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Research on the morphology, biology, productivity and yields quality of the *Amaranthus cruentus* L. in the southern part of Romania

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Abstract

Currently, according to the specialists in the field, *Amaranthus* species are part of alternative agricultural crops recommended for organic farming. In this context, our scientific approach is to analyse the adaptability of these species in the specific conditions of the southern part of Romania (Reviga village, Ialomita County). Thus, for two consecutive years, two varieties of *Amaranthus cruentus*, namely 'Bolivia 153' and 'Golden Giant', were studied regarding: morphology, biology, cultivation technology, plant productivity and quality of yields in the organic farming conditions. After the study period, the 'Golden Giant' variety was characterized by the following: 8 days - sowing-emergence period; flowering start on 21 July; 124 days - vegetation period; 839.3 Growing Degree Days (GDD) (Σ t °C > 15 °C); 23.24 g - grains mass per plant; 1.375 g - Thousand Weight Grains (TWG); 2,647 kg ha^{-1} - grains yields. By comparison, 'Bolivia 153' variety plants were presented as follows: 11 days - sowing-emergence period; flowering start on 21 July; 127 days - vegetation period; 842.4 GDD; 22.09 g - grains mass per plant; 1.46 g TWG; 23.78 kg ha^{-1} - grains yields. In average, the chemical composition of *Amaranthus cruentus* grains was: 15.20% proteins; 51.70% starch; 5.96% lipids; 13.36% cellulose and 3.35% ash. In conclusion, the experimentation area proved to be favourable to *Amaranthus cruentus* cultivation, so that the tested varieties behaved well, had a fairly uniform emergences, and the good level of grains yields and quality.

Keywords: alternative crops; *Amaranthus cruentus*; grains yield; organic agriculture; yields quality

Introduction

The economic, social and political evolution of human society in the last decades has brought to the fore the question of natural resources, scientists increasingly asking the extent to which these resources will be able to support economic development in the future and will provide food for a growing population, and will contribute to the eradication of underdevelopment (FAO, 2017). The accentuation of major socio-economic phenomena (demographic explosion, tendency of natural resources depletion, deterioration of the quality of the environment, pollution), have led to search and to find the alternative solutions for a sustainable perspective

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of the environment and biodiversity (Haros and Schoenlechner, 2017). In this context, the organic farming system is also included, as an alternative system of agricultural production, which respects the environment, biodiversity and natural resources. Also, alternative crops promoted by organic farming system are based on these principles and represent an alternative of the plant species commonly cultivated by farmers. An alternative crop could be defined as an agronomic crop not usually grown in a geographic reason, selected for use due to potential high sale value or specialized benefit to the farming system (Isleib, 2012). A crop can be very common in one geographic area and considered an alternative in another (Isleib, 2012). Crop diversity is a key tenet of organic agriculture. Having multiple crops that fill distinct niches in an agroecosystem improves the ability to manage weeds, diseases and insect pests as well as potentially improving the environmental performance of the cropping system (Duwayri, 2001). Research can help overcome production and market obstacles that enable the successful introduction of alternative crops (FAO, 2017). Risk reduction through diversification (related to climatic and biotic vagaries, particularly in fragile ecosystems and commodity fluctuations) by expanding locally adapted or introducing novel varieties and related production systems, will contribute to improved food security and income generation for resource poor farmers and protect the environment (Duwayri, 2001). In this sense, *Amaranthus* species with *Chenopodium quinoa*, represented the most popular alternative crop species. These species have the centres of origin in South America and were brought in Europe by the Spanish conquistadors, as an ornamenral plant (16th century). Until the sec. XIX the *Amaranthus* species were used as an ornamental plant, but also for the consumption of green leaves, in most areas with tropical climate, and in Africa it became an important vegetable (Cole, 1979). Amaranth is a crop with high potential for economic exploitation similar to maize, wheat, sorghum, barley, rice, and soybean (Innovation NRCACT, 1984; Rastogi and Shukla, 2013; Akin-Idowu, 2017). Amaranth has an excellent nutritional value and high genetic and phenotypic diversity. Their valuable nutritional content, their adaptability to harsh environments, their diversity of uses, and the food culture and traditions associated with these grains, are at the basis of their extensive use in the Andes over centuries (Giuliani *et al*, 2012). *Amaranthus* species have different uses: mixtures of cereals for bread or for breakfast, crêpes, pastries, cakes, as raw material in the industry (syrups, diet products, starch, and oil), salads. They can be used as an excellent feed for animals, but also as medicinal plants, in digestive disorders or as a disinfectant (Toader and Roman, 2011).

Amaranthus species is considered to potentially offer an alternative crop in temperate and tropical climate (Das, 2016). In recent decades, amaranth grain has been extensively studied for its remarkable nutritional profile and agricultural characteristics, e.g., having a short cultivation period and being drought resistance (Najdi Hejazi *et al*, 2016). Introduction of amaranth as a human food has been slow, but today it is produced and used as a grain or leafy vegetable in India, China, Southeast Asia, Mexico, the Andean highlands in South America and the United States (Robert, 1996). The Nebraska panhandle has become the most concentrated area of production of grain amaranth in the US (Rani, 2017). This statement is supported because the crop is easy to cultivate and is not pretentious with the cultivation conditions, it can also be used as a flour for obtaining pasta, but also for extracting lysine and tryptophan, starch, oil squalane, substances needed for the drug or cosmetics industry (Alvarez-Jubete *et al*, 2010). The leaves can be consumed as a soup, but also for the extraction of proteins, dyes or inflorescences can be used for various decorations (Toader and Roman, 2011). *Amaranthus* grains have a high nutritional value due to the presence, in a large quantity, of important biochemical compounds for human nutrition and health (Nadathur, 2016). Most of the biochemical components (proteins, lipids, minerals, vitamins), are present in greater quantity, compared to other species (Nadathur, 2016). Orona-Tomayo and Paredes-Lopez, in 2017, reported that, for the different *Amaranthus* species, proteins can reach up to 19.3%, even 20%; the richness of the essential amino acids was also highlighted: 5-7% lysine (g 100^{-1} g protein), 3-4% tryptophan, 3-4% leucine, which gives it a high nutritional value compared to the conventional cereals (Orona-Tamayo and Paredes-Lopez, 2017).

Information about the phenological growth stages of crops is fundamental and useful to agriculture. These researches can provide valuable data for the planning, organization and timely execution of certain agricultural activities such as those of prevention and protection that require detailed information on the specific vegetation phases of a crop (the appearance of the inflorescences, the flowering, the stages of maturity, etc.). These data can be used in mathematical modelling, which can predict the timing of phenological events according to certain conditions: temperature, precipitation, duration of sun shine, etc (Tonnang *et al.*, 2018, Erten *et al.*, 2014).

However, details about the growth and development of amaranth is fundamental to its cultivation, but reports on the phenological growth stages, development, and the life cycle of amaranth are limited (Martínez-Núñeza *et al.*, 2019; Artemyeva *et al.*, 2019). The importance of this research derives from the improve knowledge about ecology, biology and productivity of *Amaranthus cruentus* in South part of Romania, also about possibility to introduce of this plant in crops rotation system of organic farming.

Materials and Methods

Experimental design

The research was organized with the purpose of studying the morphology, biology, productivity and yields quality of *Amaranthus cruentus* species, respectively, two varieties, 'Bolivia 153' and 'Golden Giant', in terms of adaptability to the organic farming conditions of Romanian, in 2017-2018 period.

The experimental field belongs to a farm in Reviga village (44°41'34"N 27°06'26"E) (Ialomita County), in South part of Romania. The sites were managed according to organic agriculture guidelines (EC 834/2007 and EC 889/2008). The farm soil was analysed by Ialomita County Office of Pedological and Agrochemistry Studies. The pH of soil was weakly acidic oscillating between 6.1-6.5, in average 6.3. Total soluble salts for the analysed samples indicate soil without salinization problems (non-saline soils, with values <0.100%). Mineral nitrogen represents the amount of soil content in changeable and accessible form nitric and ammoniacal nitrogen. The results indicate normal soil supply in mineral N (8.4 g 100 g^{-1} of soil). The supply in Kalium (K) (potentially assimilable) extractable in Aluminium of the soil is very good for the analysed samples (> 200 K ppm). Content in humus was medium supplied for the analysed soil (2.1-4.0% humus).

The biological material for sowing came from Germany, certified by the inspection and certification body for organic agriculture system. The previous crops were peas (*Pisum sativum*, pulses crops category) to benefit from the nitrogen fixed by this plant. No other fertilizer was applied.

The soil tillage consisted in a disking after the harvesting of the previous crop and the release of vegetal debris, followed by the plowing at 25-30 cm depth. In the spring, the field was disked, followed by the preparation of the germinal bed with the combiner, at a depth of 6-8 cm.

The sowing was done by hand, in 20 of April for both years, at a depth of 1-2 cm. The area of the plot was 5 m-2 (2.5 m long, 2 m wide). The experiment was organised by Randomized Block Design Method, in four replications. The density was 100,000 grains ha^{-1}, with 50 cm between plants rows. During on the vegetation period the weed control was executed manually. Other pest or diseases not observed. The harvesting was made manually.

Collecting data, measurements and methods

During the vegetation period until harvesting, phenological observations and biometric measurements of *Amaranthus* plants were made on the dynamics (at each 8-10 days). Determinations concerned: emergence date, plants height, nodes of stem, leaves formation and their number, Leaf Area Index, appearance data of inflorescence, flowering, maturity and crop density.

Growing Degree Days (GDD) has been used to calculate the durations and thermal requirements for each phenophase. "To calculate the daily thermal units, the equation of Gilmore and Rogers (1958) was used ($GGD = [(T_{max} + T_{min})\ 2^{-1}] - T_b$), where Tmax-Tmin are daily maximum and minimum air temperatures, respectively, Tb is the base temperature, evaluated at 15 °C (Gilmore and Rogers, 1958)". The maximum and minimum daily temperatures were obtained from Ialomita weather station. The average multiannual

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temperature was 10.5 °C, with 1.0 °C higher than Romania's average multiannual temperature of 9.5 °C. The hottest month of the years was July, with a monthly average of 22.1 °C, followed by August with 21.1 °C, and the coldest was January with -3.0 °C. Separately by years it is found that in the years of experimentation, the temperatures have registered great differences in comparison with the multiannual monthly averages. Thus, for the year 2017-2018, the values of the average monthly temperature were recorded with 2.0-6.5 °C higher than the multiannual average. The warmest month was June, with the average temperature higher by 6.5 °C than the multiannual average; at a slight difference were the temperatures in July, with 5.7 °C and August, with 4.5 °C (Figure 1).

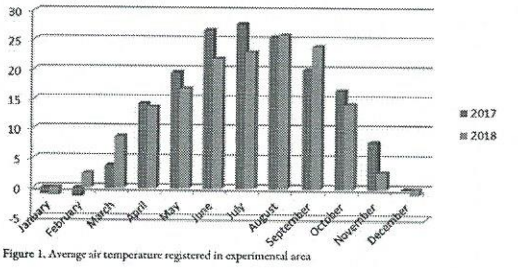

Figure 1. Average air temperature registered in experimental area

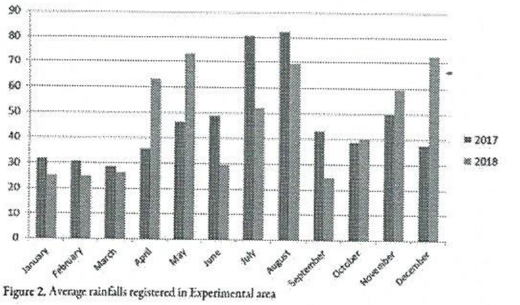

Figure 2. Average rainfalls registered in Experimental area

For the second year of the research (2018) the annual amount of rainfall was 561.3 mm, slightly higher than the multiannual average of 556.1 mm. In this agricultural year the richest precipitations were recorded in May (73.4 mm), more with 5.7 mm, followed by December (72.6 mm), with 35.9 mm more than the average, multiannual monthly. The amount of precipitation in October, November and December was 172 mm, compared to 113.1 mm, which was the multiannual average. The smallest quantities were registered in February (24.8 mm) with a deficit of 7.3 mm compared to the multiannual average and September (24.7 mm), with a minus of 8.9 mm (Figure 2).

10 plants from each plot were used for determinations of productivity elements in laboratory. Have been eliminated the marginal plants to avoid the possible errors. After manually harvesting, in laboratory was made the number and quantity of grains per plants and TWG. For the TWG determination was used the standard method with 2 repetitions of 500 pure seeds.

Chemical analyses of grains were performed in Yields Quality Laboratory of Crop Science Department, Faculty of Agriculture, University of Agronomic Sciences and Veterinary Medicine of Bucharest. The equipment was a spectrophotometer (Instalab 600) calibrated by a company from Novisad (Serbia) to determine the content of dry matter, crude protein, starch, lipids, cellulose and ash. The Instalab 600 uses Near Infrared (NIR) technology and a statistical math treatment to predict the percent of constituent concentration within a sample.

Statistical procedures

Data presentation was done by processing the media for replications and for years. Significant statistical differences were determined by the Fisher's least significant differences (LSD) test and also the Student Neuman Keuls (SNK) test with the ARM 8.5 program.

Results and Discussion

Dynamics of plants height

From the analysis of the data contained in Table 1, it turns out that, in 2017-2018 periods, no significant differences were found between the varieties experienced, in terms of vegetation dynamics.

Under normal conditions, amaranth plants are as high as 2.2 m, making their handling difficult (Martínez-Núñeza *et al.*, 2019). On average, the emergence was observed after 12 days of sowing, for the 'Bolivia 153' variety and after 15 days for the 'Golden Giant' variety. The duration of the vegetation period was 124 days for the 'Golden Giant' variety and 3 days longer for the 'Bolivia 153' variety, and the thermal consumption had values close to both varieties, namely 839.3 GDD for the 'Golden Giant' variety and 842.4 GDD for the 'Bolivia 153' variety.

