved by the recent Fundulea cultivars recommends them to replace GLOSA in most conditioms and opens new possibilities for breeding better future cultivars.
Key words: Wheat cultivars, yield, yield potential, ytability, freezing resistance, ftripe rust, fusarium head blight, protein concentration

REZUMAT
Cinci soiuri de grâu de toamnă lansate de INCDA Fundulea în perioada 2015-2024 şi o linie aşteptată a fi înregistrată în 2025 au fost testate în 51 culturi comparative în România în condiţii foarte diverse şi în experienţe speciale în anii 2021-2023. Toate soiurile lansate după 2015 au dat producţii medii mai mari decât GLOSA, în prezent soiul cel mai cultivat în România. Soiurile cele mai productive au realizat producţii cu până la 11% mai mari decât GLOSA. Ìn condiţii foarte favorabile toate soiurile noi au dat producţii de peste 11 t/ha, mai mari decât cele mai ridicate producţii obţinute cu soiul GLOSA. Variaţia producţiilor datorată condţiilor de mediu în cele 51 culturi comparative a fost mai mică la soiurile noi decât la GLOSA. Cu o singură excepţie, soiurile noi au fost deasemenea mai productive decât GLOSA în condiţii de fertilizare redusă cu azot. Aceste soiuri au o rezistenţă corespunzătoare la temperaturi scăzute, ceea ce le permite să evite în majoritatea situaţiilor pierderile de iernare şi oferă o protecţie mai bună la atacul ruginii galbene şi al fuzariozei spicelor. Soiurile recente au calitate corespunzătoare de panificaţie, fiind în majoritate superioare soiului GLOSA pentru concentraţia de proteine în bob şi tăria aluatului W. Progresul realizat de soiurile recente le recomandă pentru a înlocui soiul GLOSA în majoritatea regiunilor şi deschide noi posibilităţi de ameliorare a unor soiuri şi mai bune în viitor.

Cuvinte cheie: Soiuri de grâu, producţie, potenţial de producţie, ptabilitate, pezistenţă la ger, pugina galbenă, fuzarioza spicelor, concentrație de proteină

INTRODUCTION

Use of high-yielding cultivars, adapted to environmental conditions is essential for a good wheat production. The National Agricultural Research & Development Institute NARDI (INCDA) Fundulea has been long involved in providing such cultivars to Romanian farmers. Since 1958, when the NARDI wheat breeding program was established, it released thirty-four common wheat cultivars, which have been grown from 1971 to the present on about 40 to 69 % of the total wheat acreage in Romania (Săulescu et al., 2007; INCS Baze de date 2023). Genetic progress for yield provided by these cultivars was estimated, for different periods from 1961 to 2005, between 34 and 60 kg/ha/year (Săulescu, 1983; Săulescu et al., 1998; Mustățea and Săulescu. 2011), a progress like that reported by major breeding centers abroad (Aisawi et al. 2015: Battenfield et al., 2013; Curin et al. 2021; Mirosavljević et al. 2024).

The present paper summarizes the results obtained with cultivars released from 2015, in comparison with the cultivar GLOSA (released in 2005), which has been the most widely grown cultivar in Romania since 2011 and still had a 28% share in seed production in 2023. Part of testing these cultivars was financed through the ADER program by the Ministry of Agriculture.

MATERIAL AND METHODS

Winter wheat cultivars: PITAR (registered in 2015), VOINIC (registered in 2019), URSITA (registered in 2020), FDL ABUND (registered in 2022), FDL CONSECVENT (registered in 2024) and FDL COLUMNA (pending release) were included, along with GLOSA as control, in yield trials with balanced lattice design, on 5 to 10 m^2 plots with three replications, organized at the Agricultural Research & Development Station (ARDS) Valu lui Traian, ARDS Brăila, ARDS Mărculeşti, ARDS Teleorman, ARDS Piteşti, ARDS Șimnic, ARDS Lovrin, ARDS Oradea, ARDS Livada, ARDS Turda, (Cattle Farming Research & Development Station - CFRDS Târgu-Mureş, ARDS Secuieni, Craiova University - Agricultural Research Station Caracal, and NARDI Fundulea, during 2021-2023.

Geographically the testing sites cover a large area, from latitude 47°52’N (ARDS Livada) to 44°07’N (ARDS Teleorman) and from longitude 28°28′32″E (ARDS Valu lui Traian) to 20°46’E (ARDS

Lovrin), and are representative for the major wheat growing regions of the country. At ARDS Valu lui Traian, ARDS Teleorman, ARDS Turda, ARDS Secuieni, ARDS Caracal and NARDI Fundulea cultivars were tested with recommended Nitrogen fertilization, which varied from 82 to 143 kg N/ha depending on environment and with reduced N fertilization, varying from 0 to 50 kg N/ha, applied only in autumn. In total, data were available from fifty-one yield trials, with diverse conditions.

The recently released cultivars are the outcome of long term accumulation of genes for yielding ability and adaptability to the diverse environments of Romania. Cultivars URSITA, FDL ABUND and FDL CONSECVENT carry a 1R-1A translocation transferred through crossing with Triticale, while FDL COLUMNA carries the *Lr37/Yr18/Sr38* gene complex originated from *Aegilops ventricosa.* These alien introgressions contributed to the value of the respective cultivars.

Besides yield trials, the cultivars were tested at NARDI Fundulea for the following traits, important for yield stability:

- Winterhardiness, by exposing young plants to controlled freezing temperatures after natural hardening, in 2021, 2022 and 2023. Average freezing damage scores were used to calculate a Freezing Resistance Index (FRI=1/Freezing damage*100).
- *Fusarium* head blight resistance, by injecting *Fusarium* spores into central spikelets, as described by Galit et al. (2024a). Area Under Disease Progress Curve, averaged on three years (2021-2023), was used to calculate a FHB resistance index as 1/AUDPC*1000.

Stripe rust (*Puccinia striiformis* f.sp. *tritici* West.) resistance was estimated based on notes taken at six locations where heavy attacks were observed in 2023, as described by Galit et al. (2024b). We present the results as Stripe Rust Resistance Index calculated as 1/Stripe rust score*100.

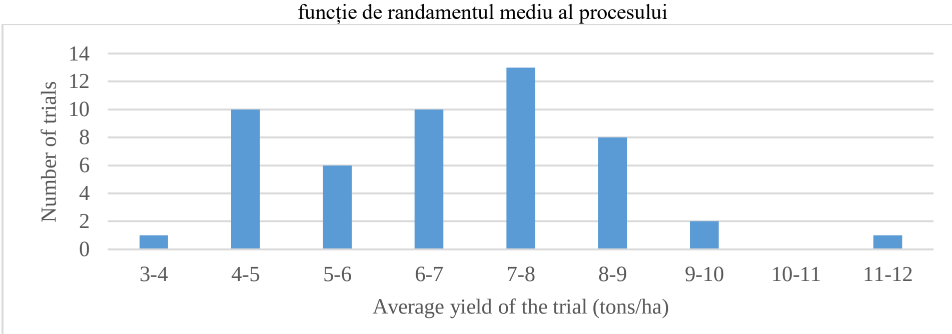
Grain protein concentration and dough strength was determined spectrophotometrically at NARDI Fundulea, ARDS Turda and ARDS Secuieni, using samples from yield trials.

We analyzed the data using ANOVA and determined the significance of differences from GLOSA based on the variance of GxE interaction. The coefficient of yield variation (s%) was used to calculate a Yield Stability Index as 1/s%*100.

RESULTS AND DISCUSSIONS

Cultivars were tested in diverse conditions of favorability, as one can see from the variation of the average yield of the trials, which varied from three to more than eleven tons/ha (Figure 1). This variation was due to very different rainfall during the vegetation period, which varied from 212.2 to 613.8 mm, to diversity of soils on which trials were performed (from typical luvisol with pH=5.02 and humus content 1.96 % to vermic chernozem with pH=7.42 and humus content 3.62, as well as to Nitrogen fertilization varying from 0 to 200 kg/ha. Testing cultivars in such diverse conditions allowed a good characterization of their adaptability.

Figure 1. Distribution of fifty-one yield trials according to the average yield of the trial// Distribuția a cincizeci și unu de încercări de producție în funcție de randamentul mediu al procesului



All cultivars registered after 2015 over yielded GLOSA on average over fifty-one yield trials, with differences from 190 kg/ha nonsignificant in VOINIC to very significant 561, 563, 652 and 736 kg/ha in FDL ABUND, URSITA, FDL CONSECVENT and FDL COLUMNA, respectively (Figure 2). Such yield increases recommend the new wheat cultivars for replacing the old cultivar GLOSA in most wheat growing regions.

Average yields reflect at the same time the yielding potential and multiple traits involved in adaptability, such as resistance to biotic and abiotic stresses, earliness, etc. To estimate yielding potential, we analyzed the highest yields, obtained in any of the yield trials, in most favorable weather, soil and management conditions (Figure 3). Cultivars released after 2015 yielded more than eleven tons/ha in the best conditions. All recent cultivars proved to have better yielding potential than GLOSA, producing maximum yields higher by 253 to 1427 kg/ha (Table 1).

Figure 2. Grain yield of wheat cultivars averaged on fifty-one yield trials// Randamentul cerealelor din soiurile de grâu

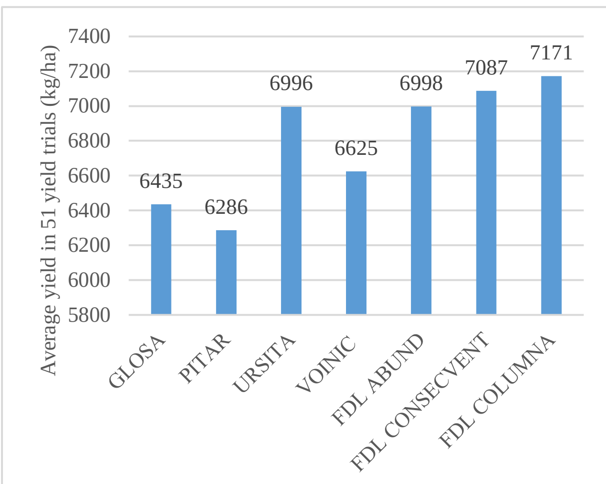
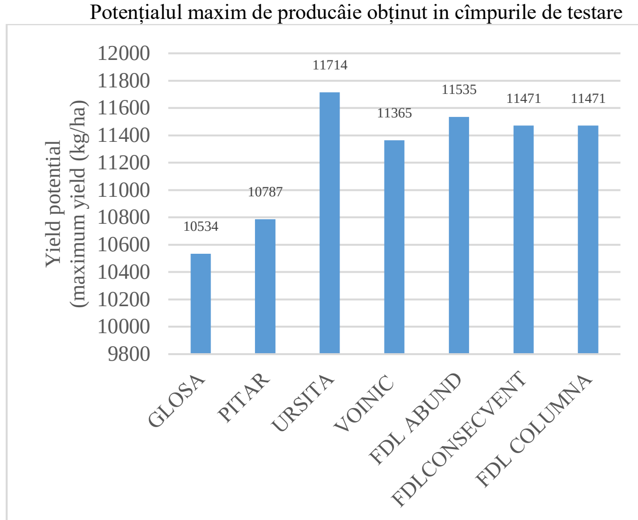


Figure 3. Highest grain yield obtained in yield trials. // Potențialul maxim de producâie obținut in cîmpurile de testare



This represents an important progress in the yielding potential of Fundulea cultivars. Yield stability, as reflected by the ratio 1/s%, was also improved in all new cultivars (Table 1).

Table 1. Yields of recent cultivars in fifty-one yield trials (2021-2023)/ Producțiile cultivarelor noi in 51 de testări de cîmp

	Average yield			Highest yield			Yield	Stability Index
Cultivar	**kg/ha**	**%**	**Difference from GLOSA (kg/ha)**	**Kg/ha**	**%**	**Difference from GLOSA (kg/ha)**	**1/s%*100**	**%**
GLOSA	6435	100	0	10534	100	0	3.72	100
PITAR	6286	97.7	-149	10787	102.4	253	3.83	103
URSITA	6996	108.7	561*	11714	111.2	1180*	3.81	102.4
VOINIC	6625	103	190	11365	107.9	831*	3.93	105.6
FDL ABUND	6998	108.7	563*	11535	109.5	1001*	3.74	100.5
FDL CONSECVENT	7087	110.1	652*	11471	108.9	937*	4.06	109.1
FDL COLUMNA	7171	111.4	736*	11961	113.5	1427*	3.75	100.8
SD 0.1%	**365**			**839**				

***) Significant at P<0.1%**

The recent cultivars were tested in seven locations both with recommended and reduced Nitrogen fertilization. Grain yields averaged on twenty-one trials (seven locations x three years) are presented in Table 2. All new cultivars, except PITAR, yielded more than GLOSA at both N fertilization levels. In plots that received lower doses of Nitrogen fertilizer, yield advantage of recent cultivars ranged from 222 to 734 kg/ha. The effect of reduced N fertilization was different among the tested cultivars, suggesting existence of genetic differences in tolerance to lower Nitrogen availability.

In addition to yield trials, we characterized the recent wheat cultivars in artificial tests for freezing tolerance and *Fusarium* head blight response. Artificial freezing tests performed at NARDI Fundulea for three years showed that all tested cultivars were damaged less than the French cultivar Apache and even less than Bezostaya 1, which was cultivated for many years in Romania without any report of significant losses during overwintering. Most of the new cultivars, especially Pitar, Voinic and Ursita were superior to GLOSA in freezing resistance (Table 3).

Table 2. Cultivar performance under two Nitrogen fertilizer doses// Performanța cultivarelor sub două doze de îngrășământ cu azot

Cultivars	With recommended N fertilization		With reduced N fertilization		Effect of reduced N fertilization
	kg/ha	Difference from GLOSA	kg/ha	Difference from GLOSA	
GLOSA	6566	0	6350	0	-216
PITAR	6474	-92	6293	-58	-181
URSITA	7163	597	6862	512	-301
VOINIC	6718	152	6572	222	-146
FDL ABUND	7188	623	6874	524	-315
FDL CONSECVENT	7118	552	7084	734	-34
FDL COLUMNA	7304	739	7001	651	-303

Table 3. Characterization of cultivars for resistance to freezing, stripe rust and *Fusarium* head blight/ Caracterizarea soiurilor pentru rezistență la îngheț, rugină și Fusarium

Cultivar	Freezing resistance		Stripe rust resistance		FHB resistance	
	1/Damage note*100	%	1/Attack note*100	%	1/AUDPC*1000	%
GLOSA	22	100	20	100	2.7	100
PITAR	28	127.3	21	105	2.9	107.4
URSITA	28	127.3	21	105	3.3	122.2
VOINIC	27	122.7	23	115	3.4	125.9
FDL ABUND	23	104.5	37	185	3.3	122.2
FDL CONSECVENT	22	100	50	250	5.7	211.1
FDL COLUMNA	21	95.5	23	115	3.6	133.3
BEZOSTAYA 1	20	90.9				
APACHE	16	72.7				

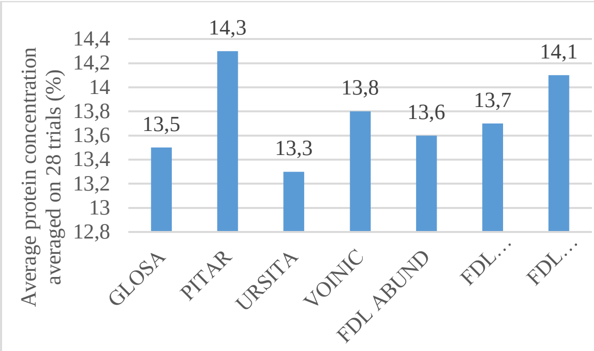
Stripe rust resistance, characterized in six locations where severe attacks were observed in 2023, showed that all recent cultivars, but especially FDL CONSECVENT and FDL ABUND offer better protection against this pathogen. The same is true for *Fusarium* head blight, where all cultivars showed better resistance than GLOSA.