The inflorescence appeared after 56 days of vegetation or after accumulation of 248.3 GDD in the case of the 'Bolivia 153' variety, and 2 days later, after the accumulation of 291.2 GDD, in the case of the 'Golden Giant' variety.

In terms of the dynamics of plant growth in height, some differences between varieties were found. Further, until maturity, the growth was 22.9 cm, with an average rate of 0.54 cm day^{-1} in the case of the 'Bolivia 153' variety, and 18 cm, with an average rate of 0.43 cm day^{-1}, in the case of the 'Golden Giant' variety.

Dynamics of nodes formation

The formation of nodes at 'Bolivia 153' variety took place during 71 days of vegetation, in which 12 nodes of stem were formed, with an average rhythm of 5.91 days node^{-1}. The first node was observed after 11 days from emergence, when 7.9 GDD were accumulated, and the intervals between the formation of nodes 2 and 5 were on average 7 days node^{-1}, with an average consumption of 28.37 GDD node^{-1}. In parallel with the intense increase in height of the stem, the rate of node formation also became more alert, so that the following 5 nodes at intervals of 3.6 days node^{-1}, with an average thermal consumption of 27.46 GDD node^{-1}. Node formation continued for another 14 days, resulting 2 nodes, at an interval of 7 days node^{-1} and with an average heat consumption of 69.9 GDD node^{-1} (Table 2).

Table 1. Dynamics of *Amaranthus cruentus* plants height (Reviga experimental field)

Data	'Bolivia 153' variety			'Golden Giant' variety		
	Height plants (cm)	Days from emergence	GDD ($\Sigma t > 15$ °C)	Height plants (cm)	Days from emergence	GDD ($\Sigma t > 15$ °C)
12 May	4.8	11	5.6	3.2	8	2.7
21 May	8.1	20	32.8	6.9	17	29.7
28 May	15.5	28	63.8	13.6	25	70.7
3 June	29.5	35	104.2	26.9	33	101.1
10 June	51.7	42	136.7	37.9	39	133.6
18 June	63.4	50	189.2	54.7	47	186.1
24 June	81.8	56	248.3	76.5	53	245.2
1 July	106.6	63	323.2	100.3	60	320.1
9 July	118.9	71	399	116.6	68	395.9
16 July	137.8	78	455.7	125.9	75	452.6
23 July	143.8	85	518.2	131.8	83	515.1
30 July	149.8	92	568.3	135.3	89	565.2
7 August	152.2	100	643.8	138.6	97	640.7
14 August	157.5	107	707.5	141.9	104	704.4
21 August	161.5	114	769.3	143.8	111	766.2
28 August	165.5	121	815.2	147.5	118	812.1
3 September	166.7	127	842.4	149.8	124	839.3

Table 2. Dynamics of stem nodes (Reviga experimental field)

Nodes per plant							
'Bolivia 153' variety				'Golden Giant' variety			
Number of stem nodes (Average)	Period		GDD ($\Sigma t > 15$ °C)	Number of stem nodes (Average)	Period		GDD ($\Sigma t > 15$ °C)
	Days from emergence	Days of previous node formation			Days from emergence	Days of previous node formation	
1	11	-	7.9	1	13	-	14.1
2	20	9	34.9	2	21	8	51.3
3	27	7	62.8	3	27	6	78.9
4	33	6	96.4	4	33	6	101.1
5	39	6	121.9	5	38	5	128.6
6	43	4	144.1	6	42	4	161.4
7	47	4	169.4	7	45	3	175
8	50	3	189.2	8	47	2	186.1
9	53	3	212.5	9	50	3	211.8
10	57	4	259.2	10	55	5	281.7
11	63	6	323.2	11	60	5	321.1
12	71	7	399	12	67	7	388.6
-	-	-	-	13	75	8	452.6

Dynamics of leaves formation

The dynamics of leaves formation is presented in Table 3.

The plants of the 'Golden Giant' variety formed during 75 days of vegetation and after a thermal consumption of 452.6 GDD, 13 nodes, with an average rhythm of 5.76 days $node^{-1}$.

The formation of the first node, for 'Golden Giant' variety, was noted 13 days after emergence, after a thermal consumption of 14.1 GDD, and the following 4 nodes were formed within a period of 25 days, with an average rhythm of 6.25 days $node^{-1}$ and an average consumption of 28.62 GDD $node^{-1}$. The formation of nodes 6-9 was staggered over 12 days, the average rhythm being 3 days $node^{-1}$ and the thermal consumption of 12.6 GDD $node^{-1}$. The process of node formation continued for another 20 days, resulting 4 nodes, with an average rhythm of 5 days $node^{-1}$.

Table 3. Dynamics of *Amaranthus cruentus* leaves formation (Reviga experimental field)

Data	'Bolivia 153' variety				'Golden Giant' variety			
	Number of leaves		Days (from emergence)	GDD ($\Sigma t > 15$ °C)	Number of leaves		Days (from emergence)	GDD ($\Sigma t > 15$ °C)
	From sowing	Days of the previous leaf's formation			From sowing	Days of the previous leaf's formation		
12 May	2	0	11	5.6	2	-	8	2.7
21 May	4	2	20	32.8	3	1	17	29.7
28 May	6	2	28	63.8	5	2	25	70.7
3 June	8	2	35	104.2	7	3	33	101.1
10 June	11	3	42	136.7	10	3	39	133.6
18 June	15	4	50	189.2	14	4	47	186.1
24 June	21	6	56	248.3	20	6	53	245.2
1 July	26	5	63	323.2	26	6	60	320.1
9 July	30	4	71	399	30	4	68	395.9
16 July	33	3	78	455.7	33	3	75	452.6
23 July	35	2	85	518.2	35	2	83	515.1
30 July	36	1	92	568.3	37	2	89	565.2
7 August	29	-	100	643.8	38	1	97	640.7
14 August	23	-	107	707.5	28	-	104	704.4
21 August	18	-	114	769.3	24	-	111	766.2
28 August	13	-	121	815.2	18	-	118	812.1
3 September	8	-	127	842.4	11	-	124	839.3

In the case of the 'Bolivia 153' variety, the leaves formation (36 leaves in total) was carried our over a period of 92 days of vegetation, in which the thermal accumulation was 568.3 GDD; the average rate was 2.55 days $leaf^{-1}$ and the average heat consumption was 15.68 GDD $leaf^{-1}$. On May 12, after 11 days from emergence, *Amaranthus* plants belong to the 'Bolivia 153' variety had 2 leaves, with a leaves area of 1.1 cm-2 $plant^{-1}$; after 29 days, the number of leaves reached 11 leaves, with an area of 529.3 cm-2 $plant^{-1}$, resulting in an average rate of 2.63 days $leaf^{-1}$ and an average consumption of 12.42 GDD $leaf^{-1}$. There were 29 days when the rate of leaf development was more alert. In this interval, 19 leaves were formed, with an average rate of 1.52 days $leaf^{-1}$ and a thermal consumption of 13.8 GDD $leaf^{-1}$; at the end of this interval, the Leaf Area Index was 2543.7 cm-2 $plant^{-1}$. The maximum value of the leaves surface, of 3,401.6 cm-2 $plant^{-1}$, was reached 21 days later, when the plants had a total of 36 leaves (Table 3).

Table 4 contain data regarding Leaf Area Index of *Amaranthus cruentus* varieties, in 2017-2018 periods.

Table 4. Dynamics of *Amaranthus cruentus* Leaf Area Index (Reviga experimental field)

Data	'Bolivia 153' variety			'Golden Giant' variety		
	Leaf Area Index (cm-2 plant⁻¹)		Days from emergence	Leaf Area index (cm-2 plant⁻¹)		Days from emergence
	Value	Days of previous nodes formation		Value	Days of previous nodes formation	
12 May	1.1	-	11	0.9	-	8
21 May	28.6	27.5	20	21.4	20.4	17
28 May	57.9	29.3	28	46.2	24.7	25
3 June	123.1	65.2	35	115.9	69.7	33
10 June	529.3	406.2	42	489.5	373.6	39
18 June	1,208.7	679.4	50	1,023.7	534.2	47
24 June	1,723.9	515.2	56	1,598.4	574.7	53
1 July	2,183.6	359.7	63	2,034.6	436.2	60
9 July	2,543.7	260.1	71	2,353.9	319.3	68
16 July	2,897.5	254	78	2,772.8	418.9	65
23 July	3,264.9	67.4	85	3,148.9	376.1	83
30 July	3,401.6	36.7	92	3,318.9	170	89
7 August	3,001.5	-	100	3,357.7	38.8	97
14 August	2,009.5	-	107	3,189.3	-	104
21 August	1,201.9	-	114	1,959.3	-	111
28 August	678.5	-	121	984.5	-	118
3 September	245.6	-	127	395.7	-	124

Regarding the dynamics of leaves formation for the 'Golden Giant' variety, it can be emphasized that the more alert rate was noticed during the period June 10-July 16, in which 23 leaves were formed. In this interval the sum of the useful temperatures was 319 GDD, resulting an average of 1.60 days $leaf^{-1}$ formation rate and a consumption of 13.86 GDD $leaf^{-1}$. On May 12 (after 8 days after emergence) the Leaf Area Index was 0.9 cm-2 $plant^{-1}$, then, as the vegetation advanced, the leaf area evolved upwards, so that on June 3 or after the accumulation of 101.1 GDD the leaf surface reached 115.9 cm-2 $plant^{-1}$; a month later, on July 1, a leaf area of 2,034.6 cm-2 $plant^{-1}$ was determined, and a maximum leaf area of 3,357.7 cm-2 $plant^{-1}$ was reached on August 7, after accumulating 640.7 GDD.

Dynamics of inflorescence formation, flowering and grains formation

Under the conditions of 2017 year, the inflorescence appeared on the 'Bolivia 153' variety plants after 56 days after emergence or 248.3 GDD accumulations, while on the 'Golden Giant' variety plants, the beginning of the inflorescence formation was noted after 58 days after the emergence, and a thermal accumulation of 291.2 GDD. The beginning of flower opening was started after 22 of days for 'Bolivia 153' variety and 23 days for 'Golden Giant' variety. The maturity stages developed during 35 of days for "Bolivia 153' variety and 9 days faster for the 'Golden Giant' maturity. The full maturity means 842.4 GDD of 'Bolivia 153' variety and 839.3 GDD of 'Golden Giant' variety (Table 5).

Productivity elements and grains yields

Following the analysis of the productivity elements, the 'Bolivia 153' variety has a number of 13,660 grains per plant, with a mass of 18.23 g $plant^{-1}$; 15,876 grains $plant^{-1}$ were determined at the 'Golden Giant' variety, their grains mass being 21.75 g $plant^{-1}$, in 2017. In 2018, the values were superior at all indexes. TWG was 1.41 g of the 'Bolivia 153' variety, being characterized by slightly larger grains, with TWG of 1.45 g, while the 'Golden Giant' variety formed smaller grains, with a TWG of 1.37 g (Table 6).

Table 5. Dynamics of *Amaranthus cruentus* inflorescence formation, flowering and grains formation (Reviga experimental field)

Amaranthus cruentus varieties	Data	Length of inflorescence (cm)	Phenophase	Days from emergence	GDD ($\Sigma t > 15\,^{\circ}C$)
'Bolivia 153'	24 June	1.8	The appearance of the inflorescence	56	248.3
	9 July	15.6	-	71	399
	16 July	25.4	The beginning of the flower opening	78	455.7
	30 July	32.6	The beginning of grains formation	92	568.3
	21 August	35.4	-	114	769.3
	3 September	37.1	Full maturity	127	842.4
'Golden Giant'	29June	1.1	The appearance of the inflorescence	58	291.2
	16 July	13.6	-	65	452.6
	21 July	27.4	The beginning of the flower opening	81	493.6
	5 August	34.7	The beginning of grains formation	95	621.7
	21 August	36.9	-	111	766.2
	3 September	39.8	Full maturity	124	839.3

Table 6. Productivity elements of *Amaranthus cruentus* (Reviga experimental field)

Year	Productivity elements	'Bolivia 153' variety	'Golden Giant' variety	Average
2017	Height of plant (cm)	166.7	149.8	158.3
	No of plants ha^{-1}, at harvesting	92,000	98,000	95,000
	No of grains $plant^{-1}$	13,660	15,876	14,768
	Mass of grains $plant^{-1}$ (g)	18.23	21.75	19.99
	TWG (g)	1.45	1.37	1.41
2018	Height of plant (cm)	178.3	169.1	173.7
	No of plants ha^{-1}, at harvesting	98,000	99,000	98,500
	No of grains $plant^{-1}$	18,911	22,921	11,469.96
	Mass of grains $plant^{-1}$ (g)	30.06	31.63	30.85
	TWG (g)	1.59	1.38	1.49

Rusu *et al.* (2009) and Marin *et al.* (2011), obtained 2,530.36 kg ha^{-1} of the grains production of *Amaranthus* sp. on the Somesan Plateau, out of the 12 *Amaranthus* varieties studied, 7 recorded grains productions over 4,000 kg ha^{-1} (4 varieties belonging to *A. cruentus* L. and 3 varieties of *A. hypochondriacus* L.) (Rusu *et al.*, 2009; Marin *et al.*, 2011).

In our experiments, the grains yields were, in average, 2,002 kg ha^{-1} in 2017 and 3,023 kg ha^{-1} in 2018. Regarding grains yields, the 'Golden Giant' variety surpassed the 'Bolivia 153' variety distinctly significant in both 2017 and 2018 years with 91 kg ha^{-1}, respectively 179 kg ha^{-1} (Table 7). Also, the same variety has a good production in 2018. Also, in 2018, this variety behaved well, significantly exceeding the average.

Table 7. Grains yields of *Amaranthus cruentus* varieties (Reviga experimental field)

Year	2017			2018		
Variety	Grains yield (kg ha^{-1})	Difference of average (kg ha^{-1})	Significance	Grains yield (kg ha^{-1})	Difference of average (kg ha^{-1})	Significance
'Bolivia 153'	1,822	- 180	ooo	2,933	- 90	oo
'Golden Giant'	2,181	179	***	3,114	91	**
Average	2,002	Control	-	3,023	Control	-

LSD 5% = 141 kg ha^{-1}; LSD 5% = 57.2 kg ha^{-1}; LSD 1% = 214 kg ha^{-1}; LSD 1% = 86.6 kg ha^{-1}; LSD 0.1% = 344 kg ha^{-1}; LSD 0.1% = 139.1 kg ha^{-1}

Chemical composition and quality yields

The values for protein content were on average 16.11%. Higher protein content was determined for the 'Golden Giant' variety (17.03%) and lower in the 'Bolivia 153' variety (15.38%) (Table 8).

Table 8. Chemical composition of *Amaranthus cruentus* grains (Reviga experimental field) (% d.m.)

Variety	Proteins	Starch	Lipids	Cellulose	Ash
2017					
'Bolivia 153'	15.38 c	51.56 c	6.41 d	5.23 b	3.34 b
'Golden Giant'	16.82 b	52.92 b	7.11 a	6.67 a	3.41 a
Average	16.10	52.24	6.76	5.95	3.375
2018					
'Bolivia 153'	15.20 d	51.45 d	6.81 c	5.05 c	3.10 b
'Golden Giant'	17.03 a	53.2 a	6.68 c	6.67 a	3.20 c
Average	16.12	52.33	6.75	5.86	3.15
2017-2018 Average	16.11	52.28	6.75	5.91	3.26
Statistical results					
LSD (P=0.05)	0.052	0.069	0.103	0.071	0.015
Standard Deviation	0.032	0.043	0.064	0.044	0.010
CV	0.2	0.08	0.95	0.75	0.29
Bartlett's X2	6.556	8.972	18.194	11.345	0.971
P (Bartlett's X2)	0.087	0.03*	0.001*	0.01*	0.808
Replicate F	1.777	1.120	0.763	1.538	1.000
Replicate Prob (F)	0.2214	0.3911	0.5425	0.2708	0.4363
Treatment F	3,477.124	1,761.780	81.365	1,589.377	936.996
Treatment Prob (F)	0.0001	0.0001	0.0001	0.0001	0.0001

Means followed by same letter do not significantly differ (P=0.05, Student-Newman-Keuls)
Mean comparisons performed only when AOV Treatment P (F) is significant at mean comparison OSL.

The starch content was on average 51.7%, with values ranging from 51.0% in the 'Golden Giant' variety to 52.4% in the 'Bolivia 153' variety. Regarding lipids, 'Bolivia 153' is best presented with a content of 6.11%, compared to the 'Golden Giant' variety, at which 5.81% lipids were determined. The cellulose content was on average 13.36%, a higher value, 15.05%, being registered in the 'Golden Giant' variety, and the ash content was on average 3.3%, the highest value, of 3.4%, being analysed in the 'Bolivia 153' variety.

In average, the protein production per ha was 404.9 kg ha^{-1}. Something more being obtained from the 'Golden Giant' variety, i.e. 530.3 kg ha^{-1}, and less from the 'Bolivia 153' variety, respectively, 280.0 kg ha^{-1} (Table 9).

Table 9. Protein production of *Amaranthus cruentus* (kg ha^{-1}) (Reviga experimental field)

Variety	Average of grains yields (kg ha^{-1})	Production of proteins (kg ha^{-1})	Difference of average	Significance
2017				
'Bolivia 153'	1822	280.0	-42.3	000
'Golden Giant'	2181	366.8	44.5	***
Average	2002	322.3	Control	-
LSD 5% = 2.25 kg ha^{-1}; LSD 1% = 3.62 kg ha^{-1}; LSD 0.1% = 5.25 kg ha^{-1}				
2018				
'Bolivia 153'	2933	445.8	-41.7	000
'Golden Giant'	3114	530.3	42.8	***
Average	3023	487.5	Control	-
LSD 5% = 2.94 kg ha^{-1}; LSD 1% = 4.18 kg ha^{-1}; LSD 0.1% = 6.05 kg ha^{-1}				

The high protein content of the 'Golden Giant' variety is noticeable, of over 16% in 2017 and over 17% in 2018. This proves the superiority of the grains of this variety which exceeded the average very significantly in both years of experimentation compared to the common wheat which has on average around 12-14%.

Conclusions

On average, for two years of experiments, the two varieties of *Amaranthus* were sowing in the second decade of April (April 17-19), plants emerged after 12-15 days, during the first decade of May and flowering in the last decade of June. From a morphological point of view, amaranth plants were characterized by: 149.8-166.7 cm of height plants; 12-13 steam nodes per plant; 36-38 leaves per plant and 3,301.6-3,357.7 cm-2 plant^{-1} Leaf Area Index. The harvest maturity was reached in the first decade of September, after 124-127 days of vegetation, in which 839.3-842.4 GDD were accumulated. The productivity elements showed: 92.000-98,000 plants per ha - density of plants; 18.23-31.63 g grains plants^{-1}; 1.37-1.59 g TWG. In terms of chemical composition, amaranth grains contain on average: 15.20-17.03% proteins; 51.45-53.2% starch; 6.41-7.11% lipids; 5.05-6.67% cellulose; 3.10-3.41% ash. In both years of research, the most productive variety proved to be the 'Golden Giant' variety, which yield was over 3,000 kg ha^{-1} and around 400 kg ha^{-1} proteins. Regarding organic agriculture technology for growing, it is recommended to sow the *Amaranthus cruentus* varieties in the second half of April, at the distance 50 cm between rows and density of 100,000 grains ha^{-1}. For weed control, repeated weeding will be applied whenever necessary, manual or mechanical. In conclusion, *Amaranthus* species reflect a good ability to adapt to the conditions of south part of Romania, and cultivation in organic agriculture conditions, with good yields and high level of quality grains.

Authors' Contributions

The authors contributed equally to the writing of the paper. All authors read and approved the final manuscript.

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Conflict of Interests

The authors declare that there are no conflicts of interest related to this article.

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CERCETĂRI PRIVIND CULTURILE AGRICOLE ALTERNATIVE ÎN SISTEMUL DE PRODUCŢIE AGRICOLĂ ECOLOGICĂ

RESEARCH ON ALTERNATIVE AGRICULTURAL CROPS IN THE ORGANIC AGRICULTURAL PRODUCTION SYSTEM

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Rezumat

Agricultura ecologică poate contribui la rezolvarea unor probleme cu care se confruntă societatea umană: reducerea biodiversităţii; degradarea mediului natural şi agricol; necesitatea furnizării pentru colectivităţile umane de produse agro-alimentare cu calitate nutritivă superioară si diversificarea alimentaţiei ş.a.

În acest context, agricultura ecologică promovează culturi agricole alternative: specii cultivate în trecut, care s-au restrâns în agricultura intensivă; specii preluate din flora spontană sau din alte zone geografice, mai puţin pretenţioase faţă de condiţiile de cultivare şi mai rezistente la factorii de stres.

Lucrarea prezintă rezultatele experienţelor efectuate începând din anul 2005, cu specii de pseudocereale (amaranthus, quinoa, hrişcă), specii oleaginoase (camelina şi dovleac pentru seminţe) şi leguminoase pentru boabe (diferite cultivare de linte). Rezultatele obţinute au demonstrat adaptabilitatea acestor specii pentru cultivare în zona solului preluvosol roşcat din partea centrală a Câmpiei Române. Speciile respective au dat producţii bune şi de calitate superioară, astfel că pot fi extinse în cultură, contribuind la diversificarea pieţei de produse agro-alimentare şi a alimentaţiei şi reprezentând surse de venituri pentru fermierii ecologici.

Cuvinte cheie: culturi alternative, agricultură ecologică, pseudocereale, plante uleioase, leguminoase pentru boabe.

Abstract

Organic agriculture can help solve some of the problems facing human society: reducing biodiversity; degradation of the natural and agricultural environment; the need to supply for human communities agri-food products with superior nutritional quality and food diversification, etc.

In this context, organic agriculture promotes alternative crops: species grown in the past, which have been restricted to intensive agriculture; species taken from spontaneous flora or from other geographical areas, less pretentious to growing conditions and more resistant to stressors factors.

The paper presents the results of experiments conducted since 2005, with species of pseudocereals (amaranthus, quinoa, buckwheat), oilseeds (camelina and pumpkin seeds) and grains legumes (different cultivars of lentils). The results demonstrated the adaptability of these species for cultivation in the area of the reddish preluvosol area from the central part of the Romanian Plain. These species have given good and high quality yields, so they can be expanded in culture, contributing to the diversification of the agri-food market and nutrition and representing sources of income for organic farmers.

Key words: alternative crops, organic agriculture, pseudocereals, oil crops, grains legumes.

INTRODUCERE

În prezent, în cadrul politicilor agricole la nivel mondial este evidenţiată ideea că sistemul de agricultură convenţională în formele sale cele mai intensive, degradează chimic, biologic şi fizic mediul înconjurător (Bavec şi Bavec, 2006). Printre efectele negative se numără şi diminuarea biodiversităţii, prin reducerea numărului culturilor agricole şi, în consecinţă, restrângerea gamei de produse alimentare şi a compuşilor nutriţionali ai alimentelor mai frecvent utilizate. În cadrul evoluţiei colectivităţilor umane şi a agriculturii, au fost utilizate în jur de 14.000 de specii de plante cultivate (Fowler şi Mooney, 1990). Aproximativ 7.000 specii se cultivă astazi în lume (FAO, 2018), mai puţin de 150 de specii sunt comercializate pentru utilizare la scară globală şi doar 12 specii furnizează peste 75% din cerinţele de alimente la nivel global, iar dintre acestea, în mare parte, în jur de 50%, asigură doar de 3 culturi agricole: porumbul, orezul şi grâul (FAO, 2004). În acelaşi timp, schimbarea dietei consumatorilor pentru produse mai sănătoase, fără reziduuri a generat apariţia unor noi pieţe pentru produsele agricole.

Din aceste motive, în lumea contemporană, atenţia specialiştilor se îndreaptă tot mai mult spre studierea unor plante agricole mai puţin cunoscute şi mai puţin cultivate în mod curent, dar care pot constitui alternative la speciile deja utilizate. Diversificarea sortimentului de culturi agricole, în special prin reintroducerea în cultură sau extinderea unor specii mai puţin cultivate, cu calităţi nutritive adesea superioare speciilor cultivate în prezent la scară largă, constituie un obiectiv de bază al agriculturii.

Aceste caracteristici se regăsesc cu precădere în cadrul sistemelor de agricultură alternativă, aşa cum este sistemul de agricultură ecologică. În acest caz, cultivarea ecologică a culturilor agricole alternative reprezintă un domeniu important pentru a obţine producţii de alimente suficiente, care să protejeze mediul înconjurător şi să reprezinte o "nişă" specială pentru produsele "ecologice". Cunoaşterea valorii alimentare a culturilor agricole alternative este foarte importantă pentru promovarea acestora, pentru a oferi suportul decizional pentru producători pentru a motiva consumatorii, pentru a cumpăra aceste produse. Aceste specii sunt cunoscute şi sub alte denumiri cum ar fi: specii neglijate, minore, rare, pierdute, promiţătoare, alternative sau tradiţionale (FAO, 2018). În literatura de specialitate sau statistici le regăsim sub denumrile de „Neglected and/or Underutilized Species" (NUS). Organizaţia FAO le defineşte ca „specii cu potenţial insuficient exploatat pentru a contribui la securitatea alimentară, nutriţie, sănătate, îmbunătăţirea serviciilor pentru mediu şi generarea de venituri suplimentare pentru agricultură" (FAO, 2018). Într-un sens strict, "alternativ" înseamnă un "nou" produs, o nouă cultură agricolă care poate fi introdusă într-o anumită regiune în vederea diversificării sortimentului de culturi în acea zonă. Ele pot fi culturi tradiţionale sau importate, ori culturi care au retrezit interesul populaţiilor locale" (Ionescu, 2017). Interesul pentru astfel de culturi agricole derivă şi din faptul că ele pot oferi beneficii ce includ, pe lângă diversificarea producţiei agricole şi a alimentelor, creşteri economice realizate pe baza veniturilor fermierilor şi a celor care prelucrează şi vând astfel de produse, dar şi prin crearea unor noi industrii bazate pe sursele regenerabile de energie, atât la nivelul comunităţilor rurale, cât şi pe scară mai largă.

Astfel, unele specii precum, pseudocereale (amaranthus, quinoa, hrişca), plante oleaginoase (şofrănelul, camelina, dovleacul, etc.), cât şi unele leguminoase pentru boabe (linte, bob, năut, fasoliţă, etc.) mai puţin cultivate, inclusiv în România, pot deveni alternative prin rolul pe care îl pot avea în dezvoltarea şi diversificarea producţiei agricole, a gamei de produse alimentare, în general, dar şi pentru dezvoltarea unei agriculturi durabile, spre care să tindă şi agricultura românească, în contextul agriculturii europene şi mondiale (Toader şi colab., 2015, Toader şi colab. 2020).

Introducerea în cultură a acestor culturi specifice depinde de un număr mare de factori, incluzând adaptabilitatea culturilor la condiţiile locale de creştere, climă, caracteristicile solului, precum şi problemele cauzate de apariţia bolilor şi dăunătorilor care pot afecta productivitatea acestor culturi. De aceea, scopul lucrării de faţă este acela de a prezenta rezultatele cercetărilor realizate începând cu anul 2005, asupra unui sortiment de culturi agricole alternative, pentru a demonstra pretabilitatea acestora la condiţiile pedoclimatice ale ţării noastre şi care ar putea fi introduse cu succes în cadrul sistemului de agricultură ecologică.