Although presently farmers are not paid for the quality of their wheat, Fundulea breeding program has bread-making quality as one important breeding goal. We present here results on grain protein concentration (%) and dough strength (W) averaged on twenty-eight trials (Figure 4). Cultivars PITAR and FDL COLUMNA were the best for both indices, but all the new cultivars, except URSITA, were superior to GLOSA.

The high grain protein percentage of FDL COLUMNA is particularly interesting because this cultivar was also among the highest yielders in yield trials. Indeed, FDL COLUMNA had, along with PITAR and VOINIC, large deviations from the regression of protein concentration on yield (Table 4).

Table 5 is a summarized characterization of the recent Fundulea cultivars, presented as percentage differences from the check cultivar GLOSA. Progress is obvious in most new cultivars and traits. Largest progress was achieved in resistance to FHB and stripe rust, cultivar CONSECVENT being the best for both these traits. Differences of 3 to 11% were observed in average yield and of 2 to 13% in yielding potential, while yield stability was improved by 1 to 9%. Despite expectations, progress was achieved in grain protein concentration and a little more in dough strength. Freezing resistance showed mixed results, some of the new cultivars being better and some equal or a little worse than GLOSA. Overall, the improvement, over the most successful cultivar so far, was important, which recommends the new cutivars for replacing GLOSA in most regions.

Figure 4. Grain protein concentration (%) and dough strength (W) of recent Fundulea wheat cultivars (averages on 28 trials)// Conținutul de proteine din cereale (%) și rezistența aluatului (W) din recentele soiuri de grâu Fundulea (media pe 28 de studii)



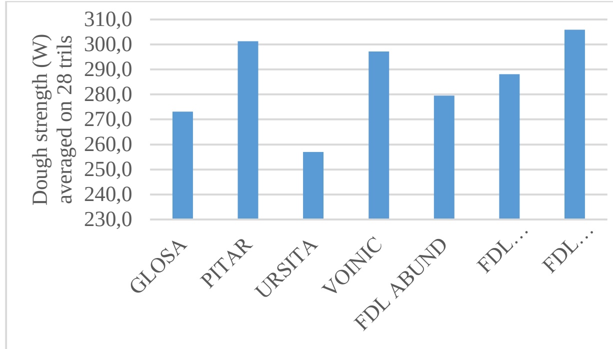


Table 4. Deviations of grain protein concentration from the regression on yield.// Abateri ale conținutului de proteine de la regresia la productivitățiі.

Cultivar	Average grain yield in 28 trials (kg/ha)	Average grain protein concentration In 28 trials (%)	Grain protein concentration expected based on regression	Deviation from the regression on yield
PITAR	5901	13.97	13.32	+0.65
FDL COLUMNA	6802	13.81	13.47	+0.34
VOINIC	6208	13.61	13.37	+0.24
FDL CONSECVENT	6757	13.53	13.46	+0.07
FDL ABUND	6646	13.5	13.45	+0.05
GLOSA	6082	13.24	13.35	-0.11
URSITA	6624	12.98	13.44	-0.46

Table 5. Percentage differences from cultivar GLOSA (%).// Diferențele procentuale față de cultivarul GLOSA (%).

Cultivar	Average yield	Highest yield	Yield Stability Index	Protein concentration	Dough strength W	Freezing resistance	Stripe rust resistance	FHB resistance
GLOSA	0	0	0	0	0	0	0	0
PITAR	-2	+2	+3	+6	+10	+27	+5	+7
URSITA	+9	+11	+2	-1	-6	+27	+5	+22
VOINIC	+3	+8	+6	+2	+9	+22	+15	+26
FDL ABUND	+9	+10	+1	+1	+2	+5	+85	+22
FDL CONSECVENT	+10	+9	+9	+1	+5	0	+150	+111
FDL COLUMNA	+11	+13	+1	+4	+12	-4	+15	+33

CONCLUSIONS

Results of three years of study in fifty-one yield trials and in special experiments showed that:

- The cultivars released after 2015 were higher yielding than GLOSA, best cultivars producing up to 11% more;
- The new cultivars achieved highest yields over eleven tons/ha, which was more than the highest yield obtained with GLOSA;
- Yield variation due to the diverse environmental conditions in the fifty-one trials was smaller in the new cultivars than in GLOSA;
- With only one exception, the new cultivars yielded more than GLOSA with reduced Nitrogen fertilization too;
- The new cultivars have freezing tolerance sufficient to avoid overwintering losses in most situations and offer better protection against stripe rust and *Fusarium* head blight attacks.

- The new cultivars have suitable bread-making quality, being mostly better than GLOSA in grain protein concentration and dough strength.
- Progress achieved by the recent Fundulea cultivars open new possibilities for breeding better future cultivars.

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THE VARIATION OF WHEAT PROTEIN CONTENT ACCORDING TO CLIMATIC CONDITIONS AND FERTILIZATION AT AGRICULTURE RESEARCH AND DEVELOPMENT STATION (ARDS) SIMNIC

VARIAȚIA CONȚINUTULUI DE PROTEINĂ DIN GRÂU ÎN FUNCȚIE DE CONDIȚIILE CLIMATICE ȘI FERTILIZARE LA SCDA ȘIMNIC

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ABSTRACT

The research focused on the behaviour of 9 genotypes of common autumn wheat cultivated at ARDS Șimnic - Craiova in the period 2020-2022, covering three years of experimentation, in which grain production in kg/ha and protein content were monitored, considering the dose of fertilizers administered by N170P50K0 and climatic conditions.
Following the research carried out, it was found that: grain production varied between 6338 kg/ha at Mt and 8535 kg/ha at the Pajura variety in 2020; between 6540 kg/ha at Mt and 7178 kg/ha at the Simnic variety in 2021 and between 6340 kg/ha at Mt 7330 at the Pajura variety in 2022.
The protein content also varied between 10.7 for Mt and 12.2 for the Dropia variety in 2020; 10.4 for Mt and 12.6 for the Otilia variety in 2021, and in 2022 it recorded values between 14.4 for the Boema1 variety and 16.6 for the Miranda.

Key words: wheat, protein, fertilizers, yield.

REZUMAT

Cercetarea s-a axat pe comportamentul a 9 genotipuri de grâu comun de toamnă cultivate la ARDS Șimnic - Craiova în perioada 2020-2022, acoperind trei ani de experimentare, în care au fost monitorizate producția de boabe în kg/ha și conținutul de proteine, având în vedere doza de îngrăşăminte administrate de N170P50K0 şi condiţiile climatice.
În urma cercetărilor efectuate s-a constatat că: producția de cereale a variat între 6338 kg/ha la Mt și 8535 kg/ha la soiul Pajura în anul 2020; intre 6540 kg/ha la Mt si 7178 kg/ha la soiul Simnic in 2021 si intre 6340 kg/ha la Mt 7330 la soiul Pajura in 2022.
De asemenea, conținutul de proteine a variat între 10,7 pentru Mt și 12,2 pentru soiul Dropia în 2020; 10,4 pentru Mt și 12,6 pentru soiul Otilia în 2021, iar în 2022 a înregistrat valori între 14,4 pentru soiul Boema1 și 16,6 pentru Miranda.

Cuvinte cheie: grâu, proteine, îngrășăminte, producție.

INTRODUCTION

In order to feed the growing world population (9.2 billion by 2050) a 70% increase in agricultural yield is needed (FAO 2009). FAO's Committee on Food Security has set its goal since 1990 providing food for every human being with the fulfilment of three conditions: sufficient food supply; assessment of food reserves; everyone's access to food sources, especially the poor (Mocanu, 2012).

Wheat is currently the most cultivated crop in the world, grown on 217 million hectares per year, with a total world production of over 700 million tons, due to its many favourable qualities for human consumption (Erenstein, 2022). It is vital to increase wheat yield in accordance with the nation's rapid population growth (Maqbool, 2023). Owing to the uneven harvests wheat in recent years both in terms of quality and in terms of quantity, a particularly important aspect for this food sector is the correct analysis of quality of raw materials in order to orient it towards bakery and pastry products and for determining appropriate corrective methods for improving the quality of wheat and wheat flour obtained by grinding in order to obtain constant quality finished products (Dodocioiu, 2015).

In recent years, the production of wheat grain has increased globally, but its quality has not improved, which can have a negative impact on animal and human health (Francess Sia Saquee, 2023).

Doses of nitrogen fertilizers may be accompanied by harmful effects for plants and may be removed if a fraction of the dose of nitrogen was applied in the late stage of plant development, while vegetative growth is terminated, and nitrogen is used in the formation of the reproductive organs, and for synthesis of protein in the grain as reserve substance thus improving quality traits of flour (Mocanu 2013; Dodocioiu, 2013).

The optimal fertilization and nutrition by macro and micro elements without insufficient or excess stages favor a normal dynamic of the accumulation of the nutritive elements and dry matter (Mocanu, 2009). Of this normal parallelism (nutrient – dry matter) we can trace the obtaining of high and quality yields (Hera Cr., 1987).

Fertilization significantly determines the amount of protein per unit area, especially through nitrogen fertilizers. Even though the phosphorus do not influence as much as the nitrogen the yield quantity and the protein content it sustains the nitrogen effect and alleviate the negative influence of high nitrogen doses on the quality and quality of the protein determining a better assimilation and metabolisation of the absorbed nitrogen forms (Rusu, 2005).

MATERIALS AND METHODS

The experiments were located in the experimental field of Agriculture Research and Development Station (ARDS) Șimnic – Craiova, in the years 2020-2022, comprising 10 variants with different varieties of wheat as follows:

Variant 1 – Glosa variety, the control variant
Variant 2 – Boema variety 1
Variant 3 – Dropia variety
Variant 4 – Miranda variety
Variant 5 – Adelina variety
Variant 6 – Șimnic 30 variety
Variant 7 – Șimnic 50 variety
Variant 8 – Șimnic 60 variety
Variant 9 – Otilia variety
Variant 10 – Pajura variety

The soil on which the experiment was placed is reddish Preluvosol, having Lower Pleistocene fluvial terrace deposits as parent material, with semi-adjacent rock, gravels, sands and clays, with a water table depth of 10 m. The soil profile is of the type: Ap, Apt, AB, Bt, Bt2, BC, Cr, Ck.

The soil has the following physical and chemical properties in the Ap horizon (0-27cm):

- Coarse sand: 7.0%
- Fine sand: 39.7%
- Dust: 21.8%
- Clay: 31.9%
- Textural class: LL
- Apparent density: 1.26g/cm3
- PT=52.2%
- PA=20.75%
- CA=5.4%
- CO=8.1%
- EU=14.7%

– pH=5.35, the soil reaction being moderately acidic
– Humus=2.7%, medium assured
– Nt=0.073%, medium supplied
– PAl=52 mg/kg, well supplied
– KAL=127 mg/kg, medium supplied

The soil belongs to the III class of quality according to the credit score of 58 points.

Fertilization was identical in all variants as follows:

In 2020, the doses of N170P50 provided by 350 kg/ha ammonium nitrate and 250 kg/ha 20-20-0 complexes were used.

In 2021, doses of N147P69 were used, which were provided by 350 kg/ha of ammonium nitrogen applied in spring and 150 kg/ha of complex 18-46-0 applied before sowing.

In 2022, doses of N170P50 were used which were provided by 250 kg/ha of 20-20-0 complex applied before sowing and 350 kg/ha of ammonium nitrate applied in spring..

RESULTS AND DISCUSSIONS

Climatic conditions during the years of experimentation as can be seen from tables 1-2 and figures 1-2, 2020 was the most favorable year for wheat cultivation, with precipitation and temperature values closer to the multiannual average. Thus, the precipitation exceeds the multi-year average exactly when it was necessary, namely in October, November, helping to good germination and growth, as well as in the months of May-June, helping to form the spike and the grain.

The temperatures were within accessible limits, registering slightly lower temperatures in the summer, thus helping the formation of the grain.

In 2021, higher temperatures were recorded in almost every month of the growing season except for May, which was 0.7°C lower. In June, during the formation of the grain, the temperatures were higher by 0.9°C, which led to its shattering.

Precipitation was also lower in 5 months out of the 9 months of the vegetation period, being very low at sowing, the sunrise did not occur on time, and 41.5 mm lower in April when the plants needed to form the ear (table 1).

In the year 2022, the climatic conditions were also less favorable for the development of the wheat crop. Thus, precipitation was below the multiannual average by -13.7 mm, and temperatures were 0.5°C higher 59.46% of the cattle livestock and in the year 2010, they registered just 53.73% (Table 1).

Table 1. Temperatures and precipitation recorded during the vegetation period for the wheat crop in the years 2020-2021-2022// Temperaturile și precipitațiile înregistrate în perioada de vegetație pentru cultura de grâu în anii 2020-2021-2022

Month	Temperature °C			Precipitation mm		
	Monthly average	Multiannual monthly average	Deviation	Monthly amount	Multiannual monthly amount	Deviation
October	14.3	11.8	2.5	32.8	44.5	-11.7
November	9.8	5.5	4.3	46.4	44.9	1.5
December	1.5	0.4	1.1	4.8	45.1	-40.3
January	6.1	-1.4	4.7	23.6	32.7	-9.1
February	3.9	1.0	2.9	20.6	30.6	-10
March	7.8	5.6	2.2	64.6	33.7	30.9
April	12.0	11.8	0.2	4.5	46.0	-41.5
May	16.2	16.9	-0.7	71.0	66.9	4.1
June	21.3	20.4	0.9	71.0	67.9	3.1
July	23.2	22.6	0.6	90.0	61.5	28.5
August	24.5	22.1	2.4	26.0	48.9	-22.9
September	21.4	17.5	3.9	37.0	42.4	-5.4
Total\average	13.5	11.2	2.1	492.3	565.1	-72.8

Tabel 2. Temperatures and precipitation recorded during the vegetation period for the wheat crop in the years 2021-2022// Temperaturile şi precipitaţiile înregistrate în perioada de vegetaţie pentru grâu cultura în anii 2021-2022

Month	Temperature °C			Precipitation mm		
	Monthly average	Multiannual monthly average	Deviation	Monthly amount	Multiannual monthly amount	Deviation
October	14.2	11.8	2.4	42.0	44.5	-2.5
November	5.8	5.5	0.3	7.0	44.9	-37.9
December	3.3	0.4	2.9	68.3	45.1	23.2
January	2.0	-1.4	0.6	79.8	32.7	47.1
February	3.4	1.0	2.4	12.8	30.6	-17.8
March	5.6	5.6	0.0	99.0	33.7	65.3
April	12.3	11.8	0.5	35.0	46.0	-11.0
May	16.4	16.9	-0.5	94.0	66.9	27.1
June	21.2	20.4	0.8	75.0	67.9	7.1
July	25.5	22.6	2.9	20	61.5	-41.5
August	24.7	22.1	2.6	13	48.9	-35.9
September	12.6	24.5	18.5	5.5	42.4	-36.9
Total\average	**12.3**	**11.8**	**0.5**	**551.4**	**565.1**	**-13.7**

In 2020, the highest productions of the three years of experimentation were obtained due to favorable climatic conditions. Yields ranged between 6334 kg/ha in the Glosa variety used as a control and 8535 kg/ha in the Pajura variety.

All tested varieties gave increased production compared to the Glosa variety used as a control, increases that were between 602 and 2197 kg/ha. The only variety with lower production compared to the control variant was Șimnic 30, with a negative increase in production -911kg/ha.

The highest production increases and obviously the highest yields were given by the Șimnic 60 varieties with a yield of 8150 kg/ha and a yield increase of 1812 kg/ha, as well as the Pajura variety 8535 kg/ha and an increase of production of 2157 kg/ha compared to the Glosa variety. The Pajura variety ranks first this year in terms of yield per hectare.

In 2021, the yield obtained from the tested varieties are lower than in 2020, due to the climatic conditions, they are shown in table 3.