Tabelul 1

Lista culturilor agricole alternative (FAO, 1994)
Alternative crops List (FAO, 1994)

Categoria	Cultura
Cereale şi pseudocereale	Grâu spelta, grâu monococcum, grâu dicoccum, hrişcă, amaranthus, quinoa, mei, teff, fonio, orez sălbatic, sorg, iarba de canare, lacrima lui Iov, etc.
Leguminoase	Linte, bob, năut, fasoliţă
Plante oleaginoase	Camelină, rapiţă de primăvară (canola), rapiţa de toamnă, şofrănel, ricin, jojoba, perilă, lalemanţia, susan, dovleac pentru ulei, etc.
Plante textile	In pentru fibre, cânepă, bumbac, etc.
Plante legumicole	Porumb dulce, ceapă eşalotă, sparanghel, piper roşu, cartof mov, cartof dulce, etc.
Plante pomicole	Kiwi, pepeni galbeni, aronia, afin, kaki, etc.
Produse ale pădurii şi floră spontană	Alune de pădure, evodia, paulowia, etc.

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MATERIAL ŞI METODĂ

Obiectivul principal al cercetărilor a fost studierea biologiei, ecologiei şi productivităţii unor culturi agricole alternative cu scopul cunoaşterii adaptabilităţii acestora la condiţiile pedoclimatice din zona preluvosolului roşcat din partea centrală a României şi de cultivare în sistemul de agricultură ecologică. În acest scop, în cadrul Universităţii de Ştiinţe Agronomice şi Medicină Veterinară din Bucureşti (USAMVB), Facultatea de Agricultură, Disciplina de Fitotehnie, au fost organizate cercetări mai ample (în condiţii de mediu controlate, în câmpul didactic şi experimental din campusul universitar şi de la ferma Moara Domnească). În aceste experienţe a fost dezvoltat un program de observaţii şi măsurători privind: particularităţile morfologice şi biologice ale speciilor luate în studiu; elementele productivităţii şi producţia de seminţe; compoziţia chimică şi calitatea recoltei.

Cercetările în câmp au fost efectuate la Câmpul Experimental Moara Domnească, situat în apropierea municipiului Bucureşti, în zona preluvosolului roşcat din partea centrală a Câmpiei Române. Au fost înfiinţate 4 experienţe cu: specii de pseudocereale: *Fagopyrum esculentum* (hrişcă), *Amaranthus* sp. (amaranthus sau ştir cultivat), *Chenopodium quinoa* (quinoa); specii oleaginoase: *Camelina sativa* (camelină), *Carthamus tinctorius* (şofrănel), *Cucurbita pepo* var. *oleifera* (dovleac pentru ulei); leguminoase pentru boabe: *Lens culinaris (linte)*, *Vigna unguiculata* (fasoliţă), *Vigna angularis* (fasole adzuki). În lucrarea de faţă sunt prezentate rezultatele obţinute pentru speciile de amaranthus, quinoa, hrişcă, camelina, dovleac pentru ulei şi linte.

Materialul biologic a provenit de pe piaţa de profil pentru comercializarea materialului semincer netratat, ecologic.

Câmpul experimental de la ferma Moara Domnească aparţine Staţiunii Didactice şi Experimentale Belciugatele a USAMVB şi este situt în relieful Câmpiei Române, subdiviziunea Câmpia Vlăsiei, în zona de tranziţie de la silvostepă către zona pădurilor de câmpie. Solul este de tip preluvosol-roşcat molic (brun-roşcat). Conţinutul în humus este de 2,6% în stratul 0-20 cm. Datorită arealului în care se formează, preluvosolul roşcat din partea centrală a Câmpiei Române prezintă însuşiri fizico-chimice şi biologice favorabile dezvoltării plantelor.

Climatul din zona fermei Moara Domnească este temperat, cu ierni aspre în care temperatura medie a lunii celei mai reci (ianuarie) coboară sub -3°C, iar temperatura medie a lunii celei mai calde (iulie) este de peste 20°C. Precipitaţiile cele mai multe cad la începutul verii, iar în lunile iulie-octombrie se instalează seceta (Ionescu, 2009).

În privinţa fitotehnicii aplicate, a fost utilizat acelaşi itinerar tehnologic pentru fiecare experienţă organizată. Astfel, după recoltarea plantei premegătoare, a fost efectuată arătura, ca lucrare de bază, la adâncimea de 20-25 cm, cu plugul în agregat cu grapa, moment în care resturile vegetale au fost mărunţite şi încorporate în sol. Până în toamnă, arătura a fost grăpată pentru mărunţirea bulgărilor, nivelarea arăturii şi distrugerea buruienilor apărute. Primăvara, în scopul mobilizării solului compactat peste iarnă şi conservării apei în sol, a fost efectuată o lucrare cu grapa cu discuri în agregat cu grapa cu colţi, iar chiar înainte de semănat a fost pregătit patul germinativ cu combinatorul, la adâncimea de 6-8 cm. Semănatul a fost efectuat manual, în lunile aprilie-mai, în funcţie de specie. Adâncimea de semănat a fost 3-5 cm. În vegetaţie au fost efectuate praşile manuale (2-4) ori de câte ori a fost necesar, în vederea controlului buruienilor. În privinţa protecţiei plantelor împotriva organismelor dăunătoare, acestea nu au produs pagube deosebite culturilor care să fi impus aplicarea unor tratamente. Recoltarea s-a realizat manual, în perioada specifică fiecărei specii. La recoltare a fost determinată densitatea plantelor din lan. Totodată, au fost prevelate câte 10 plante de dezvoltare medie, din fiecare parcelă experimentală, la care au fost determinate elementele productivităţii. De asemenea, au fost executate analize chimice într-un laborator specializat pentru determinarea conţinutului în: substanţă uscată, proteină brută, lipide, glucide, săruri minerale şi celuloză. Rezultatele obţinute în urma determinărilor au fost prelucrate prin calculul mediilor şi analiza varianţei şi calcularea diferenţelor limită pentru probabilităţile de transgresiune de 0,1%, 1% şi 5%.

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REZULTATE ŞI DISCUŢII

Rezultate obţinute la specii de amaranthus. În cadrul acestor cercetări au fost utilizate speciile: *Amaranthus cruentus,* cu soiurile: Golden Giant, Bolivia 153, Kinnaouri Dhankar; *Amaranthus hypochondriacus,* cu soiurile: Mana de Montana, Guarijio, Rio San Lorentzo, Nepal şi New-Mexico; *Amaranthus caudatus*, cu soiurile Queue de Renard - Pony tail, Oscar Blanco, Orangier riese. Semănatul a avut loc în a doua decadă a lunii aprilie, iar perioada de vegetaţie a fost de: 147 - 154 zile, pentru specia *A. cruentus*; 135 - 147 zile la specia *A. hypochodriacus*; 150 - 151 zile la specia *A. caudatus.* Recoltarea a avut loc în ultima decadă a lunii septembrie - început de octombrie, pentru toate soiurile cultivate.

Cercetările au demonstrat că speciile de *Amaranthus* nu fost pretenţioase faţă de precipitaţii, temperatură sau faţă de tipul de sol, reuşind să se obţină producţii bune şi constante în timp. Astfel, în urma determinărilor asupra elementelor de productivitate MMB a oscilat între 1,08 g la specia *A. hypocondriacus* şi 1,47 g la specia *A. cruentus*. Specia *A. caudatus* a avut o valoare intermediară de 1,33 g (tabelul 2). Rezultatele asupra producţiei au evidenţiat soiurile Golden Giant (*A. cruentus*), Rio san Lorentzo, Manna de Montana şi New Mexico (*A. hypocondriacus*) cu producţii de peste 2.000 kg/ha. Producţii ceva mai scăzute, de 1.110 - 1.200 kg/ha, au fost înregistrate la soiurile Guarijio şi Nepal (*A. hypocondriacus)* şi soiul Oscar Blanco (*A. caudatus*). Soiul New Mexico a înregistrat un spor de producţie de 684 kg/ha, iar soiul Rio san Lorentzo un spor de circa 500 kg/ha, valori asigurate din punct de vedere statistic foarte semnificativ faţă de medie. Sporuri de producţie de peste 300 kg/ha au fost obţinute la soiurile Golden Giant şi Pony tail (tabelul 3).

Tabelul 2

Masa seminţelor pe plantă la diferite specii şi soiuri de *Amaranthus* (Câmpul experimental Moara Domnească)
Amaranthus cruentus seeds yield per plant of different Amaranthus species and varietis (Moara Domnească Experimental Field)

	Specie şi soi	Masa seminţelor pe plantă (g)	MMB (g)
Amaranthus cruentus	Golden Giant	21,45	1,32
	Bolivia 153	17,8	1,40
	Kinnaouri Dhankar	14,5	1,48
	Media	*17,91*	*1,40*
Amaranthus hypochodriacus	Manna de Montana	18,8	1,08
	Guarijio	11,87	0,99
	Rio san Lorentzo	23,8	1,12
	Nepal	12,3	0,96
	New-Mexico	25,8	1,28
	Media	*18,51*	*1,08*
Amaranthus caudatus	Oscar Blanco	12,5	1,28
	Queue de Renard. Pony tail	18,7	1,49
	Orangier riese	16,2	1,22
	Media	*15,8*	*1,33*
Media		*17,40*	*1,27*

Tabelul 3

Producţia de seminţe la diferite specii şi soiuri de *Amaranthus* (Câmpul experimental Moara Domnească)
Seeds yields of Amaranthus species and varieties (Moara Domnească Experimental Field)

Soiul	Producţia de seminţe (kg/ha)	Producţia relativă (kg/ha)	Diferenţa faţă de medie (kg/ha)	Semnificaţia
Golden Giant	2100	118,9	334	***
Bolivia 153	1700	96,26	-66	O
Kinnaouri Dhankar	1500	84,93	-366	Ooo
Media	*1766*	*100*		-
DL 5% DL 1% DL 0,1%			44 kg/ha 74 kg/ha 59 kg/ha	
Amaranthus caudatus				
Manna de Montana	2000	108,3	154	-
Guarijio	1110	60,13	-746	ooo
Rio san Lorentzo	2340	126,7	494	***
Nepal	1250	67,6	-596	ooo
New-Mexico	2530	137,0	684	***
Media	*1846*	*100*	-	-
DL 5% DL 1% DL 0,1%			171 kg/ha 259 kg/ha 417 kg/ha	
Amaranthus caudatus				

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Oscar Blanco	1200	0,77	-350	ooo
Queue de Renard. Pony tail	1850	1,19	300	*
Orangier riese	1600	1,03	150	-
Media	*1550*	*100*	-	-
DL 5% DL 1% DL 0,1%			240 kg/ha 370 kg/ha 590 kg/ha	

Conţinuturile în principalii compuşi biochimici prezenţi în seminţele soiurilor speciilor de *Amaranthus* sunt prezentate în tabelul 4. Rezultatele acestor cercetări au demonstrat că toate speciile se remarcă prin bogăţia în proteine şi lipide, comparativ cu cerealele clasice. Astfel, conţinutul mediu în proteine a fost cuprins între 14,43% la *A. caudatus* şi 16,95% la *A. hypochondriacus*; s-au remarcat două soiuri - Mana de Montana şi Rio san Lorentzo - cu 17,64% şi respectiv 17,83% proteine. Pentru amidon, valorile s-au încadrat între 58,24% la specia *A. caudatus* (soiul Pony tail) şi 62,83% la *A. hypochondriacus* (soiul Guarijio), iar media pe specii a fost de 60,95%. Valorile medii ale conţinutului în lipide s-au încadrat între 5,56% la *A. hypochondricus* şi 6,24% la *A. caudatus*. Pentru celuloză, rezultatele au confirmat faptul că specia *A. caudatus* se evidenţiază, în general, prin conţinut ridicat în celuloză (peste 5%), comparativ cu 2,23% la *A. cruentus*. De asemenea, toate soiurile speciei *A. caudatus* au depăşit valoarea de 4% a conţinutului în săruri minerale, comparativ cu 2,61% la *A. cruentus* şi 3,67% la *A. hypochondricus*. În experienţă, valorile conţinuţului în săruri minerale au variat între 2,56% la *A. cruentus* (soiul Golden Giant) şi 4,91% la *A. caudatus* (soiul Oscar Blanco).

Tabelul 4

Conţinuturile în proteină, amidon, lipide, celuloză şi săruri minerale la specii şi soiuri de *Amaranthus* (% s.u.)
(Câmpul experimental Moara Domnească)
Proteins, starch, lipids, fibre and ash content of *Amaranthus* species and varieties (% d.m.)
(Moara Domnească Experimental Field)

Specia	Soiul	Proteine	Amidon	Lipide	Celuloză	Săruri minerale
A. cruentus	Golden Giant	16,23	60,24	5,81	2,21	2,56
	Bolivia 153	15,61	61,54	6,11	2,23	2,60
	Kinnaouri Dhankar	14,89	60,84	6,51	2,27	2,67
	Media	*15,57*	*60,87*	*6,14*	*2,23*	*2,61*
A. hypochondriacus	Manna de Montana	17,64	61,21	4,92	4,62	3,31
	Guarijio	16,52	62,83	5,17	4,34	3,84
	Rio san Lorentzo	17,83	62,55	6,49	4,85	3,93
	Nepal	15,83	60,75	5,43	4,66	3,75
	New-Mexico	16,94	62,78	5,82	4,93	3,54
	Media	*16,95*	*62,02*	*5,56*	*4,68*	*3,67*
A. caudatus	Oscar Blanco	14,22	60,52	6,23	5,23	4,91
	Queue de Renard Pony tail	14,43	58,24	6,44	5,65	4,73
	Orangier riese	14,64	61,16	6,05	5,76	4,63
	Media	*14,43*	*59,97*	*6,24*	*5,55*	*4,76*
Media		*15,65*	*60,95*	*5,98*	*4,15*	*3,68*

Ca urmare a acestor rezultate, pentru cultivarea în condiţiile zonei preluvosolului roşcat din partea centrală a Câmpiei Române, în condiţii de agricultură ecologică, sunt recomandate soiurile: Golden Giant (*A. cruentus*), Rio san Lorentzo şi Mana de Montana (*A. hypocondriacus*) şi Pony tail (*A.caudatus*), care s-au dovedit a fi cele mai productive şi cu calităţi deosebite în privinţa conţinutului în proteină şi lipide.