Tabel 3. Yield in kg/ha obtained in the varieties tested in 2021//Randament în kg/ha obținut în soiurile testate în 2021

Variant	Variety	Yield Kg/ha	Difference from the control variant(kg/ha)
1	**GLOSA (control)**	6540	0
2	**BOEMA 1**	6522	-18
3	**DROPIA**	5934	-606
4	**MIRANDA**	5928	-612
5	**ADELINA**	5523	-1017
6	**SIMNIC 30**	6532	-8
7	**SIMNIC 50**	6349	-191
8	**SIMNIC 60**	7178	638
9	**OTILIA**	6568	28
10	**PAJURA**	6999	459

The yields vary between 5523 kg/ha for the Adelina variety and 7178 kg/ha for the

Șimnic 60 variety, which records, as you can see, the highest production. The production increments obtained are usually small or negative. The biggest positive increases are obtained in Șimnic 60 638 kg/ha and 459 kg/ha, in Pajura variety, and 28 kg/ha in the Otilia variety. In the rest, all the other 6 varieties do not obtain increases in yield compared to the control variant, the yields obtained being lower than its yield by 8 to 1017 kg/ha.

In 2022, the productions obtained from the tested varieties are also lower than in 2020, due to the climatic conditions, but higher than in 2021. A closer look at table 4 highlights the following aspects: The increases in yield this year are mostly positive but still with lower values, being between 138 and 990 kg/ha.

The most important increases in yield are obtained in the varieties Pajura - 990 kg/ha and Otilia - 637 kg/ha.

Tabel 4.Production kg/ha obtained in the varieties tested in 2022// Producția kg/ha obținută în soiurile testate în 2022// Producție kg/ha obținută în soiurile testate în 2022//Producția kg/ha obținută în 2022 în 2022

Variant	Variety	Yield	Difference from the control variant(kg/ha)
1	GLOSA (control)	6340	0
2	BOEMA 1	6192	-148
3	DROPIA	7155	815
4	MIRANDA	6512	172
5	ADELINA	6708	368
6	SIMNIC 30	6677	337
7	SIMNIC 50	6478	138
8	SIMNIC 60	6807	467
9	OTILIA	6977	637
10	PAJURA	7330	990

The average yield over the three years of experimentation is shown in table 5.

Tabel 5. Yield kg/ha obtained on average over the three years of experimentation// Randament kg/ha obținut în medie pe parcursul celor trei ani de experimentare

Variant	Variety	Yield Kg/ha	Difference from the control variant(kg/ha)
1	GLOSA (control)	6406	-
2	BOEMA 1	6825	419
3	DROPIA	6841	435
4	MIRANDA	6460	54
5	ADELINA	6684	278
6	SIMNIC 30	6212	-194
7	SIMNIC 50	6778	372
8	SIMNIC 60	7345	939
9	OTILIA	7209	803
10	PAJURA	7621	1215

On average over the three years of experimentation, the yields of most varieties (7 out of 10) were around 6200-6700 kg/ha, being very close to the control variant Glosa whose production was 6406 kg/ha.

With the varieties Șimnic 60, Otilia and Pajura, the yields of over 7000 kg/ha and 7345 kg/ha and 7621 kg/ha were obtained, respectively.

The yield increments usually varied between 54 and 435 kg/ha, with the Śimnic 30 variety even obtaining a negative increment -194 kg/ha.

In the varieties with the highest yields, Șimnic 60, Otilia and Pajura, the yield increases were between 939 and 1215 kg/ha.

It results that the highest yields on average over the three years of experimentation are obtained in order in the varieties Pajura 7621 kg/ha, Șimnic 60 7345 kg/ha and Otilia 7209kg/ha.

It was appreciated by the amount of protein contained in the harvest of each variety. The results regarding this indicator annually and on average over 3 years are shown in table 6.

The following observations can be made from the data contained in this table:

The protein content was different in the varieties analysed according to the years of experimentation. In 2020 and 2021 the protein content was very close 10.7-12.2% in 2020 and 9.7-12.6 in 2021.

In 2022, the protein content of all tested varieties was much higher than in 2020 and 2021, reaching values of 15.1-18.0%. This is due on the one hand to the climatic conditions, and on the other hand to the fact that larger amounts of nutrients have been accumulated in the soil for 3 years. According to Biary et al. (2011), the reason for the increase in the protein following the use of nitrogen biofertilizer is the provision of nitrogen through biological fixation and the release of the absorbable nitrogen on plant roots by bacteria. In other words, the increase is associated with the better supply of nitrogen for grain and the higher nitrogen efficiency (Sharif & Lotfollah 2017).

Thus, during the period of the bellows and grain formation, the temperature was lower than in other years and the precipitation was higher.

On average over the three years of experimentation, the amount of protein was between 12.06% in the control (Glosa variety) and 13.76% in the Șimnic 30 variety. The interaction between year and biofertilizer had a significant effect on the grain protein content at the probability level of 5% (Abolghasem Moradgholi, 2021)

Analysing the protein content per ha on average over the 3 years of experimentation, it was between 772.56 kg/ha in the control and 1005.97 kg/ha in Pajura variety which had the highest production, followed by the Otilia variety 980 kg/ha and Simnic 60-954.85 kg/ha. Hammad et al. (2020) observed the improvement in soil fertility and protein contents of wheat grains following the application of organic fertilizers. However, they also reported that synthetic fertilizer resulted in the highest grain yield (Ehsan et all., 2021) the use of micronutrients mixed with macronutrients significantly increases plant growth, physiological traits, yield components, the yield, and most grain quality traits (Francesca, 2023).

T**able 6. The protein content of the wheat grains of the experimental varieties (%**)//Conținutul de proteine al boabelor de grâu din soiurile experimentale (%)

Variant	Variety	Protein content (%)			Average over 3 years (%)	The amount of protein in kg/ha
		2020	2021	2022		
1	**GLOSA (control)**	10,7	10,4	15.1	12,06	722,56
2	**BOEMA 1**	11,8	11,1	14.4	12,43	848,34
3	**DROPIA**	12,2	10,8	16.5	13,1	896,17
4	**MIRANDA**	12,1	9,7	16.6	12,8	826,88
5	**ADELINA**	11,7	10,1	15.6	12,46	832,82
6	**SIMNIC 30**	11,6	10,9	18.1	13,53	840,48
7	**SIMNIC 50**	11,2	12,1	18.0	13,76	932,65
8	**SIMNIC 60**	10,9	11,6	16.5	13,0	954,85
9	**OTILIA**	11,1	12,6	17.1	13,6	980,15
10	**PAJURA**	12,1	11,7	15.8	13,2	1005,97

CONCLUSIONS

The 10 varieties tested in 2020-2022 at Agriculture Research and Development Station (ARDS) Șimnic behaved differently both in terms of yield and its quality.

The highest yield was recorded for the varieties: Pajura -7621 kg/ha, Șimnic 60-7345 kg/ha and Otilia -7209 kg/ha.

The lowest yields were obtained for the varieties: Șimnic30 - 6212 kg/ha and Glosa - 6406 kg/ha.

The highest protein content on average over 3 years was recorded in the varieties Şimnic 50-13.76%, Şimnic 30-13.53% and Otilia -13.6%, and the lowest content in the variety Glosa -12.06% and Boema 1-12.43%.

However, the highest amount of protein per hectare is obtained in the variety with the highest production per hectare, namely Pajura -1005.97 kg/ha followed by the variety Otilia- 980.15 kg/ha and Șimnic 60 - 954.85 kg/ha.

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EXPERIMENTING NEW TECHNOLOGICAL OPTIONS REGARDING THE ACCLIMATIZATION OF POTATO MICROPLANTS AND THE PRODUCTION OF MINITUBERS UNDER PROTECTED SPACE

EXPERIMENTAREA UNOR NOI VARIANTE TEHNOLOGICE PRIVIND ACLIMATIZAREA MICROPLANTELOR DE CARTOF ŞI PRODUCEREA DE MINITUBERCULI ÎN SPAŢIU PROTEJAT

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ABSTRACT

Micropropagation allows the development of applied research in the production of potato planting material by creating new methodological solutions and concepts. Vitro potato plants are used in the production of minitubers only under protected spaces, which will then be cultivated in the open field (clonal field) to produce the first generation of Prebase tubers. The purpose of the experience was the comparative evaluation in two periods of the year of the number and weight of minitubers/plant, for three Romanian potato varieties - Asinaria, Darilena and Foresta -regenerated from meristematic cultures.

Key Words: Solanum tuberosum L., tissue culture, protected space, minituber production

REZUMAT

Micropropagarea permite dezvoltarea cercetărilor aplicative în cadrul producerii materialului de plantat la cartof prin realizarea de soluţii şi concepte metodologice noi. Vitroplantele de cartof sunt utilizate în producerea de minituberculi doar în spaţii protejate, care vor fi apoi cultivaţi în câmp deschis (câmp clonal) pentru a produce prima generaţie de tuberculi Prebază. Experienţa a avut ca scop evaluarea comparativă în două perioade ale anului a numărului şi greutăţii minituberculilor/plantă, a trei soiuri româneşti de cartof - Asinaria, Darilena şi Foresta -regenerate din culturi meristematice.

Cuvinte cheie: Solanum tuberosum L., culturi de ţesuturi, spaţii protejate, producţia de minituberculi

INTRODUCTION

Modern vegetative propagation procedures have led to the development of new research directions, with important theoretical and practical applications. Modern practices of *in vitro* multiplication ensure not only the obtaining of a finite number of plants in a short time, but also the storage of surplus plant material at a given time, and its conservation for a longer or shorter period of time, in the so-called *in vitro genes banks* (Chiru, 2002). The quality of the seed potato is a complex notion, characterized by the phytosanitary, biological and physical properties of the tubers; potato production capacity as well as its quality depend on the variety and the quality of the planting material which contributes more than 50% to the achievement of large and constant productions (Draica and Man, 1982, cited by Bărdaş, 2004). The production of potato minitubers is the classic intermediate step to make possible the use of the material obtained *in vitro* in the field. The techniques used for the production of minitubers are diverse, but they are mainly based on the propagation of microplants or microplant cuttings in a sterile organic substrate (Draica et al., 2004, cited by Nistor et al., 2013). Tissue culture plants do not rely on photosynthesis; instead, they use sucrose as an energy source. Therefore, an early hardening process could start while the plants are still *in vitro*. This process could gradually prepare the plantlets for photosynthesis and stomatal activation so that water loss through the cuticle is minimized (Zobayed et al., 2000). Acclimatization is the adaptation of micropropagated plants that are transferred to the *ex vitro* environment. In order to increase the survival rate of vitroplants, special attention is paid to physical and chemical factors, but also to culture media with balanced compositions of macroelements and microelements. According to Pospíšilová et al., 1999, plantlets can be prepared *in vitro* for the acclimatization phase taking the following measures, either individually or in combination: decrease in mineral salt concentration (e.g. Murashige-Skoog medium with half the mineral salts); increasing the concentration of the gelling agent, this has the effect of strengthening the root structure; changing the sucrose concentration (higher or lower) from the growth medium.

MATERIAL AND METHOD

This study was carried out in 2023 at NIRDPSB Braşov, in the Plant Tissue Cultures Laboratory, and the transplantation of microplants took place in the *insect-proof* space that are part of the laboratory equipment. The varieties used (Table 1) are part of the active conservation *in vitro* collection which is represented by Romanian varieties and are part of the multiplication program carried out in the laboratory, intended for rapid multiplication.

Table 1. Characterization of the varieties used in the study//Caracterizarea soiurilor utilizate în studiu
(Source: Varieties brochure NIRDPSB Brasov, 2022, www.potato.ro

Variety	Maturity group	Shell color	Pulp color	The tubercle form	Starch content %	Year of listing
Asinaria	semi-early	yellow	cream-colored	long oval	15.58	2019
Darilena	semi-early	yellow	light yellow	oval	17.58	2018
Foresta	late	red	dark yellow	short oval	11.17	2021

Only virus-free plantlets (ELISA tested) are used as a source of explants. Two variants of culture media were used: culture medium **MS** (Murashige and Skoog, 1962) including vitamins supplemented with 2% sucrose and 0.8% agar compared to the other variant of culture medium **MS/2** in which the composition of macro, micro elements and vitamins is half, with sucrose 3.5% and agar 10%. Equal amounts of NAA 5 ml/l (growth regulator) and PPM 3 ml/l (antimicrobial agent-Plant Preservation Mixture) are added to both nutrient medium variants, and the pH of the culture medium is adjusted to 5.7 before the sterilization process and the addition of the gelling agent. Sterilization of the culture medium is carried on at 121 ^{0}C and a pressure of 1.1-1.2 atmospheres. The distribution of the culture medium in the culture containers as well as the inoculation of the explants took place in the hood with laminar flow, with sterile air, the hood being located in a sterile area (room) of the laboratory. Fifteen explants were inoculated per box, obtaining a stock of plantlets for each of the three genotypes to carry on the experiment. The cultures were incubated for 6 weeks at 18-21 ° C under 3000 Lux of light irradiation, in the growth chamber, with a photoperiod of 16 hours of light and 8 hours of darkness. After 6 weeks the plantlets, each 10-12 cm tall with 9-10 internodes were removed from the culture containers, rinsed with tap water to remove excess agar and transferred to the *insect-proof* space. They were planted in 20 cm black plastic pots, filled with a substrate containing red peat, black peat and perlite (2:1:1), NPK 16:16:16 fertilizer was added to the composition. The peat-based substrate ensured good aeration at the root level and retained an optimal amount of water for the growth and development of the plantlets. The microplants were watered four to five times per week. After four weeks of growth, moisture intake was reduced to 3 applications (waterings) per week. Treatments with foliar fertilizers (Razormin, CropMax) were also use weekly. After planting, our experimental conditions required applying periodic prophylactic treatments with fungicides. The plants stood out for their vigor, obtaining an acclimatization (survival) percentage of 100%.

RESULTS AND DISCUSSION

The bifactorial experiment (2x3), with three repetitions, was carried out by combining two factors: the experimental factor A-the culture medium with two gradations: a_1 and a_2 and the experimental factor B-the variety with three gradations: b_1, b_2 and b_3. Two months after planting, the number and average weight of minitubers/plant, from the three potato varieties studied, was analyzed. In September minitubers were harvested and the data regarding the number and average weight of minitubers obtained were recorded.

Data 19.07

Table 2. Influence of the culture medium on the average number of minitubers/plant // Influenţa mediului de cultură asupra numărului de minituberculi/plantă

Culture medium (A)	Minitubers number/pl.	Diff.	Sign.
MS a_1(Ct)	2.73	-	-
MS/2 a_2	3.73	1.00	ns
DL 5%=1,02			
DL 1%=1,68			
DL 0,1%=3,14			

Table 3. The influence of the genotype on the average number of tubers/plant // Influenţa genotipului asupra mediei numărului de minituberculi/plantă

Variety (B)	Minitubers number/pl.	Diff.	Sign.
Asinaria b_1	3.50	0.20	ns
Darilena b_2	2.90	-0.40	ns
Foresta b_3 (Ct)	3.30	-	-
DL 5%=1,47			
DL 1%=2,02			
DL 0,1%=2,78			

Regarding the average number of minitubers/plant obtained from plantlets from the two types of tested culture media (Table 2), but also the interaction of the variety (Table 3), in the first harvest period (July), no significant differences were recorded compared to established controls.

Table 4. The interaction between the two analyzed factors (culture medium and variety) on the average number of minitubers/plant //Interacţiunea dintre cei doi factori analizaţi (mediul de cultură şi soiul) asupra numărului mediu de minituberculi/plantă

Variety/Culture medium	Minitubers number/pl. from MS	Diff.	Sign.	Minitubers number/pl from MS/2	Diff.	Sign.	Diff. (a_1-a_2)	Sign.
Asinaria b_1	2.60	0.20	ns	**4.40**	0.60	ns	1.80	ns
Darilena b_2	2.80	0.00	ns	**3.00**	-0.80	ns	0.20	ns
Foresta b_3(Ct)	2.80	-	-	**3.80**	-	-	1.00	ns
DL 5%=2,07				DL 5%=1,88				
DL 1%=5,90				DL 1%=2,69				
DL 0,1%=11,18				DL 0,1%=4,04				

Table 4 highlights the results obtained through the interaction of the two experimental factors on the number of minitubers/plant where the differences are insignificant.