Rezultate obţinute la quinoa. Desfăşurarea vegetaţiei la toate variantele experimentale a fost uniformă, cu diferenţe relativ puţin importante între acestea. Recoltarea a avut loc la începutul lunii octombrie, la circa 160 de zile de la semănat. Masa a 1000 de seminţe a variat între 1,13 şi 1,22 g (tabelul 5). Producţiile rezultate, de 1.870 kg/ha şi 2.540 kg/ha, sunt comparabile cu ceea ce este cunoscut în literatura de specialitate pentru această specie (2.000-3.000 kg/ha). Acest lucru demonstrează că specia *Chenopodium quinoa* s-a adaptat bine în condiţiile pedoclimatice ale zonei centrale a Câmpiei Române şi cultivării în sistem ecologic.

Tabelul 5

Masa seminţelor pe plantă, MMB şi producţia de seminţe la specia *Chenopodium quinoa* (Câmpul experimental Moara Domnească)
Seeds weigth per plant and grains yield for Chenopodium quinoa (Moara Domnească Experimental Field)

Masa seminţelor/plantă (g/pl)	14,8-21,2
MMB (g)	1,13-1,22
Producţie evaluată (kg/ha)	1870 - 2540

Importanța în cultură a acestei specii provine din valoarea alimentară deosebită. Calitatea sa nutrițională, exprimată prin compoziția chimică, a făcut ca această specie să fie desemnată de către NASA's Controlled Ecological Life Support System (CELSS) (Sistemele NASA de susținere a vieții ecologice controlate), cea mai bună sursă de proteine vegetale pentru sistemele de susținere a vieții autoportante pentru stații spațiale și colonii (Schlick și Bubenheim 1993, 2013). "Această cultură agricol „nouă", bogată în proteine și cu proporții potrivite de aminoacizi esențiali, poate oferi o mai mare versatilitate în satisfacerea nevoilor oamenilor în misiunile spațiale pe termen lung" (Schlick și Bubenheim, 1993). De altfel, Adunarea Generală a Organizației Națiunilor Unite (ONU) împreună cu FAO, au declarat anul 2013 drept „Anul Internațional al Quinoa" datorită cerințelor actuale de a crește producția de alimente de calitate pentru a hrăni populația lumii în contextul schimbărilor climatice, oferind astfel, o alternativă pentru acele țări care suferă de insecuritate alimentară (FAO, 2018).

Aceste caracteristici au fost urmărite și confirmate de rezultatele cercetărilor efectuate asupra compoziției chimice și calității recoltei de quinoa obținută la ferma Moara Domnească. În aceste cercetări, compoziția chimică medie pe anii de experimentare a semințelor de quinoa s-a prezentat astfel: proteine între 15,47 și 16,71%; amidon între 63,44 și 65,44%; lipide între 5,43 și 6,90; celuloză între 2,16 și 2,19%; săruri minerale între 2,09 și 2,31% (tabelul 6). Astfel, a fost evidențiat faptul că, semințele de quinoa sunt superioare cerealelor clasice din punct de vedere al compoziției chimice, mai ales în cazul conținuturilor în proteină și lipide. Semințele de quinoa sunt mai bogate în proteine (conțin, în medie, peste 16%) comparativ cu cerealele clasice (10 - 14%). De asemenea, la quinoa conținutul în lipide a fost în medie de 6,10%, iar la cerealele clasice limitele sunt, de regulă, de 0,4 - 4,6%, cu excepția porumbului care poate depăși uneori această valoare.

Tabelul 6

Compoziția chimică la semințele speciei *Chenopodium quinoa* (Câmpul experimental Moara Domnească)
Chemical compozition for Chenopodium quinoa grains (Câmpul experimental Moara Domnească)

Compoziție chimică	Valori
Proteine	15,47 - 16,71
Amidon	63,44 - 65,44
Lipide	5,43 - 6,90
Celuloză	2,16 - 2,19
Săruri minerale (cenușă)	2,09- 2,31

Rezultate obținute la hrișcă. Materialul biologic pentru studierea acestei specii a provenit din: Polonia, Germania și Grecia. Perioada de vegetație a variat între 80 de zile la proveniențele Germania și Polonia și 90 de zile la proveniența Grecia. Hrișca nu a fost pretențioasă față de tipul de sol, reacția solului, planta premergătoare sau fertilizare. S-a dovedit că poate reuși pe solurile mai sărace sau pe cele care necesită drenare din cauza excesului de umiditate. Datorită faptului că are creștere rapidă, plantele luptă bine cu buruienile și, ca urmare, în condiții normale de cultivare nu sunt necesare multe lucrări de îngrijire. În cazul experiențelor de la ferma Moara Domnească, masa a 1000 de semințe a fost, în medie, de 27,7 g.

Tabelul 7

Masa semințelor pe plantă, MMB la specia *Chenopodium quinoa* (Câmpul experimental Moara Domnească)
Grains weigth per plant and Thousand Weight Grains for Chenopodium quinoa (Moara Domnească Experimental Field)

Proveniența	Masa semințelor pe plantă (g)	MMB(g)
Polonia	0,70	28,3
Germania	0,72	29,8
Grecia	0,65	25,2
Media	***0,69***	*27,7*

Referitor la producția de semințe, aceasta a oscilat între 979 kg/ha și 1.439 kg/ha. Provenineța Germania a depășit media cu un spor de producție asigurat statistic, ca foarte semnificativ, de 227 kg/ha.

Tabelul 8

Producția de semințe la specia *Fagopyrum esculentum*(Câmpul experimental Moara Domnească)
Fagopyrum esculentum seeds yield (Moara Domnească Experimental Field)

Proveniența	Producția (kg/ha)	Producția relativă (kg/ha)	Diferența față de medie (kg)	Semnificația
Polonia	1.218	100,4	6	-
Germania	1.439	118,7	227	***
Grecia	979	80,7	-233	Ooo
Media	***1.212***	***100***	-	-

DL 5% 25 kg/ha

DL 1% 37 kg/ha
DL 0,1% 60 kg/ha

Un rol important în creşterea suprafeţelor cultivate cu hrişcă îl au interesul actual al consumatorilor faţă de produsele alimentare cu valoare nutritivă ridicată şi pentru diversificarea produselor alimentare, dar şi preocupările din ultima vreme în politicile agricole la nivel mondial, faţă de natură şi faţă de protecţia biodiversităţii. În urma cercetărilor efectuate, s-au remarcat valorile superioare ale conţinutului în proteine (peste 14,3% şi peste 16% la cele mai bune variante analizate), comparativ cu cerealele (10 - 14%). Rezultatele obţinute pentru celelalte componente biochimice, şi anume, lipide, celuloză şi săruri minerale, nu au fost constatate diferenţe semnificative în funcţie de materialul biologic folosit la semănat sau în funcţie de condiţiile meteorologice ale anului de cultivare. Astfel, au rezultat: 14,8 - 16,5% proteine; 62,6 – 63,6% amidon; 3,8 – 4,3% lipide, 10,2 - 10,6% celuloză; 2,0 - 2,7% săruri minerale.

Tabelul 9

Conţinuturile în proteină, amidon, lipide, celuloză şi săruri minerale la seminţele de *Fagopyrum esculentum* (% s.u.)
(Câmpul experimental Moara Domnească)
Proteins, starch, lipids, fibre and ash content of Fagopyrum esculentum grains (% d.m.) (Moara Domnească Experimental Field)

Provenienţă	Proteine	Amidon	Lipide	Celuloză	Săruri minerale (Cenuşă)
Polonia	15,6	62,9	3,8	10,2	2,1
Germania	16,5	63,6	4,1	10,4	2,0
Grecia	15,2	63,5	3,9	10,6	2,0
Media	*15,7*	*63,3*	*3,93*	*10,4*	*2,03*
Materialul biologic utilizat la semănat					
Polonia	15,0	62,6	4,1	10,6	2,6
Germania	15,2	63,4	4,3	10,5	2,7
Grecia	14,8	63,3	3,8	10,6	2,1
Media	*15,0*	*63,1*	*4,06*	*10,56*	*2,46*

Rezultate obţinute la camelina. Semănatul celor două proveniențe ale seminţelor de camelina, Slovenia şi Fundulea, a fost realizat în prima decadă a lunii aprilie. Semănarea mai timpurie împiedică infestarea cu buruieni a terenului. De asemenea, această specie nu este deloc pretenţioasă în ceea ce priveşte solul sau condiţiile climatice. După circa 80 - 90 de zile de vegetaţie a avut loc recoltarea, respectiv, la inceputul lunii iulie. La recoltare, plantele de camelina au prezentat seminţe cu o masa a 1000 de seminţe ce a ocilat între 1,23 g şi 1,34 g (tabelul 10). Productivitatea culturii de camelina variază în funcţie de momentul însămânţării, utilizarea sau nu a fertilizatorilor, calitatea solului, etc. În funcţie de aceşti factori productivitatea culturilor se înscrie între 800 şi 2.300 kg/ha (Toncea şi colab., 2013). În urma aplicării unei tehnologii ecologice de cultivare la ferma de la Moara Domnească, genotipurile de camelina au produs în medie 1.474 kg/ha producţie de seminţe, fără diferenţe mari între cele două genotipuri. Totuşi, provenienţa de la Fundulea a înregistrat sporuri de producţie de circa 100 kg/ha, ceea ce confirmă adaptarea acestui genotip la cultivarea în zona de sud a ţării.

Tabelul 10

Analiza elementelor productivităţii plantei la camelina (Câmpul Experimental Moara Domnească)
Camelina productivity compounds (Moara Domneasca Experimental Field)

Elementele productivităţii	Genotipul Slovenia	Genotipul Fundulea	Media
Înălţime plantă (cm)	46,4	47,1	46,75
Numărul de silicule/plantă	101,5	109,1	105,3
Numărul de seminţe/plantă	514,6	612,1	563,3
Numărul de seminţe/siliculă	5,1	5,6	5,3
Masă seminţe/plantă (g)	0,59	0,72	0,65
MMB (g)	1,23	1,34	1,28

Tabelul 11

Producţia de seminţe la camelina (Câmpul Experimental Moara Domnească)
Camelina seeds yield (Moara Domnească Experimental Field)

Genotipul	Producţia de seminţe (kg/ha)	Diferenţa faţă de medie (kg/ha)	Semnificaţia
Genotip Slovenia	1.455	-19	ooo
Genotip Fundulea	1.494	20	***
Media	***1.474***	***Mt.***	-

DL 5%= 7,5 kg/ha
DL 1%= 11,3 kg/ha
DL 0,1% = 18,2 kg/ha

Camelina este o plantă oleaginoasă cu potențial nutritiv de excepție datorat conținuturilor în proteine cuprins între 25-30% și în lipide între 29 până la 41%, în funcție de varietate și care poate fi o sursă alternativă pentru hrana omului sau pentru hrana animalelor. Comparativ cu alte culturi oleaginoase, cercetările au demonstrat că această specie este tolerantă la temperaturi scăzute și secetă; datorită compoziției chimice a fost promovată în ultimii ani ca o cultură energetică pentru obținerea de biocombustibil, în special pentru aviație. În cercetările realizate la ferma Moara Domnească, s-a constat că, în privința compoziției chimice nu au existat diferențe majore între genotipurile utilizate pentru semănat. Se remarcă conținutul în lipide, de peste 31% și cel de proteine de peste 25-26%.

Tabelul 12

Compoziția chimică a semințelor la genotipurile de camelina (% s.u.) (Câmpul Experimental Moara Domnească)

Camelina genotypes chemical composition (% d.m.) (Moara Domneasca Experimental Field)

Genotipul	Proteine	Lipide	Glucide	Celuloză	Săruri minerale
Genotip Slovenia	25,16	31,61	36,30	12,26	4,30
Genotip Fundulea	26,43	31,75	36,27	12,74%	4,28

Rezultate obținute la dovleac pentru ulei. Plantele de dovleac au format în condițiile de la Moara Domnească, 1- 3 fructe pe plantă, după o perioadă de vegetație de circa 121 zile. Aceste fructe au avut un conținut, în medie, de 145,3 semințe/fruct și revenind o masă medie a semințelor pe plantă de 56,7 g. Semințele au avut masa a 1000 de semințe cuprinsă între 164,2 și 172,1 g, în medie de 168,2 g. În urma aplicării unei tehnologii de cultivare ecologice a fost recoltată o producție medie de semințe de 570 kg/ha, valoare care se situează la nivelul recoltelor obținute în mod normal la această specie. Maximul de producție obținută a fost de peste 700 kg/ha, ceea ce recomandă culturea de dovleac ca cultură alternativă pretabilă spre cultivare zonei centrale a Câmpiei Române.

Tabelul 13

Analiza elementelor productivității și producția de semințe la *Cucurbita pepo* var. *oleifera* (Câmpul Experimental Moara Domnească)

Cucurbita pepo var. *oleifera* productivity compounds and grains yield (Moara Domneasca Experimental Field)

Elementele productivității	Media	Limite de variație
Lungime plantă (cm)	152,1	148,1 - 156,2
Numărul de fructe/plantă	2,2	1,9 - 2,4
Numărul de semințe/plantă	337,1	251,9 – 421,8
Numărul de semințe/fruct	145,3	102,6 – 188,2
Masă semințe/plantă (g)	56,7	42,2 – 71,2
MMB (g)	168,2	164,2 – 172, 1
Producția de semințe (kg/ha)	570	421 - 710

În urma analizării compoziției a chimice semințele de dovleac pentru ulei, se remarcă ca și la camelină, conținutul în lipide de circa 37% și de circa 30% în proteine. Celelalte componente au fost: 18,50% glucide, 14,80% celuloză și 5,41 săruri minerale. Aceste valori au ilustrat capacitatea de adaptabilitate a speciei pentru cultivare în sistemul de agricultură ecologică în condițiile de la ferma Moara Domnească.