Table 5. The influence of the culture medium on the average weight of minitubers/plant // Influenţa mediului de cultură asupra mediei greutăţii minituberculilor/plantă

Culture medium (A)	Minitubers weight/pl. (g)	Diff. (g)	Sign.
MS a_1(Ct)	20.14	-	-
MS/2 a_2	19.99	-0.15	ns
DL 5%=7,66			
DL 1%=12,67			
DL 0,1%=23,72			

Table 6. The influence of the variety on the average weight of minitubers/plant // Influenţa soiului asupra greutăţii medii a minituberculilor/plantă

Variety (B)	Minitubers weight/pl. (g)	Diff. (g)	Sign.
Asinaria b_1	20.85	5.78	ns
Darilena b_2	24.27	9.20	*
Foresta b_3 (Ct)	15.07	-	-
DL 5%=8,64			
DL 1%=11,90			
DL 0,1%=16,39			

Analysis of the average weight of minitubers/plant under the influence of the culture medium (Table 5) shows a negative difference compared to the control variety but insignificant from a statistical point of view. Regarding the average weight of the minitubers/plant, under the influence of the varieties studied, Darilena variety stands out with a significant positive difference (9.2 g), compared to the control, Foresta variety (Table 6).

Table 7. The interaction between the two analyzed factors (culture medium and variety) on the minitubers weight/plant // Interacţiunea dintre cei doi factori analizaţi (mediul de cultură şi soiul)

Variety/Culture medium	Minitubers weight/pl. (g) from MS	Diff. (g)	Sign.	Minitubers weight/pl (g) from MS/2	Diff. (g)	Sign.	Diff. (a_2-a_1) (g)	Sign.
Asinaria b_1	22.70	14.30	*	**19.00**	-2.74	ns	-3.70	ns
Darilena b_2	29.32	20.92	*	**19.22**	-2.52	ns	-10.10	ns
Foresta b_3(Ct)	8.40	-	-	**21.74**	-	-	13.34	*
DL 5%=2,07				DL 5%=11,66				
DL 1%=5,90				DL 5%=11,66				
DL 0,1%=11,18				DL 1%=17,06				

Regarding the influence of the interaction between the culture medium and the variety, on the average weight of the minitubers/plant, for the plantlets from the MS culture medium, the varieties that registered significant positive differences are the Darilena variety (20.92g) and the Asinaria variety (14.3g) , related to the control variety; for the plantlets from the MS/2 culture medium, the Foresta variety obtained a significant positive difference (13.34 g), in relation to the two varieties in the experiment (Table 7).

Data 19.09

Table 8. Influence of the culture medium on the number of microtubers/plant at harvest // Influenţa mediului de cultură asupra numărului de microtuberculi/plantă la recoltare

Culture medium (A)	Minitubers number/pl.	Diff.	Sign.
MS a_1(Ct)	4.40	-	-
MS/2 a_2	4.67	0.27	ns
DL 5%=0,68			
DL 1%=1,13			
DL 0,1%=2,11			

Table 9. Influenţa genotipului asupra numărului de microtuberculi la recoltare // The influence of the genotype on the number of microtubers at harvest

Variety (B)	Minitubers number/pl.	Diff.	Sign.
Asinaria b_1	5.30	1.70	***
Darilena b_2	4.70	1.10	**
Foresta b_3(Ct)	3.60	-	-
DL 5%=0,72			
DL 1%=0,99			
DL 0,1%=1,36			

For the second harvest period (September), the number of minitubers obtained from the plants from the experimental culture media did not show significant differences for the two types of media (Table 8). The study of the influence of the variety on the number of minitubers/plant is highlighted with a very significant positive difference for the Asinaria variety (1.7) and with a distinctly significant positive difference for the Darilena variety (1.1), compared to the Foresta variety studied (Table 9).

Table10. The combined influence between the two studied factors (culture environment and variety) that react on the average number of minitubers at harvest // Influenţa combinată intre cei doi factori studiaţi (mediul de cultură şi soiul) ce reacţionează asupra numărului de minituberculi la recoltare

Variety/Culture medium	Minitubers number/pl. from MS	Diff.	Sign.	Minitubers number/pl. from MS/2	Diff.	Sign.	Diff. (a_2-a_1)	Sign..
Asinaria b_1	5.20	2.00	*	5.40	1.40	*	0.20	ns
Darilenab$_2$	4.80	1.60	*	4.60	0.60	ns	-0.20	ns
Foresta b_3(Ct)	3.20	-	-	4.00	--		0.80	ns
DL 5%=1,02							DL 5%=0,99	
DL 1%=2,89							DL 1%=1,45	
DL 0,1%=5,48							DL 0,1%=2,27	

Table 10 shows the results obtained from the combined interaction between culture medium and variety on the number of minitubers/plant. For the plantlets from the MS culture medium, significant positive differences were observed in the Asinaria (2) and Darilena (1.6) varieties compared to the control variety. The plantlets from the MS/2 culture medium led to the formation of minitubers with a higher number for the Asinaria variety (1.4) with a significant positive difference, compared to the control variety.

Table 11. The influence of the culture medium on the average weight of the minitubers/plant at harvest (September) // Influenţa mediului de cultură asupra greutăţii medii a minituberculilor/plantă la recoltare (septembrie)

Culture medium (A)	Minitubers number/pl.	Diff.	Sign.
MS a_1(Ct)	55.68	-	-
MS/2 a_2	81.91	26.23	*
DL 5%=16,83			
DL 1%=27,86			
DL 0,1%=52,14			

Table 12. The influence of the variety on the average weight of minitubers at harvest (September)//Influenţa soiului asupra greutăţii medii a minituberculilor la recoltare (septembrie)

Variety (B)	Minitubers number/pl.	Diff.	Sign.
Asinaria b_1	54.10	32.05	ns
Darilena b_2	130.23	108.18	***
Foresta b_3(Ct)	22.05	-	-
DL 5%=54,60			
DL 1%=75,20			
DL 0,1%=103,53			

From the analysis of the results in table 11, it can be observed that the seedlings from the MS/2 culture medium, has an influence on the average weight of minitubers/plant with a positive significant difference compared to the control culture medium

Testing the influence of the variety on the average weight of minitubers/plant Darilena variety drew our attention with a very significant positive difference (108.18 g) compared to Foresta, the variety chosen as a control (Table 12).

Table 13. The influence of the interaction between the two studied factors on the average weight of minitubers/plant at harvest (September) // Influenţa interacţiunii între cei doi factori studiaţi asupra greutăţii medii a minituberculilor/plantă la recoltare (septembrie)

Variety/Culture medium	Minitubers weight/pl. (g) from MS	Diff. (g)	Sign.	Minitubers weight/pl. (g) from MS/2	Diff. (g)	Sign.	Diff. (a_2-a_1) (g)	Sign.
Asinaria b_1	55.04	39.98	ns	53.16	24.12	ns	-1.88	ns
Darilena b_2	96.94	81.88	*	163.52	134.48	*	66.58	*
Foresta b_3(Ct)	15.06	-	-	29.04	-		13.98	ns
DL 5%=77,21				DL 5%=64,48				
DL 1%=219,58				DL 1%=89,74				
DL 0,1%=416,19				DL 0,1%=126,27				

Based on the analysis of the results in table 13, it is found that the influence of the combined interaction between the two factors on the average weight of minitubers/plant, differentiates the Darilena variety which obtains significant positive differences for plantlets from both culture mediums used: 81.88 g (for plantlets from MS culture medium) and 134.48 g (for plantlets obtained from MS/2). By comparing the two culture media, a positive difference is observed in the plantlets from the MS/2 culture medium compared to the MS culture medium, leading to a significant positive difference for the same variety Darilena (66.58 g).

CONCLUSIONS

1. The results highlight both the role of the genotype and the use of the nutrient medium for the growth and development of vitro plants, as well as the influence of their interaction in achieving the production of minitubers from the protected space.
2. The acclimatization method was conditioned by choosing the nutrient substrate that ensured a high percentage of plantlets survival.
3. Vitro plants inoculated on the MS/2 culture medium, in the composition of which half of the salts and vitamins were added, showed no differences in growth, both *in vitro* and ex vitro, and thus significant savings in chemical substances are achieved.

4. It is recommended to optimize the culture media used for the different varieties from the *in vitro* collection and newly created varieties that should be studied for their *in vitro* performance in order to successfully multiply *in vivo*.

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ASPECTS OF IN VITRO MICROTUBERIZATION, ON MEDIA WITH DAMINOZIDE, IN POTATO LOCAL VARIETIES (*SOLANUM TUBEROSUM* L.), FROM THE SUCEAVA GENE BANK COLLECTION

ASPECTE ALE MICROTUBERIZĂRII *IN VITRO*, PE MEDII CU DAMINOZIDĂ, LA VARIETĂȚI LOCALE DE CARTOF (*SOLANUM TUBEROSUM* L.), DIN COLECȚIA BĂNCII DE GENE SUCEAVA

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ABSTRACT
The "in vitro" reactivity of the potato is, in general, very good, but that of the local genotypes can be quite varied, in terms of the growth speed, the size of the leaflets, the vigour of the plantlets or the microtuberization. The potato varieties from the "in vitro" collection are subcultured, periodically, on different micromultiplication media, constituting sources of biological material that will be passed into conservation media, or in different experiments of revitalization, or inducement of microtuberization. Daminozide (N-dimethylaminosuccinamic acid, B9, Alar) is a systemic growth regulator originally registered in the United States, in 1963, for use on ornamental plants, respectively on potted chrysanthemums. Its degree of harmfulness is very low, being classified in Category IV of toxicity, but it must be handled with care, as some studies consider it to have a carcinogenic effect if ingested. For the potato "in vitro" culture, it can be used in all stages, except the meristem inoculation, having a stimulating effect on the growth of the leaf surface and microtuberization, at concentrations of 6 -15 mg/litter of medium. Another result of the action of daminozide is the reduction of the length of the internodes, at concentrations of 20 - 30 mg/litter of medium, allowing a slow growth, at 6 – 10^{0}C, the extension of the duration between two subcultures, a preservation of 2 - 3 years, for the genotypes in the collection and stimulation of microtuber growth.

Keywords: potato, microtubers, slow growth, daminozide, in vitro conservation

REZUMAT
Reactivitatea in vitro a cartofului este, în general, foarte bună, dar cea a genotipurilor locale poate fi destul de variată, în ceea ce privește viteza de creștere, mărimea frunzulițelor, vigurozitatea plantulelor sau predispoziția pentru microtuberizare. Varietățile de cartof din colecția" in vitro" sunt subcultivate, periodic, pe diferite medii de micromultiplicare, constituind surse de material biologic care vor fi trecute în conservare, sau în diferite experimente de revigorare, sau de stimulare a microtuberizării. Daminozida (Acid N dimetilaminosucinaminic, B9, Alar) este un regulator de creștere sistemic, înregistrat inițial în Statele Unite în 1963, pentru utilizare pe plante ornamentale, respectiv pe crizanteme în ghiveci. Gradul său de nocivitate este foarte scăzut, fiind încadrat în Categoria IV de toxicitate, dar trebuie manipulat cu atenție, deoarece unele studii îl consideră ca având un efect cancerigen, dacă este ingerat. La cultura cartofului "in vitro", poate fi folosit în toate etapele, cu excepția inoculării de meristeme, având efect stimulativ asupra creșterii suprafeței foliare și a microtuberizării, la concentrații de 6 -15 mg/litru de mediu. Un alt rezultat al acțiunii daminozidei este reducerea lungimii internodurilor, la concentrații de 20 - 30 mg/litru de mediu, permițând o creștere lentă, la 6 – 10^{0}C și prelungirea duratei între două subculturi, o conservare de 2 - 3 ani, pentru genotipurile din colecție și stimularea creșterii microtuberculilor.

Cuvinte cheie: cartof, microtuberculi, creștere lentă, daminozidă, conservare in vitro

INTRODUCTION

The potato collection at the Suceava Genebank, maintained "*in vitro*", by *slow growth*, starts from the varieties cultivated, year after year, in the experimental field and includes, mainly, old varieties collected, above all, from mountain areas of Romania. The local populations resulted from a long selection of the material, according to the needs and preferences of the growers, as well as the action of the environment, having a high culinary value, some of them having resistance genes of value for breeders.

The "*in vitro"* reactivity of potato is generally very good, but that of local genotypes can be quite specific, in terms of growth speed, leaf size, plantlet vigour or predisposition to microtuberization.

The potato varieties from the "*in vitro"* collection are periodically subcultured on different micromultiplication media, constituting sources of biological material, subsequently subcultured on conservation media for periods of 2 - 3 years, or in various revitalization experiments, to stimulate microtuberization, or facilitate the acclimatization (Ibănescu M., Constantinovici D. and Strajeru S., 2007).

The experiments aimed to increase the preservation period by ensuring the viability and vitality of some genotypes with a higher sensitivity to the stressful conditions of preservation, as well as the effect of the presence of daminozide, in different concentrations, in association with other components of the culture medium, on the microtuberization process.

Daminozide (Synonyms: N-dimethylaminosuccinamic acid, B9, Alar) is a systemic growth regulator originally registered in the United States in 1963 for use on ornamental plants, namely chrysanthemums grown in pots. Its degree of acute and subacute harmfulness is very low, being classified as Category IV of toxicity, but it must be handled carefully, as some studies affirm that ingestion of the substance may have a carcinogenic effect (EPA-738-F-93-007, 1993).

For the *in vitro* potato culture media, daminozide can be used in all stages, except for meristem inoculation, having a stimulating effect on the growth of leaf surface and microtuberization, at concentrations of 6 - 15 mg/litter of media. Another result of the action of daminozide is the reduction of the internodes length, respectively of the plantlets, at concentrations of 20 - 30 mg/litter of medium, favouring the extension of the period between two subcultures, which can be used for 2 - 3 year conservation, through *slow growth*, of the genotypes from the collection, but also to stimulate the microtubers production.

The paper presents a synthesis of the observations made for several years, in which daminozide was used in the culture media, for the periodic cycles of preservation and micromultiplication, through which the collection of local potato genotypes is maintained, with an emphasis on the effects of this growth regulator on microtuberization.

MATERIAL AND METHOD

All the experiments were carried out on the basis of the subcultivation of uninodal mini-cuttings, resulting from the plantlets of local potato varieties collection, previously regenerated *in vitro* (Constantinovici D., 2004).

The basic medium used was MURASHIGE SKOOG – (MS - 1962) (Murashige T., Skoog F., 1962). The concentration of inorganic compounds in the culture media for the micropropagation phase (**M_{14}; M_{34}**) as well as those of microtuberization (**M_{36}; M_{37}**) was the one recommended by the authors. The organic compounds varied within fairly wide limits.

The main growth regulators used were kinetin (K), benzyladenine (BA), ὰ naphthyl acetic acid (NAA), with the addition of daminozide, in concentrations that varied from 6 to 30 mg/litter of medium, the maximum concentration being in a microtuberization medium (**M_{37}**).

The experiments tracked down the effect of the presence of daminozide, in different concentrations and in associations with other components of the culture medium, on the microtuberization process.

The medium (20 ml) was poured into 170 ml vials of (5.5 cm diameter / 9.5 cm height). The vials were covered with aluminum foil and sterilized for 20 min at 121^0C. After placing the inocula on the medium, the vials were covered with double polyethylene film, fixed with rubber rings and were transferred to the growth chamber at a temperature of 20 – 22^{0}C, and photoperiod of 16/24 hours, with a light intensity of 2500 lx. After resuming the inoculum growth processes, the vials were transferred to the conservation room, under slightly restrictive conditions, with a temperature varying between 6 and 12^{0}C, photoperiod 10/24 hours, and the light intensity of 1000 lx, generated by LED tubes.