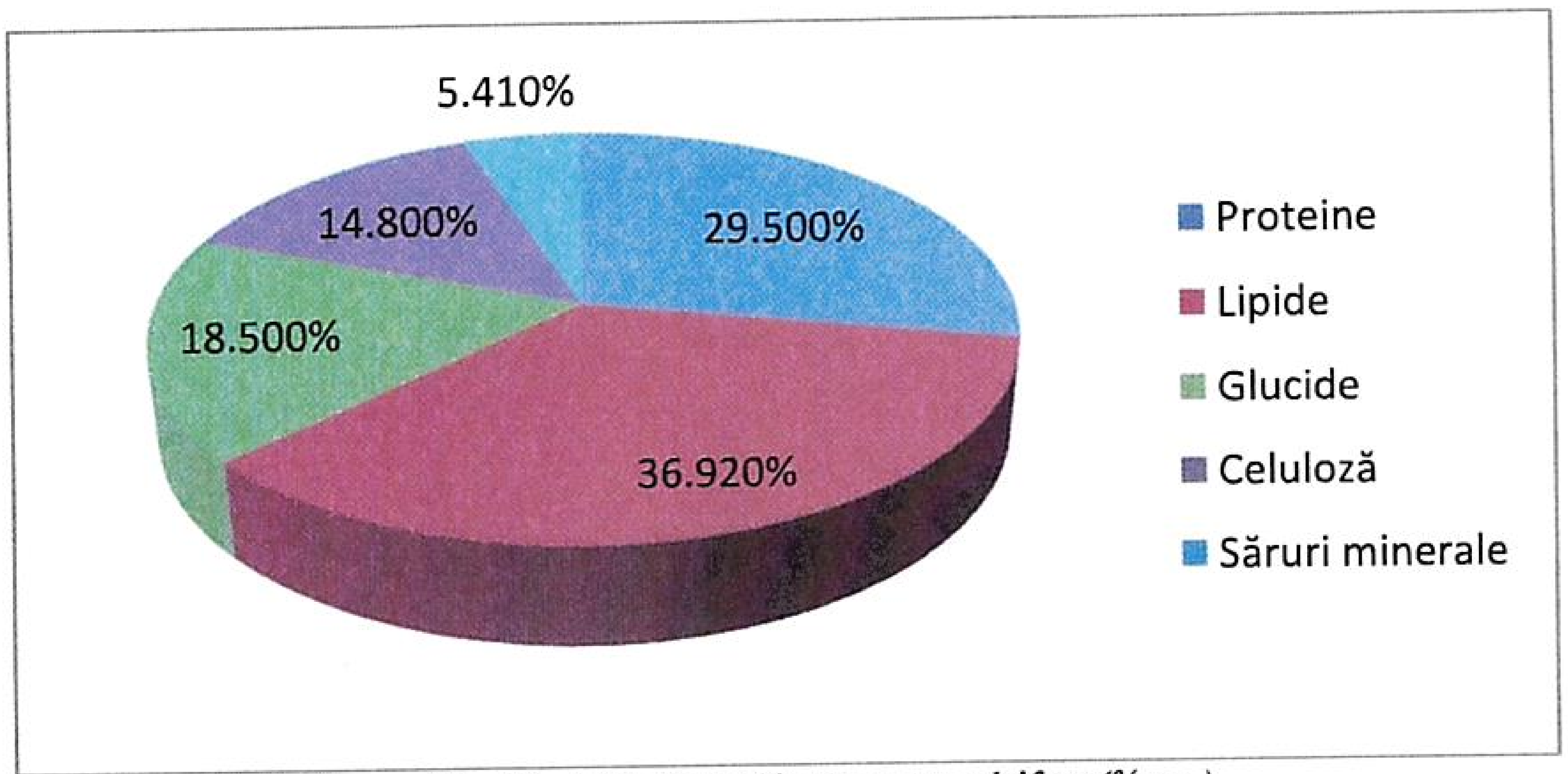

Fig. 1. Compoziția chimică la Cucurbita pepo var. oleifera (% s.u.)
Fig. 1. Chemical compiztion of Cucurbita pepo var. oleifera (% d.m.)

Rezultate obținute la linte. Cultura comparativă de linte a inclus studierea a 7 cultivare (Beluga, Sorte du Puy, Masoor (Turcia), Richlea (Franța), Laird (Turcia), Eston (Grecia), Moara Domnească), semănate în prima decadă a lunii aprilie. Sub aspectul duratei perioadei de vegetație, diferențele între variantele experimentale au fost nesemnificative. Cultivarele au ajuns la maturitatea de recoltare după 84 – 92 zile de vegetație. Valorile MMB (tabelul 14) au fost cuprinse între 21,5 şi 64,0 g, în medie pe experiență de 37,3 g. Semințe mari au format doar genotipurile Richlea şi Laird, la care masa a 1000 de semințe a fost de 50,6 g, respectiv 64,0 g. Producțiile de semințe obținute reflectă favorabilitatea zonei de experimentare, precum şi productivitatea bună a materialului biologic testat. Comparativ cu media experienței, cea mai mare producție a fost obținută la genotipul Laird, care a dat 1.325 kg/ha şi a depăşit media cu 161 kg/ha, spor asigurat statisc ca fiind foarte semnificativ. Acest genotip a fost urmat, sub raportul productivității, de genotipul Richlea, cu 1.230 kg/ha şi un spor față de media experienței de 66 kg/ha, precum şi de genotipul Masoor, cu 1.222 kg/ha şi un spor față de medie de 58 kg/ha, ambele sporuri fiind asigurate statistic. Genotipul Moara Domnească a realizat o producție de 1.157 kg/ha, cu 7 kg/ha sub media experienței, în acest caz diferența nefiind asigurată statistic. Astfel, genotipurile de linte s-au comportat bine, fiind obținute recolte bune care fundamentează concluzia că în zona solului preluvosol roşcat din partea centrală a Câmpiei Române sunt întrunite condiții favorabile pentru cultura lintei.

Tabelul 14

Producțiile de semințe la cultura comparativă cu genotipuri de linte (Câmpul Experimental Moara Domnească)
Seeds yields at comparative crop with lentil genotype (Moara Domnească Experimental Field)

Materialul biologic (genotipul)	Producția		Diferența (kg/ha)	Semnificația	MMB (g)
	kg/ha	%			
Beluga	1.000	85,9	-164	ooo	21,5
Sorte du Puy	1.100	94,5	-64	oo	29,3
Masoor (Turcia)	1.222	104,9	58	*	31,7
Richlea (Franța)	1.230	105,7	66	**	50,6
Laird (Turcia)	1.325	113,8	161	***	64,0
Eston (Grecia)	1.067	91,7	-97	ooo	32,6
Moara Domnească	1.157	93,4	-7	—	31,8
Media	1.164	100	Mt	—	37,3

DL5% = 46,2 kg/ha
DL 1% = 63,1 kg/ha
DL 0,1% = 86,4 kg/ha

În urma analizelor chimice efectuate la linte a rezultat următoarea compoziție chimică: 22,18% proteine, 3,03% lipide, 33,29% glucide, 3,20% celuloză şi 4,00% săruri minerale. Valorile au oscilat nesimnificativ de la un cultivar la altul, ceea ce a demontrat că plantele de linte s-au adaptat bine la condițiile de cultivare ecologică şi şi-au păstrat caracteristicile nutriționale din zonele de proveniență.

Tabelul 15

Compoziția chimică a semințelor la genotipurile de linte (% s.u.) (Câmpul Experimental Moara Domnească)
Lentil genotypes chemical composition (% d.m.) (Moara Domneasca Experimental Field)

Genotipul	Proteine	Lipide	Glucide	Celuloză	Săruri minerale
Beluga	21,78	3,25	32,98	2,7	4,11
Sorte du Puy	21,14	3,40	33,57	3,2	4,04
Laird	22,85	2,95	33,98	4,5	3,94
Richlea	22,67	2,81	33,21	3,6	3,91
Masoor	22,27	3,06	33,43	2,8	4,13
Eston	22,34	3,02	32,87	2,3	4,07
Moara Domnească	22,21	2,78	33,02	3,9	3,84
Media	**22,18**	**3,03**	**33,29**	**3,20**	**4,00**

CONCLUZII

În urma cercetărilor întreprinse, în cadrul disciplinei de Fitotehnie, de la Facultatea de Agricultură, USAMV din Bucureşti, în condițiile solului preluvosol roşcat din partea centrală a Câmpiei Române şi de cultivare în sistem ecologic au rezultat următoarele concluzii:

1. În contextul actual al dezvoltării agriculturii pe plan mondial, precum şi pentru protejarea biodiversității şi întoarcerea la o agricultură mai prietenoasă cu mediul, aşa cum este agricultură

wooder

ecologică, atenţia specialiştilor se îndreaptă şi spre alte culturi agricole noi, cum sunt culturile agricole alternative, mai puţin cunoscute, dar care pot deveni o alternativă a speciilor clasice cultivate.

2. Interesul pentru astfel de culturi agricole alternative derivă şi din faptul că, ele pot oferi beneficii potenţiale ce includ, pe lângă diversificarea producţiei agricole şi a alimentelor, creşteri economice realizate pe baza veniturilor fermierilor şi a celor care prelucrează şi vând astfel de produse, dar şi prin crearea unor noi industrii bazate pe sursele regenerabile de energie, atât la nivelul comunităţilor rurale, cât şi pe scară mai largă.
3. Totodată, culturile alternative pot constitui o oportunitate şi pentru fermieri datorită faptului că acestea pot reprezenta surse de venituri suplimentare faţă de culturile clasice, având un preţ de valorificare mai ridicat.
4. Un alt avantaj al acestor plante ar fi faptul că nu necesită inputuri mari, deoarece nu sunt pretenţionse faţă de condiţiile de cultură şi pot supravieţui unor climate aspre.
5. Nu sunt pretenţioase la fertilizare şi, de asemenea, sunt tolerante la boli şi dăunători, putând deveni o soluţie pentru cei care practică agricultura ecologică, care presupune inputuri mai reduse.
6. Aceste specii reprezintă şi o alternativă pentru sistemul de agricultură ecologică, bazat pe rotaţia culturilor, ce are drept scop păstrarea biodiversităţii, managementului riscului de mediu şi al securităţii alimentare.
7. Diversificarea sortimentului de culturi agricole, în special în privinţa unor specii mai puţin cultivate, dar cu cerinţe climatice asemănătoare şi calităţi nutritive superioare speciilor cultivate, în prezent la scară largă, constituie un obiectiv de bază al agriculturii ecologice.
8. Zona solului preluvosol roşcat din partea centrală a Câmpiei Române, întruneşte condiţii favorabile pentru cultivarea plantelor agricole alternative luate în studiu (amaranthus, quinoa, hrişcă, camelină, dovleac pentru ulei, linte) cu condiţia utilizării unui material biologic de calitate, adaptat condiţiilor naturale din zonă precum şi cu condiţia aplicării unei tehnologii corecte de cultivare, în care o problemă importantă este controlul buruienilor.
9. În aceste condiţii, speciile de amaranthus au produs producţii de seminţe de peste 1.700 kg/ha. S-au evidenţiat soiurile Golden Giant (*A. cruentus*), Rio san Lorentzo, Manna de Montana şi New Mexico (*A. hypocondriacus*) cu producţii de peste 2.000 kg/ha. La speciile de *A. caudatus*, media pe experienţă a fost de 1.550 kg/ha.
10. Producţiile la quinoa au oscilat între 1.870 kg/ha şi 2.540 kg/ha, ceea ce corespunde cu informaţiile din literatura de specialitate pentru această specie (2.000-3.000 kg/ha). Acest lucru demonstrează că specia *Chenopodium quinoa* s-a adaptat bine în condiţiile pedoclimatice ale zonei centrale a Câmpiei Române şi cultivării în sistem ecologic. Ca şi la speciile de *Amaranthus*, la quinoa se remarcă bogaţia în proteine cuprinse între 15,47 şi 16,71% şi lipide între 5,43 şi 6,90%, superioare cerealelor clasice.
11. Pentru hrişcă, producţia de seminţe a oscilat între 979 kg/ha şi 1.439 kg/ha. Ca şi la celelate două specii de pseudocereale, sunt demne de subliniat valorile superioare ale conţinutului în proteine, în medie peste 15% şi peste 16% la cele mai bune variante analizate.
12. În plus, la aceste specii de pseudocerele, trebuie evidenţiat că acestea nu conţin gluten, deci pot fi consumate de persoane care suferă de celiachie (alergie la gluten).
13. Pentru camelină, au fost obţinute producţii medii de seminţe de 1.474 kg/ha, fără diferenţe mari între cele două genotipuri analizate. Totuşi, provenienţa de la Fundulea a înregistrat sporuri de producţie de circa 100 kg/ha, ceea ce confirmă adaptarea acestui genotip la cultivarea în zona de sud a ţării, comparativ cu cel din Slovenia. În privinţa compoziţiei chimice, se remarcă conţinutul în lipide, de peste 31% şi cel de proteine de peste 25-26%.
14. La dovleacul pentru ulei, producţia a fost de 570 kg/ha, situându-se la nivelul producţiilor din ţările cultivatoare, fapt care reflectă adaptabilitatea acestei culturi agricole alternative la condiţiile climatice din zona de sud a României şi la cele de cultivare în sistemul de agricultură ecologică. În urma analizării compoziţiei chimice, seminţele de dovleac pentru ulei se remarcă prin conţinuturile în lipide de circa 37% şi de circa 30% în proteine.
15. Pentru linte au fost obţinute recolte bune, de 1.164 kg/ha, care fundamentează concluzia că în zona solului preluvosol roşcat din partea centrală a Câmpiei Române sunt întrunite condiţii favorabile pentru cultura lintei. Pentru compoziţia chimică a rezultat un conţinuturile ridicate în proteine, de 22,18% şi în glucide, 33,29%. Aceste valori au demonstrat că plantele de linte s-au adaptat bine la condiţiile de cultivare ecologică şi şi-au păstrat caracteristicile nutriţionale din zonele de provenienţă.
16. În concluzie, rezultate ilustrează condiţiile naturale favorabile pe care le găsesc culturile agricole alternative în arealul de cercetare, ceea ce reprezintă premise bune pentru realizarea de culturi reuşite şi de producţii bune, de calitate superioară.