RESULTS AND DISCUSSION

The potato is a crop of great importance, which multiplies vegetatively and for which rapid micropropagation procedures have been developed. The entire methodology, starting from meristem inoculation and subculture of microcuttings is dependent on the pre-existence of axillary buds. Elongation of shoots could be obtained on a simple medium, while tuberization requires higher concentrations of sucrose, cytokinins and various growth regulators, among which is daminozide (Cachiţă CD, 1987).

The medium **M_{14}**, with daminozide 6 mg/l, generated vigorous plants, showing secondary shoots, or well-individualized axillary buds and a more pronounced differentiation between the genotypes in the collection. The colour shades of the shoots were distinct, ranging from raw green to dark purplish. Rooting was very good (photo 1 - 5).

Photo 1 - 5. Aspects of the development of plantlets and microtubers obtained on the M_{14} medium, for the SVGB-15102 potato genotype (Sânpetru Almașului, Sălaj) //Foto 1 - 5. Aspecte ale dezvoltării plantulelor și a microtuberculilor obținuți pe mediul M_{14}, la genotipul de cartof SVGB-15102 (Sânpetru Almașului, Sălaj)

A good evolution of the plantlets was, also, obtained in the case of the medium **M_{34}**, containing kinetin 2 mg/l, benzyladenine 0.2 mg/l, ANA 0.4 mg/l and an addition of 10 mg/l of daminozide, in order to obtain a richer sprouting, to maintain the vigour of the plantlets and to regenerate microtubers. Five months after the subculture of the microcuttings, on the **M_{34}** medium, it was possible to observe, in several varieties, the regeneration of plantlets with multiple shoots, relatively short internodes, the presence of microtubers and a rich rooting (photo 6 - 10).

In addition to maintaining the vigour and vitality of the plantlets, the stimulation of the microtuberization process has been and will remain the focus of any *in vitro* culture laboratory, which has the potato as its object of activity, being both a way of valorising the material owned, or to facilitate acclimatization.

Daminozide, especially in combination with other components of culture media (cytokinins, sucrose, vitamins, etc.) has the ability to increase the regeneration rate of microtubers. As in the case of other types of reaction, the process of microtuberization of different local genotypes in the collection can show quite pronounced variations.

Culture media **M_{36}** and **M_{37}**, contain daminozide and sucrose, in different concentrations, in combination with vitamins and benzyladenine, in equal proportions, but higher than usual (Tissue culture CIP Training Manual, 2014).

In the first stages of growth, the plantlets on the medium **M_{36}** (benzyladenine 5 mg/l, ANA 0.2 mg/l with an addition of 6 mg/l of daminozide and 80 g of sucrose/1 l of medium) were smaller in height (3 - 5 cm), and for those on the medium **M_{37}** (benzyladenine 5 mg/l, ANA 0.2 mg/l with an addition of 30 mg/l of daminozide, and 20 g of sucrose/1 l of medium) could be noted a tendency to increase the leaf surface and to shorten of the shoot length (Photo 11 - 14)

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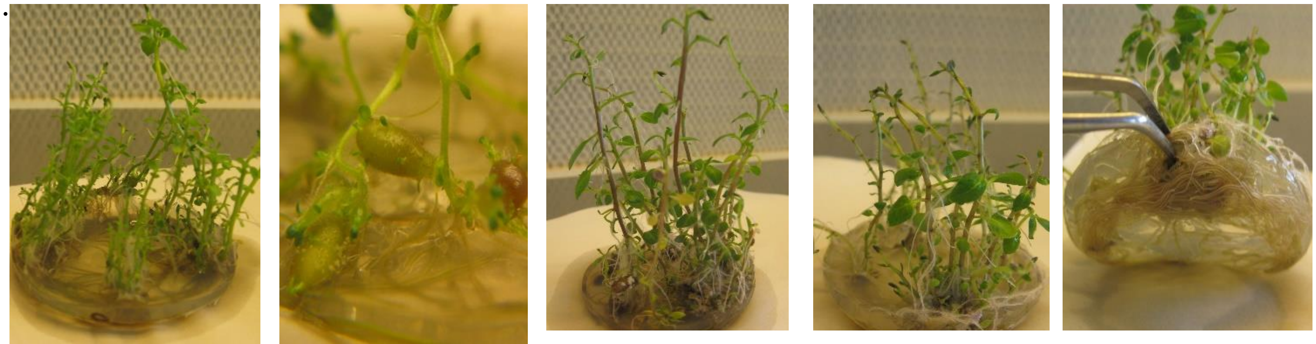

Photo 6 - 10. Aspects of plantlets development on the M_{34} medium, for potato genotypes SVGB-5144 (Moldova Sulița, Suceava), SVGB-5667 (Ruda Ghelari, Hunedoara), SVGB-12496 (Tupilați, Neamt) and SVGB-14369 (Galănești, Suceava, aerial part and rooting) // Foto 6 - 10. Aspecte ale dezvoltării plantulelor pe mediul M_{34}, la genotipurile de cartof SVGB-5144 (Moldova Sulița, Suceava), SVGB-5667 (Ruda Ghelari, Hunedoara), SVGB-12496 (Tupilați, Neamț) și SVGB-14369 (Gălănești, Suceava, parte aeriană și înrădăcinare).

Photo 11 - 14. Flasks with plantlets on M_{36} medium (left) and plantlets on M_{37} medium (right)// Foto 11 - 14. Flacoane cu plantule pe mediul M_{36} (stânga) și plantulă de pe mediul M_{37} (dreapta)

A summary of the evolution of some parameters regarding the number and average weight of microtubers, in the 40 potato genotypes developed on these culture media is presented in table 1.

Table 1

Evolution of the number and average weight of microtubers on culture media M_{36} and M_{37} //Evoluția numărului și greutății medii a microtubrilor pe mediile de cultură M_{36} și M_{37}

Specification	Medium M_{36}	Medium M_{37}
Total number of microtubers	2046	1295
Minimum number of microtubers/variant	6	8
Medium number of microtubers/variant	51,15	32,38
Maximum number of microtubers/variant	107	71
Number of variants with < 10 microtubers	2	2
Number of variants with < 50 microtubers	20 (50%)	33 (82%)
Number of variants with 50 – 100 de microtubers	18 (45%)	17 (18%)
Number of variants with > 100 microtubers	2 (5%)	-
Average weight of microtubers	0,20	0,29
Number of variants with an average weight of microtubers < 0,20 g	24 (60%)	10 (25%)
Number of variants with an average weight of microtubers > 0,20 g	16 (40%)	30 (75%)

The plantlets on medium 36 had the capacity to regenerate over 2000 microtubers, but 60% recorded weights below the average of 0.20 g, of all variants.

Genotypes on medium 37 regenerated something under 1300 microtubers, but 75% had weights above average.

Photo 15 - 17. Aspects of sampling regenerated microtubers on M_{36} medium // Foto 15 - 17. Aspecte ale prelevării microtuberculilor regenerați pe mediul M_{36}.

Photo 18 - 20. Aspects of sampling regenerated microtubers on M_{37} medium // Foto 18 - 20. Aspecte ale prelevării microtuberculilor regenerați pe mediul M_{37}.

The variability of the reaction of the different genotypes on the two culture media can also be observed in figures 1 and 2, which show the number of regenerated microtubers and their average weight, in the 40 genotypes developed on the media **M_{36}** and **M_{37}**, for six months, under the conditions offered by the preservation cell, at 6 – 10^{0}C, photoperiod of 10/24 hours, with 1000 lx.

Figure 3 shows an overview of the evolution of these two recorded parameters, on both media.

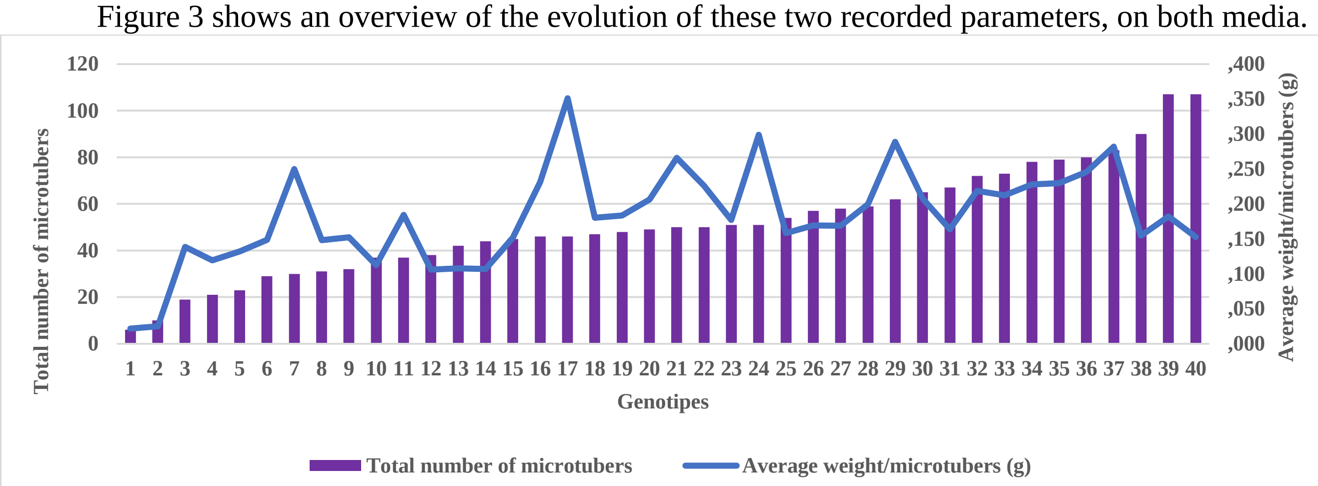

Figure 1. Variation of the number of microtubers and their average weight, in 40 genotypes grown for six months on the medium M_{36} // Figura 1. Variația numărului de microtuberculi și a greutății lor medii, la 40 de genotipuri dezvoltate timp de șase luni pe mediul M_{36}

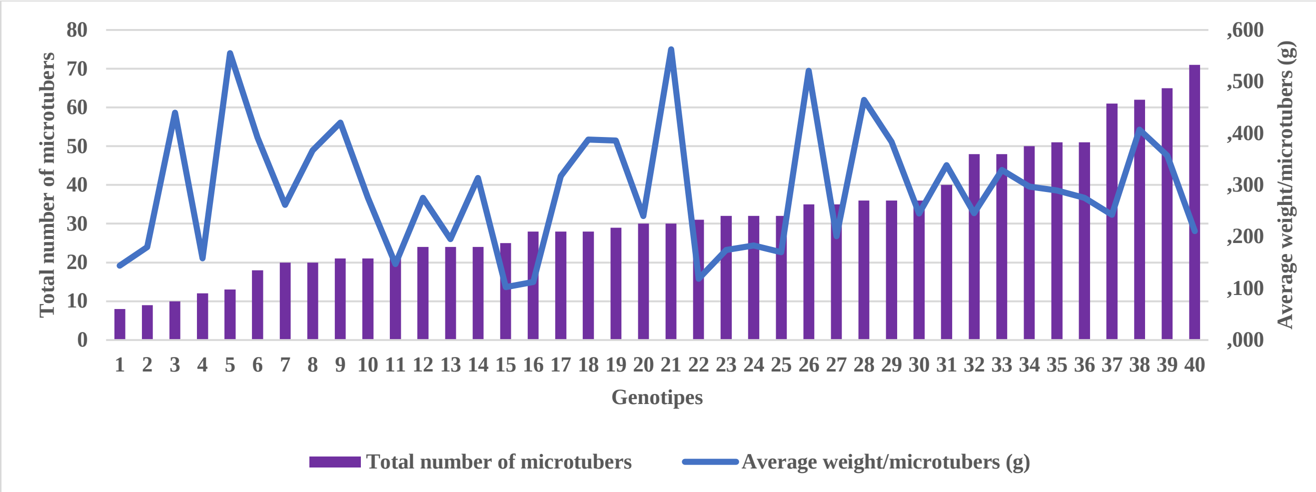

Figure 2. Variation of the number of microtubers and their average weight, in 40 genotypes grown for six months on the medium M_{37} // Figura 2. Variația numărului de microtuberculi și a greutății lor medii la 40 de genotipuri dezvoltate timp de șase luni pe mediul M_{37}

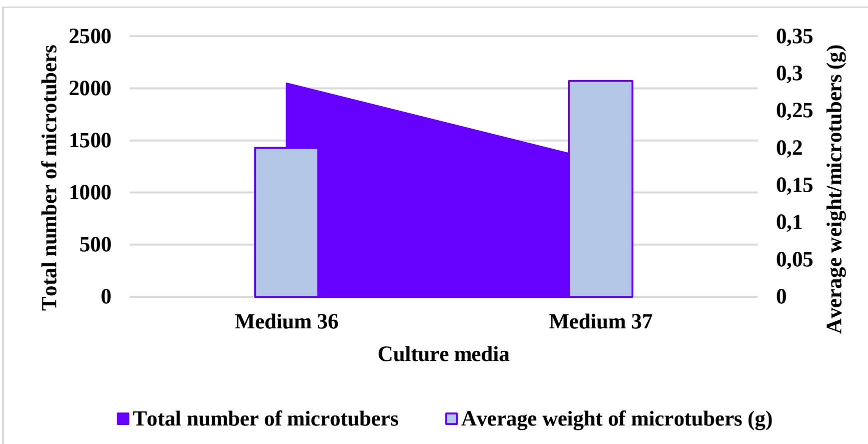

Figure 3. The number of microtubers and their average weight, in 40 genotypes grown for six months on the media M_{36} and M_{37}// Figura 3. Numărul de microtuberculi și greutatea lor medie, la 40 de genotipuri dezvoltate timp de șase luni pe mediile M_{36} și M_{37}

The regeneration of microtubers was recorded in all 40 genotypes, on both culture media, they stand out, especially, in the variants with anthocyanin. Many times shoots were formed at their apical part, which can also be used for subculture on fresh medium.

The presence of daminozide in concentrations over 25 mg/litter of medium, along with the decrease in the concentration of inorganic compounds in the MS medium, results in the development of plants with a reduced height, short internodes, but with a good development of the leaf and roots, which makes it particularly valuable in medium-term conservation methodologies (2 - 3 years) of the collection of local varieties, representing the main concern of the "*in vitro"* culture laboratory of the Suceava Gene Bank (Tanasă A.C., D. Constantinovici and S. Străjeru, 2023).

The possibility of maintaining all varieties at temperatures between 6 – 12^{0}C is an element of great importance in extending the time periods between two subcultures and postponing the appearance of senescence phenomena, which have proven to be closely related to the genotype but also to the culture medium.

New "*in vitro"* preservation technologies are always being researched, but the *slow growth* method is accessible in most cases. "*In vitro"* conservation does not intend to replace the conventional *in situ* and *ex situ* methods of preserving plant genetic resources, being only a complementary methodology.

CONCLUSIONS

1. Daminozide can be used to maintain the vigour of the collection, by regeneration after the conservation period, at concentrations of 6 – 15 mg/litter of medium;
2. Microtuberization of local potato varieties, although varying both in number and average weight of microtubers, can be stimulated on media containing daminozide 25 – 30 mg, together with benzyladenine and/or sucrose, in amounts of 5 mg and 80 g/litter of medium;
3. The growth speed of potato crops, on media containing daminozide as a retardant, in a concentration of 25 - 30 mg/litter of media, in combination with a decrease in temperature to 8 – 12^0C, allows extending the intervals between plant transfers to more than two to three years;
4. The "*in vitro"* conservation method is one of the most effective for a large number of potato genotypes, for a developing collection.

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COMPARATIVE STUDY OF SOME ROMANIAN WHEAT VARIETIES CULTIVATED IN ECOLOGICAL AND CONVENTIONAL SYSTEM AT A.R.D.S. VALU LUI TRAIAN

STUDIUL COMPARATIV AL UNOR SOIURI ROMÂNEȘTI DE GRÂU CULTIVATE ÎN SISTEM ECOLOGIC ȘI CONVENȚIONAL LA S.C.D.A. VALU LUI TRAIAN

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ABSTRACT:
In this paper, 25 winter wheat varieties were tested in the SE area of Romania (Dobrogea/Valu lui Traian) both in conventional agriculture system, as well as ecological. Under the climate conditions of the period 2021 - 2023, 9 genotypes were analysed to identify the varieties most adapted to local pedoclimatic conditions. During the growing season, phenological observations and biometric determinations were carried out.