MULTUMIRI

Pe această cale, aducem mulţumirile cuvenite tuturor celor care, prin sprijinul şi sfaturile oferite, au contribuit la realizarea obiectivelor acestor cercetări. Astfel, aducem mulţumiri colectivului de la Disciplina de Fitotehnie pentru implicare, dedicaţie şi profesionalism. De asemenea, mulţumim conducerilor Universităţii de Ştiinţe Agronomice şi Medicină Veterinară Bucureşti şi Facultăţii de Agricultură pentru asigurarea condiţiilor necesare pentru realizarea cercetărilor, atât în Câmpul Experimental de la Moara Domnească cât şi în laboratoarele disciplinei de Fitotehnie.

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EXPERIMENTAL RESULTS REGARDING MORPHOLOGICAL, BIOLOGICAL AN YIELD QUALITY OF *AMARANTHUS HYPOCHONDRIACUS* L. SPECIES UNDER THE CENTRAL PART OF ROMANIAN PLAIN CONDITIONS

REZULTATE EXPERIMENTALE PRIVIND CARACTERISTICILE MORFOLOGICE, BIOLOGICE ŞI DE CALITATE A RECOLTEI LA SPECIA *AMARANTHUS HYPOCHONDRIACUS* L. ÎN CONDIȚIILE DIN PARTEA CENTRALĂ A CÂMPIEI ROMÂNE

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Abstract: *The paper presents the results of research made in 2007 year at the Biobasis within USAMV-Bucharest Campus regarding morphological and biological characteristics, chemical composition and yield quality of Amaranthus hypochodriacus species. It worked with 5 different cultivars, coming from the world collection: Manna de Montana, Rio san Lorentzo, Nepal, Guarijio and New-Mexico. The duration of the vegetation period was of 130-147 days, the late cultivar was Manna de Montana, with a vegetation period of 147 days, and most early proved to the Rio San Lorentzo cultivar with 135 days of vegetation. The height of Amaranthus hypochodriacus plants varied between 132.8 cm for New-Mexico cultivar and 75.3 cm for Nepal cultivar. The productivity of Amaranthus hypochondriacus cultivars was illustrated by grains yields of 11.1-25.3 q/ha, data which mirror an important adjustment capacity to the cropping condition in the area and resistance to drought and high temperatures. The chemical composition of grains was following: 16.95% proteins; 62.02% starch; 5.56% lipids; 4.68% fibres and 3.67% ash.*

Rezumat: *Lucrarea prezintă rezultatele cercetărilor efectuate în anul 2007, în Biobaza din campusul USAMV Bucureşti, referitor la caracteristicile morfologice, biologice şi de calitatea recoltei la specia Amaranthus hypochondriacus. S-a lucrat cu 5 soiuri provenite din colectia mondială: Manna de Montana, Rio san Lorentzo, Nepal, Guarijio şi New-Mexico. Perioada de vegetație a fost cuprinsă între 130 şi 147 zile, cel mai târziu soi a fost Manna de Montana cu 147 zile de vegetație şi cel mai precoce s-a dovedit a fi Rio san Lorentzo cu o perioadă de 135 zile de vegetație. Înălțimea plantelor speciei Amarathus hypochondriacus a variat între 132,8 cm la soiul New-Mexico şi 75,3 cm la soiul Nepal. Productivitatea speciei Amaranthus hypochondriacus a fost ilustrată prin producții de semințe de 11,1-25,3 q/ha, date ce reflectă o mare capacitate de adaptare şi rezistență la cultivarea în condiții de secetă şi temperaturi ridicate. Compoziția chimică a semințelor a fost următoarea: proteine 16,95%, amidon 62,02%, lipide 5,56%, celuloză 4,68%, cenuşă 3,67%.*

Key words: *Amaranthus hypochondriacus, morphology, biology, cultivars, chemical composition.*
Cuvinte cheie: *Amaranhtus hypochondriacus, morfologie, biologie, soiuri, compoziție chimică.*

INTRODUCTION

Amaranthus species has a long, distinguished history as a religious and ceremonial plant and as a food. In fact, its use as an ornamental bloom is a relatively recent development. A native of South America, *amananthus'* name is derived from the Greek *amarantos*, which means "*unfading*" and is an appropriate reference to the flower's long-lasting deep red, green or yellow blooms. *Amaranthus hypochondriacus* sinonim with *Prince-of-Wales-feather* or *Prince's feather* is widely cultivated as pseudocereal, ornamental, and fodder crops in many tropical to warm-temperate regions of the world. Occasionally, *A. hypochondriacus* occurs as escapes near the places of cultivation; there are no reliable reports of its successful naturalization in the flora area. The wild progenitor of *Amaranthus hypochondriacus* seems to be *A. powellii* (J. D. SAUER 1967); hybridization with other cultivated taxa (e.g., *A. cruentus*) probably also played some role. The initial cultivated form probably emerged in southwestern North America, within the original range of native *A. powellii* (J. D. SAUER, 1967). The grains are high in lysine and the young leaves are high in iron and calcium. Can be planted after the frost date, requires full sun. The grains can be cooked as a hot cereal or ground and used as flour.

MATERIAL AND METHOD

The experiments with *Amaranthus hypochondriacus* species were made in the Biobasis within USAMV-Bucuresti Campus, in Didactical Field of Field Crops Department, Faculty of Agriculture Bucharest. The studied cultivars were: *Manna de Montana, Rio san Lorentzo, Nepal, Guarijio and New-Mexico* belonging of world collection.

Chemical analysis has been done in the Yield Quality Laboratory of Field Crops Department from the Faculty of Agriculture, with infrared spectrophotometer NIR Instalab 600 which was callibrated of Metron Novi Sad Laboratory. There were performed following chemical analysis: moisture, dry matter content, proteins, starch, lipids, ash and fibre.

RESULTS AND DISCUSSIONS

The duration of the vegetation period was of 130-147 days, the late cultivar was Manna de Montana, with a vegetation period of 147 days, and most early proved to be the Rio San Lorentzo cultivar with 135 days of vegetation (table 1). Also, the New Mexico cultivars had a longer growing season, about 140 days, but emergence was fastest, after 15 days from sowing.

Table 1

Phenology date of *Amaranthus hypochondriacus* cultivars (USAMVB Experiment Field, 2007)

Cultivars	Sowing data	Emergence data	Number of sowing/emergence days	Harvesting data	Number of emergence /maturity days
Manna de Montana	April 17	May 8	21	October 3	147
Guarijio	April 17	May 4	17	October 2	136
Rio san Lorentzo	April 17	May 7	19	September 18	135
Nepal	April 17	May 4	17	September 19	137
New-Mexico	April 17	May 2	15	September 18	140

Morphological determination for *Amaranths hypochondriacus* cultivars emphasized the following morphological traits: height of 75.3-132.8 cm; the stalk formed 7-10 knots, 12-42 leaves and a main inflorescence with the length comprised between 27.08-37.7 cm (table 2). The values of grains yields per plants oscillated from 11.8 to 25.8 g and TGW had an average of 1.08 g (table 3).

Even if the temperatures of 2007 year were very high, it resulted good values of grains yields with an average of 18.4 q/ha, being distingushed New-Mexico (25.3 q/ha) and Rio san Lorentzo (23.4 q/ha). The Manna de Montana cultivar had intermediary yield of 20.0 q/ha (figure 1).

The chemical composition of grains was as follows: 16.95% proteins; 62.02% starch; 5.56% lipids; 4.68% fibres and 3.67% ash (table 4). Research emphasized the important influence of experimental year weather conditions on grains chemical composition. In this way, in 2007, an extremely droughty year, with high temperatures, *Amaranthus hypochondriacus* grains accumulated more protein (15.83-17.83%) in comparison with cereals grains (12-14%) and lipids (4.92-6.49%) in comparison with cereals (1.5-4.8%).

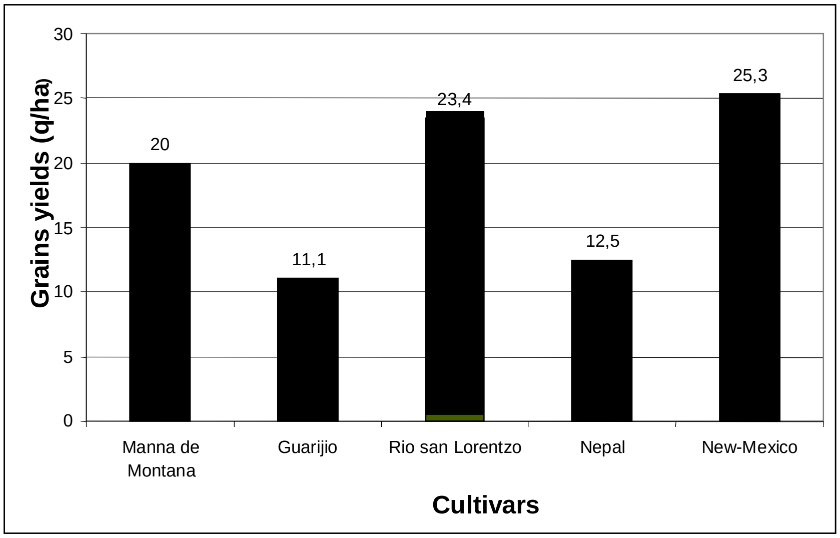

Figure 1. Grains yields of *Amaranthus hypochondriacus* cultivars
(USAMVB Experimental Field, 2007)

Table 2

Morphological characteristics of different *Amaranthus hypochondriacus* cultivars
(USAMVB Experimental Field, 2007)

Morphological characteristics of plants	Manna de Montana	Guarijio	Rio san Lorentzo	Nepal	New-Mexico
Plants height (cm)	126.5	82.2	88.7	75.3	132.8
Stems colors	Green reddish	Red with green shadows	Green yellowish	Purple red	Green yellowish
Number of leaves/main stem	37	18	42	12	23
Leaves colors	Light green	Green with dark reddish ribs	Green with light reddish shades	Dark reddish	Dark green
Inflorescences length (cm)	27.08	28.5	37.7	26.7	40.1
Inflorescences color and form	Bright green; Straight inflorescence, compacted	Dark red with purple shades, branched inflorescence	Red-purple with light green shades or yellow; straight inflorescence, compacted	Dark red to garnet; lax inflorescence	Green yellowish; straight inflorescence, compacted

Table 3

Grains yields per plant and TGW by *Amaranthus hypochondriacus* cultivars
(USAMVB Experimental Field, 2007)

Cultivars	Grains yields per plant (g)	Difference (g)	TGW (g)	Difference (g)
Manna de Montana	18.8	0.3	1.08	0
Guarijio	11.8	-6.7^{ooo}	0.99	-0.09^{ooo}
Rio san Lorentzo	23.8	5.3***	1.12	0.04*
Nepal	12.3	-6.2^{ooo}	0.96	-0.12^{ooo}
New-Mexico	25.8	7.3***	1.28	0.20***
Average	18.5	Control	1.08	Control
		DL 5%	0.61 g/plant	0.03 g
		DL 1%	0.93 g/plant	0.04 g
		DL 0,1%	1.49 g/plant	0.07 g

Table 4

Proteins, starch, lipids, ash and fibres contents of *Amaranthus hypochondriacus* grains by different cultivars (% d.m.) (USAMVB Experimental Field, 2007)

Cultivars	Proteins	Starch	Lipids	Fibre	Ash
Manna de Montana	17.64	61,21	4.92	4.62	3.31
Guarijio	16.52	62.83	5.17	4.34	3.84
Rio san Lorentzo	17.83	62.55	6.49	4.85	3.93
Nepal	15.83	60.75	5.43	4.66	3.75
New-Mexico	16.94	62.78	5.82	4.93	3.54
Average	16.95	62.02	5.56	4.68	3.67

CONCLUSIONS

As a consequence of research performed in 2007 year for *Amaranthus hypochondriacus*, following conclusions concerning morphological, biological and yields quality may be emphasized as important:

1. The duration of the vegetation period was of 130-147 days, the late cultivar was Manna de Montana, with a vegetation period of 147 days, and most early proved to be the Rio San Lorentzo with 135 days of vegetation.

2. The heights of *Amaranthus hypochodriacus* plants varied between 132.8 cm for New-Mexico cultivar and 75.3 cm for Nepal cultivar

3. The productivity of *Amaranthus hypochondriacus* cultivars was illustrated by grains yields of 11.1-25.3 q/ha, data which mirror an important adjustment capacity to the cropping condition in the area and resistance to drought and high temperatures.

4. By comparison, at cereals, folowing chemical composition was achieved: 16.95% proteins; 62.02% starch; 5.56% lipids; 4.68% fibres and 3.67% ash.

5. As a consequence of the effected research, it was issued the conclusion that the *Amaranthus hypochondriacus* cultivars find favourable conditions in the area of the reddish preluvosoil area from the central part of Romanian Plain.