Keywords: wheat, ecological, conventional, Dobrogea.

REZUMAT:
În lucrarea de față au fost testate 25 de soiuri de grâu de toamnă în zona de SE a României (Dobrogea/Valu lui Traian) atât în sistem de agricultură convențională, cât și ecologică. În condițiile climatice din perioada 2021 - 2023 au fost analizate 9 genotipuri pentru a identifica soiurile cele mai adaptate condițiilor pedoclimatice locale. În timpul vegetației s-au efectuat observații fenologice și determinări biometrice.

***Cuvinte cheie: grâu, ecologic, convențional, Dobrogea*.**

INTRODUCTION

In the year 2021, the total area cultivated with wheat in conventional system was 2,175 thousand ha, with a production of 10,434 thousand tons, and, in the year 2022, 2,144 thousand ha were cultivated with wheat, with a production of 8,559 thousand tons. The difference in production was 1,875 thousand tons (INSSE.ro).

The dynamics of the total area (ha) and the number of operators in organic agriculture varied greatly. The increased interest in the consumption of products obtained in an ecological system has led to an increase in the cultivated area. In the year 2000, the total area was 17,388 ha, reaching, in the year 2022, to 644,520 ha and 13,260 operators (madr.ro/organic-agriculture.html). Organic agriculture can contribute significantly to solving one of the major contemporary problems, such as global warming (Agricultura-ecologică în România "După 23 de Ani", Eng. Ion Toncea, PhD, Eng. Tudor Stanciu, PhD).

The evolution of yields is clearly influenced by pedoclimatic factors, therefore, in order to achieve high yields, it is necessary to cultivate (conventional or ecological) varieties that are well adapted to local environmental conditions. Many experimental results have shown us that the yields obtained in organic agriculture are smaller than those obtained in conventional agriculture (Carr et al., 2006; Hildermann et al., 2009; Seufert and Ramankutty, 2017; Grausgruber et al., 2022).

In order to increase the stability of yields from one year to another, the new varieties of winter wheat must combine a high yield potential and good resistance to biotic and abiotic stress conditions (Săulescu et colab., 2006).

The present paper aims to study the behaviour of several autumn wheat varieties in terms of their productive potential, as well as their resistance to the pedoclimatic conditions in Dobrogea, in order to highlight their adaptability to current climate conditions.

MATERIAL AND METHOD

This paper presents data obtained during the period 2021 - 2023, under the pedoclimatic conditions of ARDS Valu lui Traian, Constanța County. The soil on which the experimental field was located is chernozem, with a sandy texture, containing 3.5% humus, 32-34% clay, and a pH between 7.4 and 7.6.

Due to its geographical position, latitude 44°15'5"N longitude 28°30'12"E, altitude 80 m, climate is part of the agroclimatic zone I "warm - dry", which is characterised by the most generous thermal resources, but also by the least precipitations, compared to the rest of the country. The climate is temperate-continental, with features related to the presence of the Black Sea and the Danube nearby. Solar radiation is between 128 – 136 kcal/cm^2, and the sunshine duration is between 2,275 and 2,350 hours/year (Agricultural Dobrogea from legend … to globalization, Aurel Lup, page 33).

At ARDS Valu lui Traian, 2 testing experiments of various wheat varieties and lines were conducted using the randomised block method, in 3 repetitions and both in ecological and conventional agricultural systems. Over the 3 years of experiments, the sowing density was 550 bg/m^2. Specific operations were carried out according to the characteristics of each year. Sowing was done at the optimal time, but emergence was uneven and delayed, due to climate conditions. In the ecological system, the preceding plant was sunflower, while in the conventional system it was peas (2021), maize (2022), and rapeseed (2023). In the conventional system, the herbicide Sekator (0.15 l/ha) was applied, and the fertilisation applied during the testing period consisted of 78 kg P_2O_5 s.a. and 120 kg N s.a.

The experimental results were statistically processed through variance analysis (Săulescu and Săulescu, 1967; Ceapoiu, 1968).

RESULTS AND DISCUSSIONS

In the analysis of the climate conditions of the agricultural year 2020 – 2021, we can state that it was a favourable year for achieving high yields. It can be observed that it was a year with temperatures above the multiannual average, except for the month of April, when temperatures were lower. The positive deviations of the annual average temperatures emphasise the phenomenon of climate change. The rather low precipitations recorded in the months of September (24 mm/m^2), October (18.6 mm/m^2) and November (23.2 mm/m^2) have contributed to an uneven emergence. The surplus of precipitations werw recorded in the months of December (69.6 mm/m^2) and January (98.6 mm/m^2), but also the temperatures which have maintained high values, have contributed to the emergence of vigorous and strongly developed crops from winter.

Table 1

Distribution of rainfall (mm) during the growing season of winter wheat at A.R.D.S. Valu lui Traian, during 2021-2023 period//
Distribuția precipitațiilor (mm) în timpul perioadei de vegetație a grâului de toamnă la S.C.D.A. Valu lui Traian, în perioada 2021-2023

Month	2020-2021	Multiannual average 81 years	Deviation	2021-2022	Multiannual average 82 years	Deviation	2022-2023	Multiannual average 83 years	Deviation
IX	24.0	35.5	-11.5	22.2	35.4	-13.2	75.6	35.9	39.7
X	18.6	37.6	-19.0	101.6	38.4	63.2	6.0	38.0	-32.0
XI	23.2	40.8	-17.6	39.8	40.8	-1.0	21.4	40.5	-19.1
XII	69.6	34.9	34.7	83.4	35.5	47.9	17.6	35.3	-17.7
I	98.6	29.9	68.7	13.4	29.7	-16.3	43.4	29.9	13.5
II	20.2	25.1	-4.9	28.2	25.1	3.1	8.2	24.9	-16.7
III	70.8	29.3	41.5	31.2	29.3	1.9	23.8	29.3	-5.5
IV	75.8	32.7	43.2	31.0	32.6	-1.6	107.4	33.5	73.9
V	82.0	42.5	39.5	21.2	42.3	-21.1	10.2	41.9	-31.7
VI	118.0	48.3	69.7	33.6	48.2	-14.6	23.8	47.9	-24.1

Month	2020-2021	Multiannual average 81 years	Deviation	2021-2022	Multiannual average 82 years	Deviation	2022-2023	Multiannual average 83 years	Deviation
VII	33.8	43.9	-10.1	25.4	43.7	-18.3	33.2	43.6	-10.4
TOTAL	**634.6**	**400.5**	**234.1**	**431.0**	**401.0**	**30.0**	**370.6**	**400.7**	**-30.1**

During the following period, temperatures close to the multiannual average and rich precipitations were also recorded (table no. 1), as follows: March (70.5 mm/m^2), April (75.8 mm/m^2), May (82.0 mm/m^2), June (118 mm/m^2), and July (33.8 mm/m^2).

The agricultural year 2021 – 2022 was marked by an increase in average monthly temperatures and an uneven distribution of precipitations. Thus, the average monthly temperatures remained high, registering positive deviations from the multiannual average, with a maximum of +3.15°C in February (table no. 2). The precipitations recorded in the months of September (22.2 mm/m^2), October (101.6 mm/m^2), and November (39.8 mm/m^2) contributed to a uniform, albeit delayed, emergence. The maintenance of high temperatures in the months of December, January, and February continued the growing state of the crops throughout the winter. In the following period, were recorded temperatures higher than the multiannual average (with the exception of March), and low precipitations, as follows: March (31.2 mm/m^2), April (31.0 mm/m^2), May (21.2 mm/m^2), June (33.6 mm/m^2) and July (25.4 mm/m^2).

In the agricultural year 2022 – 2023, the rise in average monthly temperatures and the uneven distribution of precipitations was maintained. Thus, average monthly temperatures remained high, recording positive deviations against the multiannual average, the maximum being +5.69 °C in January. Precipitations recorded in the months of September (75.6 mm/m^2), October (6.0 mm/m^2), and November (21.4 mm/m^2) have contributed to a delayed and uneven emergence. In the following period, there were recorded temperatures close to the multiannual average and reduced precipitations, as follows: March (31.2 mm/m^2), April (31.0 mm/m^2), May (21.2 mm/m^2), June (33.6 mm/m^2), and July (25.4 mm/m^2).

Table 2

Monthly average temperatures (°C) during the growing season of winter wheat during 2021-2023 period // Temperaturile medii lunare (°C) în timpul perioadei de vegetație a grâului de toamnă în perioada 2021-2023

Month	2020-2021	Multiannual average 79 years	Deviation	2021-2022	Multiannual average 80 years	Deviation	2022-2023	Multiannual average 81 years	Deviation
IX	20.21	17.47	2.74	17.58	17.47	0.11	18.58	17.48	1.1
X	16.1	12.12	3.98	11.13	12.1	-0.97	13.24	12.12	1.12
XI	6.2	6.9	-0.7	8.66	6.95	1.71	9.26	6.98	2.28
XII	6.18	2.13	4.05	4.12	2.15	1.97	4.43	2.19	2.24
I	3.4	-0.3	3.7	2.04	-0.27	2.31	5.48	-0.21	5.69
II	3.23	1.14	2.09	4.33	1.18	3.15	3.25	1.21	2.04
III	4.72	4.6	0.12	2.82	4.57	-1.75	7.16	4.6	2.56
IV	9.33	9.98	-0.65	11.28	10	1.28	9.93	10	-0.07
V	16.33	15.62	0.71	16.1	15.62	0.48	15.57	15.62	-0.05
VI	20.29	20.06	0.23	21.22	20.07	1.15	21.02	20.08	0.94
VII	24.35	22.37	1.98	24.1	22.39	1.71	25.09	22.3	2.79
TOTAL	**11.8**	**10.2**	**1.66**	**11.2**	**10.2**	**1.01**	**12.1**	**10.2**	**1.88**

In conclusion, the agricultural year 2020 - 2021 was a favourable year for winter wheat culture, even if the fall precipitations were lower and temperatures higher, but the mild winter and abundant precipitations that were excessive until physiological maturity contributed to achieving high yields in both experimented systems.

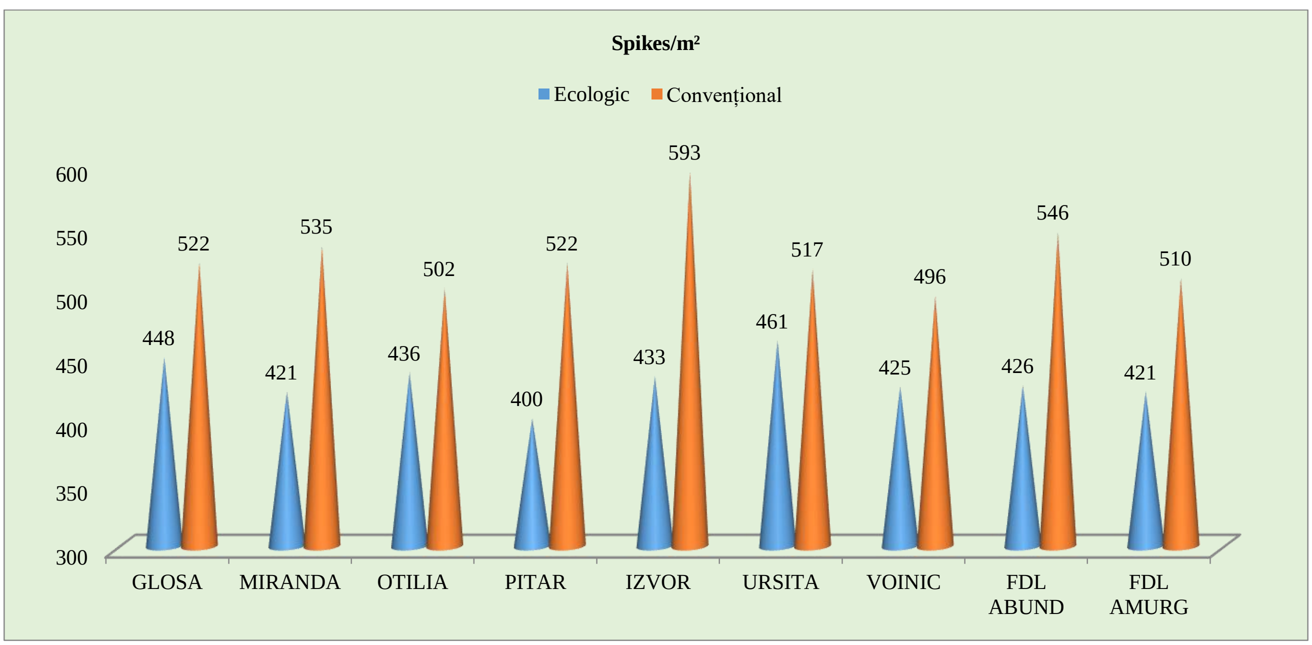
The agricultural year 2021 – 2022 was characterised by a rainfall regime close to the multiannual average. Although the multiannual deviation was positive, the distribution of precipitations was uneven, registering excessive amounts in the months of October and December, then there was a shortage of precipitations in most of the months. Monthly temperatures were higher than the monthly multiannual average, exceptions being only the months of October and March, which were colder than the normal climatological conditions. All these meteorological influences had as a consequence a yield that varied from a minimum of 2,793 kg/ha to 5,500 kg/ha in an ecological system, and a minimum of 3,761 kg/ha to 5,967 kg/ka in a conventional system.

The year 2022 - 2023 was characterized as being an unfavourable year for wheat cultivated in ecological systems, the yields being reduced quantitatively. Monthly average temperatures were much higher than the multiannual monthly average (table no. 2) having large and even very large positive deviations, such as the month of January, which had a positive deviation of 5.69°C compared to the multiannual average of the month. For wheat cultivated in conventional system, the precipitations in April led to obtaining good yields.

During the research, determinations were made on productivity elements. Regarding the number of spikes/m^2 (chart no. 1), notable differences can be observed between the two crop systems. Thus, in the ecological system, the minimum average for the period 2021-2023 was recorded for the Pitar variety (400 spikes/m²), while the maximum average obtained was for the Ursita variety (461 spikes/m²). A high number of spikes/m² was also recorded for the Glosa (448), Otilia (436), and Izvor (433) varieties. By comparison, in the conventional system, the minimum average was obtained for the Voinic variety (496 spikes/m²), and the maximum average for the Izvor variety (593 spikes/m²). The minimum average recorded in the conventional system (496) was higher than the maximum average achieved in the ecological crop system (461). spic

Chart 1

Average number of spikes/m² at winter wheat varieties tested during 2021-2023 periode //Media nr. de spice/m² la soiurile de grâu comun de toamnă testate în perioada 2021 – 2023



The values of the weight of a thousand grains (chart no. 2) during the testing period were influenced by the evolution of climate factors. It is observed that, in the ecological system, the minimum average was obtained for the Otilia variety (37.04 g), while the maximum average was obtained for the FDL Amurg variety (48.08 g). High values were also obtained for the Glosa (44.79 g), Ursita (43.68 g), and FDL Abund (42.67 g) varieties. In the conventional system, the minimum average was obtained for the Otilia variety (38.95 g), and the maximum average for the Pitar variety (43.75 g). Close to the maximum average were also the FDL Amurg (43.69 g), Izvor (43.46 g), and Glosa (43.37 g) varieties. The weight of a thousand grains during the period 2021-2023 was medium to high in both crop systems.

From the perspective of hectolitre weight (chart no. 3), the average values obtained highlight a considerable difference between the two crop systems. Thus, in the ecological system, the minimum average was for the Miranda variety (64.7 kg/hl), while the maximum average was obtained for the FDL Amurg variety (70.0 kg/hl). High values were also obtained for the Voinic (69.9 kg/hl) and FDL Abund (69 kg/hl) varieties. In the conventional system, the minimum average was obtained for the Miranda variety (71.4 kg/hl), and the maximum average for the Ursita variety (75.9 kg/hl). Close to the maximum average were also the Izvor (75.6 kg/hl) and Otilia (75.4 kg/hl) varieties.

Chart 2

Average of thousand grains weight at winter wheat varieties tested during 2021-2023 period // Media masei a o mie de boabe (MMB) la soiurile de grâu comun de toamnă testate în perioada 2021 – 2023

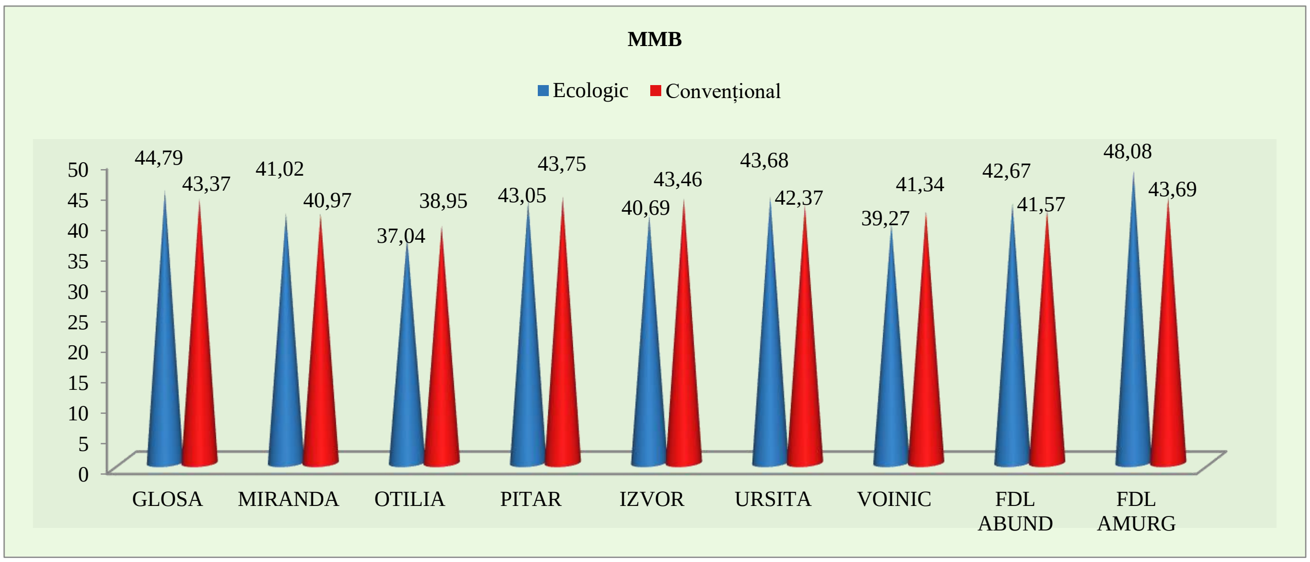
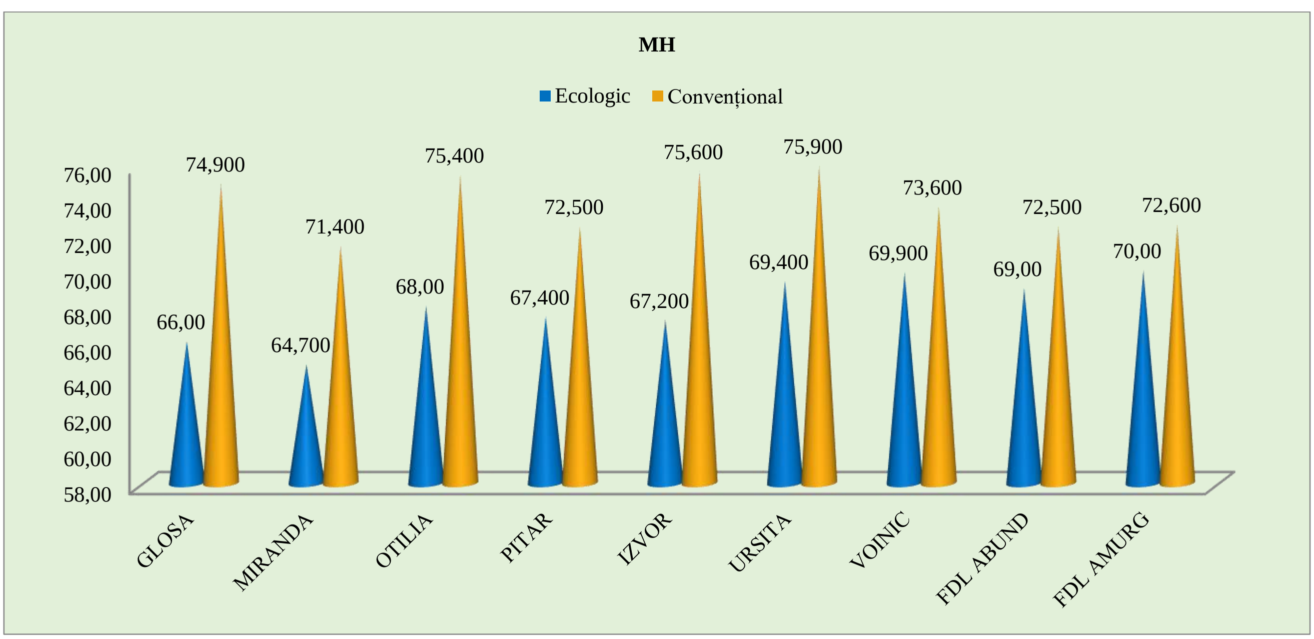


Chart 3

Average of hectolitre weight at winter wheat varieties tested during 2021-2023 period // Media masei hectolitrice înregistrată la soiurile de grâu comun de toamnă testate în perioada 2021 – 2023



The average yields obtained at the studied genotypes quantify the influence of climate factors, as well as the crop system used. Thus, in the conventional system, the highest average yield was obtained for the Voinic variety (6,107 kg/ha), followed by the Ursita variety (6,046 kg/ha). The Glosa variety recorded an average yield of 5,647 kg/ha, with no significant differences in yield. The lowest yield in the conventional system was obtained for the FDL Abund variety (4,792 kg/ha). The same variety, FDL Abund, in the ecological system, achieved a quite high yield of 4,173 kg/ha, close to the yield obtained for the Glosa variety, which recorded the peak yield of 4,280 kg/ha. The differences in yields between the two studied systems demonstrate the influence of the level of fertilisation, plant protection treatments, and the evolution of climate conditions.

Following the statistical calculation (table no. 3), it can be observed that in the ecological system there were no significant differences compared to the control Glosa, and in the conventional system the only significance was significantly negative, achieved for the variety FDL Abund.

Chart 4

Average of yields at winter wheat varieties tested at A.R.D.S Valu lui Traian, during 2021-2023 period//Media producțiilor la soiurile de grâu comun de toamnă testate în perioada 2021 – 2023

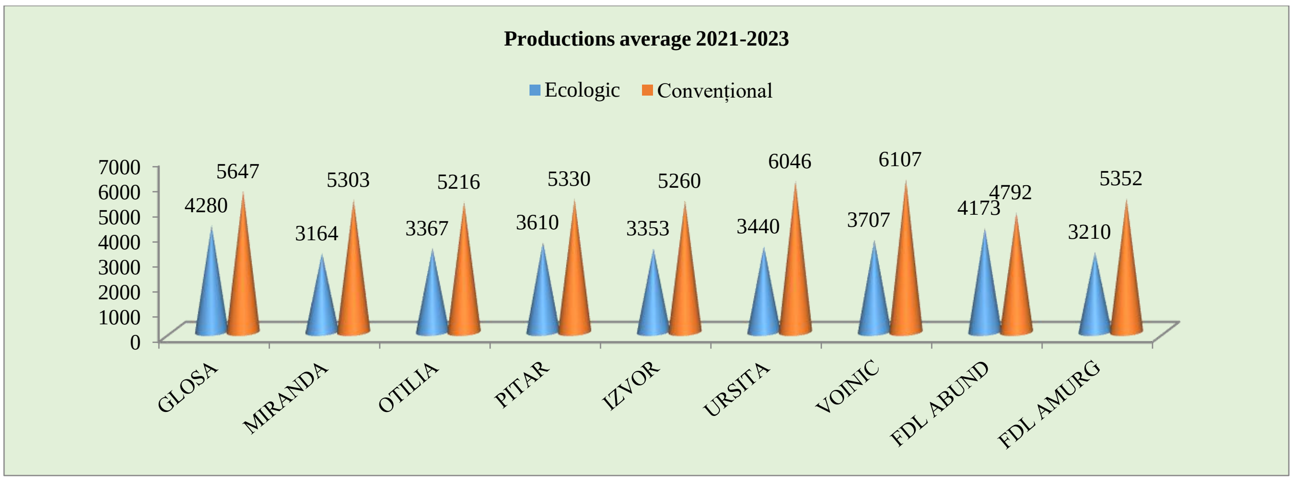


Table 3

Yields of winter wheat varieties tested under ecological and conventional system at S.C.D.A. Valu lui Traian, during 2021-2023 period// Producțiile obținute la soiurile de grâu studiate în sistem ecologic și convențional în perioada 2021-2023

	Ecological				**Conventional**			
Variant	**Average**	**Diff. kg/ha**	**%**	**Signif.**	**Average**	**Diff. kg/ha**	**%**	**Signif.**
Glosa	**4,280**	Mt	100	-	5,647	Mt	100	-
Miranda	3,164	-1,116	74	NS	5,303	-344	94	NS
Otilia	3,367	-913	79	NS	5,216	-431	92	NS
Pitar	3,610	-670	84	NS	5,330	-317	94	NS
Izvor	3,353	-927	78	NS	5,260	-387	93	NS
Ursita	3,440	-840	80	NS	6,046	399	107	NS
Voinic	3,707	-573	87	NS	6,107	460	108	NS
FDL Abund	4,173	-107	98	NS	4,792	*-855*	85	o
FDL Amurg	3,210	-1070	75	NS	5,352	-295	95	NS
DL 5% = 1439 DL 1% = 1983 DL 0.1% = 2729					DL 5% = 652 DL 1% = 905 DL 0.1% = 1,246			

CONCLUSIONS

1. The influence of climate conditions (frequent droughts, high temperatures) was reflected on productivity elements, especially in the ecological system.
2. The minimum average weight of a thousand grains was close in both crop systems (37.04 g in the ecological system, and 38.95 g in the conventional system).
3. The maximum average hectolitre mass recorded a notable difference of 5.9 kg/hl between the two crop systems (ecological system 70.0 kg/hl; conventional system 75.9 kg/hl).
4. The studied varieties reacted differently to the agricultural system and the environmental conditions during the period 2021-2023. Thus, in the ecological crop system, the FDL Abund variety (4,173 kg/ha) achieved a yield close to the control variety Glosa (4,281 kg/ha), while in the conventional crop system, the varieties Ursita (6,046 kg/ha) and Voinic (6107 kg/ha) recorded yields above the control variety Glosa (5,647 kg/ha).
5. Compared to the control variety Glosa, in both crop systems, no positive significances were recorded, the only significance obtained being negative (the FDL Abund variety) in the conventional system.
6. Cultivating varieties with good adaptability to local conditions becomes a necessity for achieving stable yields.

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CLIMATE CHANGE, AMENDMENTS AND FERTILIZATION AS THE MAIN DRIVERS OF MAIZE YIELD: IMPLICATIONS FOR FOOD SECURITY IN LONG-TERM EXPERIMENTS AT A.R.D.S. LIVADA

SCHIMBĂRILE CLIMATICE, AMENDAMENTELE ȘI FERTILIZAREA CA PRINCIPALI FACTORI AI PRODUCȚIEI DE PORUMB: IMPLICAȚII PENTRU SECURITATEA ALIMENTARĂ ÎN EXPERIMENTELE PE TERMEN LUNG DE LA S.C.D.A. LIVADA

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ABSTRACT

This work investigates the impact of climate change on maize yields at A.R.D.S. Livada. Data on temperature, precipitation, and maize grain yield from 2019, 2022, and 2023 were compared with historical data from 1962-2018 and 2020/21. Results indicate a significant decrease in maize yield during the dry year of 2022, with yields dropping by 26 to 80 q/ha for fertilization treatments and 58 to 70 q/ha for amendments compared to 2019. In 2022, the performance of all treatments, except the highest rate of amendment, was lower than their respective controls. In 2023, the hottest year, yield differences relative to the control were smaller for fertilization treatments and higher for amendments compared to 2019. In conclusion, this study highlights that drought, a key consequence of climate change, reduces the effectiveness of fertilization and amendments, which can even be detrimental. However, under hot conditions with adequate precipitation, organic amendments can enhance maize yield better than fertilization.

Keywords: climate change, climate change responses, long-term experiments, maize , yield, production, fertilization, amendments, precipitation

REZUMAT

Lucrarea de față își propune să investigheze impactul schimbărilor climatice asupra recoltelor de porumb din experientele de lungă durată de la Statiunea de Cercetare Dezvoltare Agricolă Livada. Datele cu privire la temperatura, precipitații și recolta de porumb din 2019, 2022, si 2023 au fost comparate cu datele istorice 1968-2018. Rezultatele indică o scădere semnificativă a producției de porumb pe parcursul anului uscat din 2022, cu diminuări considerabile de la 26 până la 80 q/ha în cazul factorului "fertilizare" și de 58 până la 70 q/ha pentru factorul "amendare". În anul 2022, cu excepția celei mai mari rate de amendament, performanta tuturor tratamentlor a fost mai redusă decât în cazul variantei control. Anul 2023 a fost considerat cel mai călduros an din istorie, diferența relativă în cazul fertilizării situându-se inferior față de cea în cazul "amendare" în condițiile anului 2019. Cu toate acestea, în condiții de temperaturi ridicate, cu precipitații adecvate, modificările datorate amendamentelor pot spori mai bine randamentul de porumb decât fertilizarea.

Cuvinte cheie: schimbări climatice, răspunsurile la schimbările climatice, experimente pe termen lung, porumb, randament, producți, fertilizare, amendamente, precipitații.

INTRODUCTION

Climate change, a subject debated across multiple publications is a major challenge in today's and future agriculture as temperature and precipitations will be altered significantly (Akmal, 2010). This issue is particularly important within the agriculture sector as all the environmental changes have a direct impact on our soils, making food production more difficult than ever (Li, 2022). This is particularly concerning for the ever-growing global population as global production losses might lead to price shocks and trigger export restrictions, possibly leaving certain countries more prone to famine (Dikr, 2022).

Soils with low pH levels, known as acidic soils, present notable obstacles to both agricultural productivity and environmental sustainability. These soils frequently lack essential nutrients, which inhibit plant growth and disrupts vital nutrient cycling processes. To tackle these challenges, experts recommend the application of amendments and fertilizers to enhance soil fertility and maintain crop productivity. Long-term experiments have become paramount in understanding the intricate interactions between soil chemistry, plant nutrition, and greenhouse gas (GHG) emissions under different agroecosystems.

According to results from major long term agricultural experimental fields, (Domnez, 2023) despite remaining uncertainties related to how rising carbon dioxide levels, intensive practices& fertilization, escalation in temperature, shifts in precipitation frequency and intensity will affect food production and food security. In addition to temperature increases, prolonged droughts could exacerbate water shortages and crop yield failures, depending on the respective crops'growth thresholds. Moreover, increasing extremes, including dry and wet spells or heat stress, may decrease crop production (FAO, 2015).

In conjunction with these long-term changes, global warming is also expected to contribute to an increase in the frequency and duration of extreme temperatures and precipitation (droughts, floods, and heat waves), which may increase the near-term variability in crop yields and trigger short-term crop price fluctuations (Ostberg, 2018).

The versatility of chemical fertilizers is undeniable: they possess properties that match the high expectations and needs of intensive agriculture. They can also have an impact on nutrient cycles, combining them with organic fertilizers, regularly observing, and, in general, aiming for rationality are critical parts of increasing productivity in a safe and sustainable manner. Agro-ecological factors are dominant in the forming process of the yield of field crops. The year weather conditions are decisive in the yield creation process of crops and their interaction with other factors leads to regulation of particular growth phase in which the quantity and quality of the final yield are formed.

Facing an increasing food demand due to population growth and economic development, these reductions will have to be compensated for by (1) the direct physiological impacts of increased atmospheric CO_2 concentrations, which are beyond local human control; as well as (2) advances in agricultural management (e.g. fertilizer input or irrigation), technology, and breeding or (3) expansion of agricultural land (FAO, 2015).

Observations of the effects of climate trends on crop production indicate that climate change has already negatively affected wheat and maize yields in many regions, as well as globally. There are direct and indirect effects of climate change on agricultural production systems. Direct impacts are the results of changing physical attributes like rainfall patterns and temperature ranges on certain agricultural production systems. Indirect effects are those that have an impact on productivity by altering other species, including invading species, pests, disease vectors, and pollinators. These unintended consequences may be rather significant. Given the large number of interacting characteristics and links—many of which are yet unknown—they are far more challenging to evaluate and project.

MATERIAL AND METHOD

The research were conducted at Agricultural Research Development Station Livada, comparing average maize yields and the yield difference relative maize crop across the years 2019, 2022, and 2023 in four long-term experiments: one amendment x fertilization experiment and three fertilization experiments which were established in 1961 and 1967, respectively. The experiments are located in North-Western Romania (47°52'07.3"N 23°07'10.2"E) which has a continental temperate climate. The annual average temperature recorded at the weather station A.R.D.S. Livada over the last 62 years is 8,5°C, while the annual average amount of precipitation is 756.6 mm. The amendment x fertilization experiment comprise eight levels of fertilization and nine levels of amendment, all variants being replicated 4 times in a split plot design with amendment as the main block. The experimental soils at Livada Research Station are classified as Luvisols (haplic luvisol-WRB Classification System), with acidic pH, poor in potassium, relatively low humus content, as well as low base saturation.

The year 2019 experienced relatively normal climatic conditions, albeit with a precipitation sum of nearly 200 mm in May and higher average temperatures compared to the multi-year average. The climatic conditions for the year 2022 were extreme, characterized by a rainfall deficit of nearly 200 mm. During the months of May, June, and July the monthly average temperatures exceeded the multi-year average by: 10°C in May; 4°C in June; 3°C; 4°C in August. Instead, 2023 was considered the hottest year in history, exceeding the multi-year temperature average of 1961-2021 by 7.8 degrees in January, and with an average of 4.1 for the months of August, September, and October (Figure 1, Figure 2).

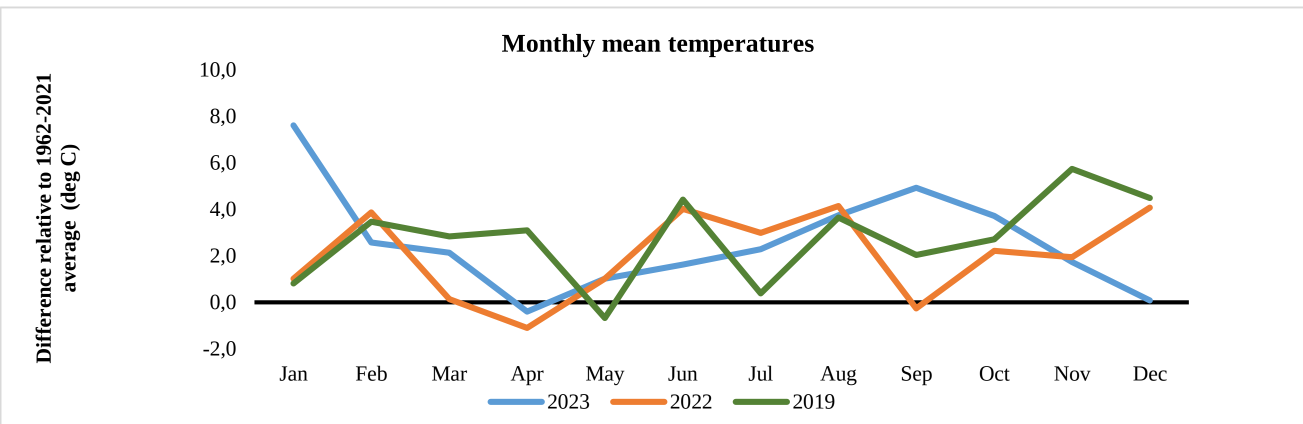

Figure 1. Differences in monthly mean temperatures (ºC) for the years 2019, 2022, and 2023 compared to the period 1962-2018//
Diferențele de temperaturi medii lunare (ºC) pentru anii 2019, 2022 și 2023 față de perioada 1962-2018

RESULTS AND DISCUSSION

From a yield standpoint, the year 2019 is considered one of the most productive years in the Livada long-term experiments history for maize cultivation. On the other hand, the year 2022 was widely regarded as the driest year in the recorded history of experiences, with critical pluviometric deficit in May, June, July, and August. Monthly average temperatures exceeded the multi-year average by 10°C in May, 4°C in June, 3°C and 4.1°C in August. 2023 was considered the hottest year in history, exceeding the multi-year temperature average of 1961-2021 by 7.8 degrees in January, and 4.1 degrees in average for the months of August, September, and October.

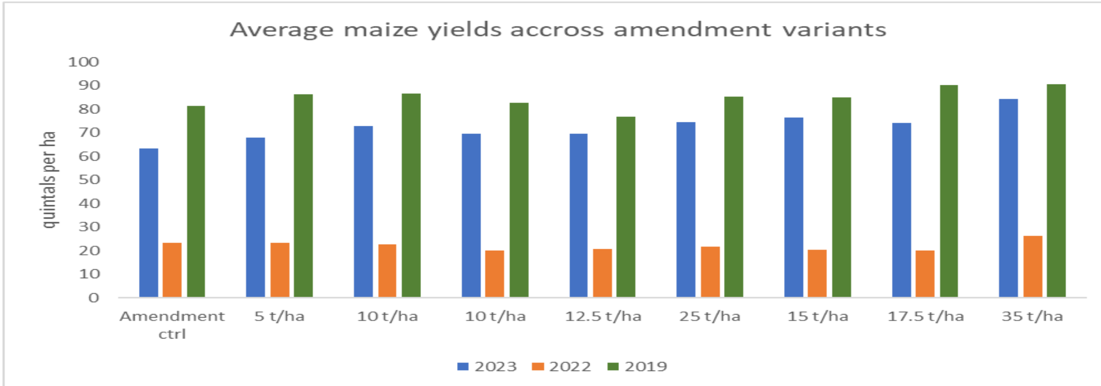

Figure 2. Differences in monthly precipitations for the year 2019, 2022, 2023 compared to the average obtained for the period 1962-2018//
Diferențele de precipitații lunare pentru anii 2019, 2022, 2023 față de media obținută pentru perioada 1962-2018

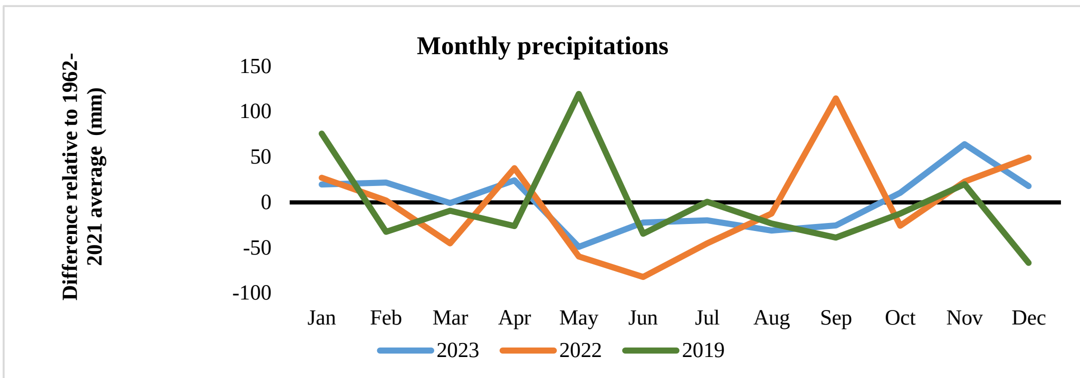

Figure 3. Average maize yields obtained across amendment variants (t/ha) for the years 2019, 2022 and 2023//
Producțiile de porumb obținute în cazul amendării pentru anii 2019, 2022, 2023

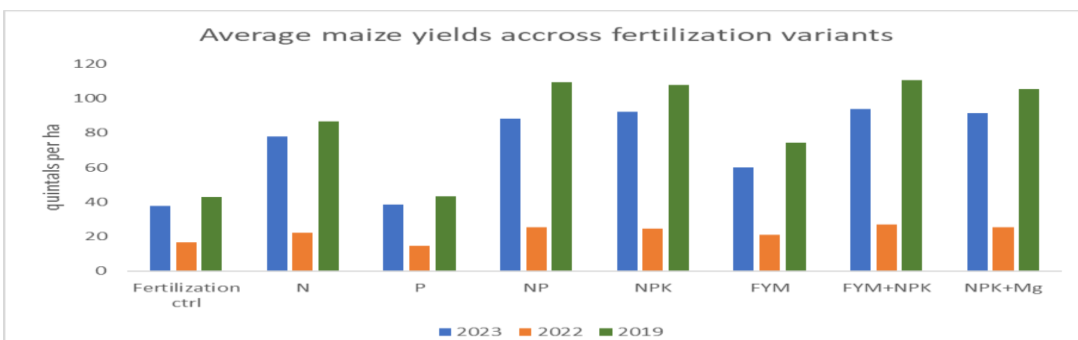

Figure 4. Average maize yields obtained across fertilization variants for the years 2019, 2022 and 2023//
Producțiile de porumb obținute în cazul fertilizării pentru anii 2019, 2022, 2023

Maize yield decreased in 2022 (dry year) between 26 and 80 q/ha across **fertilization** treatments compared to 2019. At the same time, the performance of all fertilization treatments considerably decreased compared to the not fertilized control. Furthermore, P fertilization treatment showed negative changes in maize yield in 2022 compared to the control. In 2023 (hottest year), maize yield differences relative to the control were lower compared to 2019 regardless of fertilization.

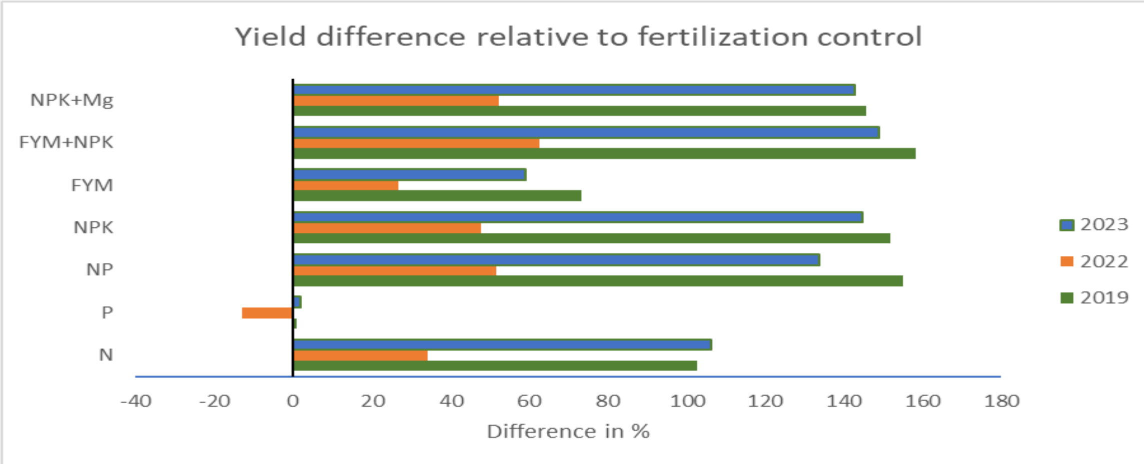

Figure 5. Yield difference (%) across fertilization variants for the years 2019, 2022 and 2023 compared to control// Diferența de randament (%) între variantele de fertilizare pentru anii 2019, 2022 și 2023 comparativ cu martorul

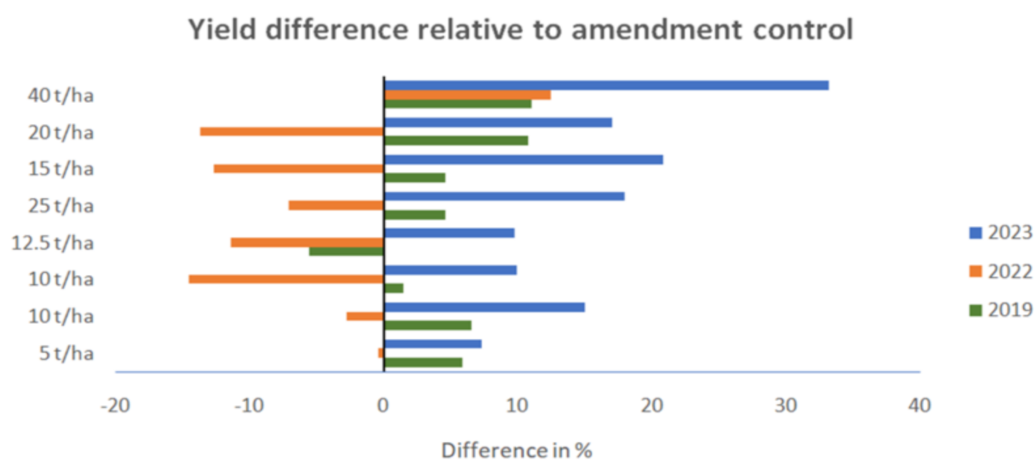

Figure 6. Yield difference (%) across amendment variants (t/ha) for the years 2019, 2022 and 2023 compared to control// Diferența de producție (%) între variantele de modificare (t/ha) pentru anii 2019, 2022 și 2023, comparativ cu martor

Maize yield decreased in 2022 (dry year) between 58 and 70 q/ha across amendment treatments compared to 2019. Remarkably, the performance of all amendment treatments was below that of the amendment control, except the highest rate of amendment which showed a positive change compared to the control. In 2023 (hottest year), maize yield differences relative to the control were higher compared to 2019.

Moreover, increasing extremes, including dry and wet spells or heat stress, may decrease crop production (FAO, 2015).In conjunction with these long-term changes, global warming is also expected to contribute to an increase in the frequency and duration of extreme temperatures and precipitation (droughts, floods, and heat waves), which may increase the near-term variability in crop yields and trigger short term crop price fluctuations (Ostberg, 2018).

CONCLUSIONS

1. Drought, a main consequence of climate change decreases the beneficial effect of fertilization and amendment on maize yield.

2. Amendment factor becomes irrelevant, even detrimental in the context of drought.
3. Hot conditions with suitable precipitations can increase maize crop yield under amendments in contrast to fertilization.

Due to the speed at which climate change is occurring and impacting agriculture, there is a high degree of urgency to newly install or modify LTEs so that they allow researchers to assess the long-time effects of mitigation measures. A recommendation would be to expand the suite of measured parameters in order to more effectively capture the effects of climate change.. Beyond yield, critical parameters could include soil organic carbon content, soil moisture & temperature dynamics, drought stress or microbial activity. Addressing the long-term climatic changes associated with the LTE research themes, various potential adaptation strategies can be tested in the ongoing experiments, including the selection of crops, timing for management operations and pesticide use. Increasing the resilience of agricultural systems through experiments on how to mitigate the impacts of climate change on agricultural productivity is a promising approach. For this, a monitoring plan can be implemented to assess effective and profitable options comprising varied experimental methods, fertilization, tillage and crop rotations with suitable crop species for climate change adaptation. In this regard, the most suitable for capturing climate change are long-term experiences (Domnez, 2023).

Figure 7. Aerial view of LTE of Livada , october 2022// Fotografie aeriană a ELG de la Livada, octombrie 2022

Figure 8. Aerial view of LTE of Livada , july 2023// Fotografie aeriană a ELG de la Livada, iulie 2023

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