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Original paper

Test of some insecticides for *Tanymecus dilaticollis* Gyll. control, in organic agriculture conditions

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Abstract The research focus to study the effectiveness of some active substances of insecticides for the control of maize leaf weevil (*Tanymecus dilaticollis*) in the organic agriculture conditions at the Plant Protection Laboratory of National Agricultural Research and Development Institute Fundulea (NARDI). In experiment, were used some permitted active substances in organic farming, according to Annex 2 of Regulation 889/2008 for the pests control, respectively: neem oil, spinosad and *Bacillus thuringiensis* for treatment of seeds and the same products applied in vegetation period of maize plant. The highest value of saved plants was 82.78% for treatment of maize seeds with neem oil and for spinosad applied in vegetation with 79.78%. The attack intensity had the highest level in the untreatment variant (5.90) and the lowest was in the variant of seed treated with neem oil (3.72). In conclusion, this experiment demonstrates the good efficacy of these products, that could be an alternative method for pest control in organic farming, in Romania.

Keywords Effectiveness of insecticides, maize, organic agriculture, pest control, *Tanymecus dilaticollis*.

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Introduction

Organic agriculture has the fastest growing development in the food sector today, with a rate of organic food sales between 20-25% per year (FAO [4]). The total organic area reaches over 45 million hectares, in 2018 (WILLER & al [23]). In Romania, organic agriculture means over 326 thousand ha. The cereals are the most important crops, with around 114 thousand ha, respectively, the maize crop occupies the largest surface, over 70 thousand ha (MARD [15]).

An essential factor for maize cultivation is the optimal density of plants in the strand to allow for high quality and economically efficient production. The maize leaf weevil, *Tanymecus dilaticollis* Gyll. (*Curculionidae* Family) is the most important pest of maize in Romania. This insect is a polyphagous pest and causes considerable damage in other crops such as sunflower, sugar beet, sorghum, soybean, lucerne (PAULIAN & al [18]; POPOV & al [19], GEORGESCU & al [6]).

Maize plants are attacked during emergence time and up to the 4-leaf stage when they can be roasted in the maize cornet area; for 2-3 leaf stage, adults eat plants from the cornet, causing the mass destruction of the crop, which requires its re-sowing (PAULIAN [17]). Due to the attack, the leaves at the base of the plant can be circularly perforated.

Maize plants past the 4-5 leaf stage are no longer the source of food for the pest that passes on other spontaneous plants. If untreated maize seeds are sown, damage can be very high and maize crop can be compromised 100% (BARBULESCU & al [1]).

Even if the seed is treated with specific products, the crop must be monitored permanently, because in a strong attack, the losses can be massive. Until the 5-leaf stage, the crop should be monitored daily or at least once every two days to see if the treatment has worked, if there are any living pests on the plant or if the second or third treatment is needed (GEORGESCU & al [7]).

After several years of use of chemical pesticides, today's agriculture is increasingly focusing on finding milder solutions to the environment in pest control actions. The resistance of cultivated species to conventional insecticides is well known, but disease management caused by insects is often neglected. Bio insecticides are the best remedies in situations where farmers have failed to control insects, despite the use of high doses of chemical pesticides. In contrast to these, bio insecticides offer long-term protection to both the crop and the soil.

Pests of maize crops can cause multiple inconveniences. They infest crops and reduce the yield of total agricultural production, but also its health. When dealing with pests, such as *Tanymecus dilaticollis*, most farmers use pesticides that can negatively impact their health, pollute water resources through leaks, and, if pesticides are used abusively or incorrectly, they can kill plants. Finding new ways to get rid of pests without requiring the use of chemicals has become a priority for many conventional farmers and, priority for organic farming. Pest management in organic farming is achieved by using appropriate cropping techniques, biological control, and natural pesticides (mainly extracted from plant or animal origins).

On the other hand, harmfulness of *Tanymecus dilaticollis* has increased in the last years in the Romania. Adults consume leaves margins and destroy apical meristems. Control measures include limiting maize production to 2 or less years in a crop rotation. Maize and sunflower are necessary to alternate with cereals in crop rotation (AGROATLAS [14]). According data of "Journal General de l'Europe", in the specific pedoclimatic conditions of South and South East of Romanian agricultural land, around one million ha of maize and sunflower emerging crops are exposed every spring to this soil insect attack (JOURNAL GENERAL DE L'EUROPE [9]). *T. dilaticollis* is amongst the most important pests on maize and sunflower in especial in Eastern and Central Europe (GERGINOV [5]; KACSÓ [10]; KESZTHELYI & al [11]; KIRKOV [12]; KRUSTEVA & al [13]; POPOV, BARBULESCU [19]; SÁRINGER, TAKÁCS [20]) and can also damage sugar beet, wheat, barley, oat, bean, tobacco, watermelon and alfalfa (ČAMPRAG & al [2]).

Currently, various agronomic (soil tillage, crop rotation, proper time of sowing, conditions favoring rapid seedling development and plant density) and chemical (seed-dressing formulations, spraying with pyrethroids, organophosphates, phenylpyrazoles and nereistoxin analogues) measures are applied to control *T. dilaticollis* (BARBULESCU & al [1]; ČAMPRAG & al [2]; KIRKOV [12]; KRUSTEVA & al [13]; VOINESCU [22]). To reduce the large yield losses caused by adults and environmental risks connected with broad spectrum insecticide application, new biocontrol products need to be developed and included in integrated pest management (IPM) schemes for this pest.

According to Guidelines on Good Plant Protection Practice of European and Mediterranean Plant Protection Organization [3], the basic strategies includes various cultural methods can reduce *Tanymecus dilaticollis* population and damage: crop rotation, time of sowing, conditions favouring rapid seedling development and plant density. It is important to assess the insect population in autumn before overwintering and then in spring when the plants start to grow. Insecticide spray application is the main control method; nevertheless, preventive systemic seed-dressing formulations may be used as well.

The importance of this experiment derives from the priority of farmers to find new viable solutions to control the attack of this important pest in maize crops, which respects the principles of organic farming and ensures the protection of the crop under conditions of economic efficiency. Also, these results could be an alternative for conventional farmers in the actual context of sustainable use of pesticides and restricting the application of chemical pesticides.

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Materials and Methods

The design of the experiment

These researches continue a serie that started at NARDI Fundulea, in 2014. The research was carried out in the Experimental Field of Plant Protection Department, National Agricultural Research and Development Institute Fundulea (NARDI), Calarasi County, Romania, in 2016-2018 periods.

The experimental field of NARDI Fundulea is located in a climatic region of the plain, with an average annual temperature of 11.3°C. Between April and October average temperature is over 17.34°C; and in June-August the temperature exceeds 20°C. Annual precipitations generally range from 400 to 530 mm. The spring season is poorly shaped, the transition from spring to summer is short, and from autumn to winter it is longer. Monthly average temperatures for the experimentation period (2016-2018) as well as multi-annual averages are shown in Table 1. From the examination of the data in the table it is noted that the multiannual average (in the last 50 years) for January-October was 12.34°C. The months with the highest temperatures are July and August, with 22.5°C and 21.9°C respectively, and the lowest value (the coldest month) is recorded in January, with -2.4°C. Analyzing the average data for the period 2016-2018, it can be seen that the average temperature for the January-October period was 13.82°C, higher than 1.48°C compared to the multiannual average. The spring was also very early, with a difference from the 2.4°C multiannual average for February and 0.8°C for March. The warmest month was August with an average temperature of 24.1°C, means 2.2°C higher than the multiannual average of this month. At a slight difference was the temperature in June, by 1.8°C compared to the multiannual average.

Table 1. Temperatures recorded at NARDI Meteorological Station and multiannual averages (°C) (2016-2018)

Year	Month										Average
	I	II	III	IV	V	VI	VII	VIII	IX	X	
2016	-4.3	6.2	7.3	14.0	16.1	22.9	24.1	23.9	19.1	10.3	13.96
2017	-0.2	2.2	4.4	13.8	16.8	21.6	23.6	23.3	16.6	9.0	13.11
2018	-2.4	-0.3	4.7	15.8	19.4	22.6	22.8	25.0	17.2	19.1	14.39
Average (2016-2018)	-2.3	2.7	5.5	14.5	17.4	22.4	23.5	24.1	17.6	12.8	13.82
Multiannual average	-2.4	-0.3	4.7	11.1	16.9	20.6	22.5	21.9	17.2	11.2	12.34
Deviations from the multiannual average	-0.1	2.4	0.8	3.4	0.5	1.8	1.0	2.2	0.4	1.6	1.48

Between 2016 and 2018, the sum of rainfalls between January and October (Table 2) averaged 555.6 mm, with a surplus over the multi-annual average of 27.6 mm; however, due to the inadequate rainfall distribution, droughts occurred in the summer months. For the sowing period of maize there was a deficit of about 28 mm from the average of the area. It is noted in April 2018, with a deficit of 56 mm from multiannual average and June 2018 with a 74 mm surplus over the average.

Table 2. Rainfalls recorded at NARDI Meteorological Station and multiannual averages (mm) (2016-2018)

Year	Month										Average
	I	II	III	IV	V	VI	VII	VIII	IX	X	
2016	59.0	72.3	72.2	71.5	52.6	50.1	46.2	59.0	72.3	72.2	627.4
2017	53.9	31.1	85.1	18.1	36.7	23.3	77.4	59.3	15.0	111.6	511.5
2018	57.6	56.8	70.4	3.0	42.8	146.2	83.6	5.0	31.8	30.7	527.9
Average (2016-2018)	56.8	53.4	75.9	30.9	44.0	73.2	69.1	41.1	39.7	71.5	555.6
Multiannual average	33.0	31.1	37.5	59.0	72.3	72.2	71.5	52.6	50.1	46.2	525.5
Deviations from the multiannual average	23.8	22.3	38.4	-28.1	-28.3	1.0	-2.4	-11.5	-12.9	25.3	27.6

The soil type in experimental field was cambic chernozem (GEORGESCU & al [8]).

Regarding the hydro-physical and chemical properties of the Fundulea cambic chernozem, we mention the following: a clayey texture on horizon A and on the other horizons; apparent density values (1.19 in A horizon and 1.40-1.44 in deep sub-horizons); the total porosity (56% in Ap and 46-48% in deep sub-horizons), the aeration (18% in Ap and 10-13% in deep sub-horizons), indicating relatively loose and moderately tilled soil, wilting coefficients moderate ranging from 10.9-11.9% in horizon A, 10.3-10.8% in horizon AB and below 8.8-10.3% in horizon Bv and useful water capacity (32% in Ap and 24-26% in deep sub-horizons) small-medium. Also, the hydraulic permeability of the soils from experimental field is good (15.6-21.1 mm/h) in horizon A (15.6-21.1 mm/h) and

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medium in the deep horizons (10.4-12.2 mm/h) (PARTAL & al [16]).

From an agrochemical point of view, the soil from Fundulea is characterized by a weak acid (pH) reaction (6.3-6.8) in horizon A and neutral – weak alkaline (7.2-7.4) in the horizons AB and Bv, as well as a total capacity of high cation exchange (18.8-19.7 me/100 g soil), and a very high degree of saturation with bases (V) (88.7-100%) over the whole soil profile, corresponding to the adsorptive complex of the soil (clay + humus), (PARTAL & al [16]).

The supply of the chernozem from Fundulea with nutrients is also good, especially in the sub-horizon A (0-15 cm): 3% humus, 0.18% total Nitrogen, 0.08% Phosphorus total, 28 ppm phosphorus and 87-98 ppm Potassium (PARTAL & al [16]).

The hybrid used in the research was Olt, FAO 450, originated from NARDI Fundulea.

The experiments have been placed in maize monoculture, with pea strips for the delimitation of plots.

The distance between the rows was 70 cm and the density of sowing was 60816 seeds/ha.

The soil tillage consisted of a plow to 28-32 cm depth in September, after harvest of maize. Tillage has been used over to control weeds, to incorporate previous crop residues, and to prepare the seedbed.

In the spring, the plot was disking twice, prepared the seedbed and sowing. Sowing was done manually, for a better density of plants. Also, the weed control has been manualy, to ensure a very good management of weed control.

The experimental variants were as follows:

- Tree variants for seeds treatment:
- V1 – untreated control;
- V2 – seed treatment with neem oil (commercial product was Neem oil, at a dose of 2.5 mL/250 g of seed);
- V3 – seed treatment with spinosad (commercial product was Laser 240 SC, at a dose of 2.5 mL/250 g of seed);
- V4 – seed treatment with 54% *Bacillus thuringiensis* (commercial product was Bactospeine DF, at a dose of 0.01%);
- Tree variants for vegetation period:
- V5 – vegetation treatment with neem oil (commercial product was Neem oil at a dose of 250 mL/ha);
- V6 – vegetation treatment with spinosad (commercial product was Laser 240 SC, at dose 250 mL/ha);
- V7 – vegetation treatment with 54% *Bacillus thuringiensis* (commercial product was Bactospeine DF, at a dose of 0.01%).

These products are in accordance with Regulation (CE) 889/2008 of applying Regulation 834/2007, Annex II and are accepted as input in the organic agriculture.

Method of experimentation

After the emergence of maize plants, after (8-10 days after sowing) when the rows became visible, we were marked 20 plants on the four central rows on each experimental plot. When maize plants reached the 4-leaf stage (BBCH 14) the intensity of the attack was determined. The insecticides used for the vegetation treatment were applied after marked maize plants.

This scale attack intensity ranged from: 1 – unattacked plant to 9 – plant completely destroyed.

We noted:

Note 1: plant not attacked;
Note 2: plant with 2-3 simple bites on the leaf edge;
Note 3: plants with bites or clips on leaf edge;
Note 4: plants with leafs chafed in proportion of 25%;
Note 5: plants with leafs chafed in proportion of 50%;
Note 6: plants with leafs chafed in proportion of 75%;
Note 7: plants with leafs chafed almost at the level of the stem;
Note 8: plants with leafs completely chafed and beginning of the stem destroyed;
Note 9: destroyed plants, with stem chafed close to soil level (PAULIAN [17]; POPOV, BARBULESCU & al [19]; GEORGESCU & al [8]; TOADER & al [21]).

At 30 days of emergence, the percentage of plants saved (%) was determined by counting the plants on the entire plot and reporting them to the number of seeds sown per plot.

Data were statistically analyzed by analysis of variance and the Student Neuman Keuls (SNK) test with the ARM 8.5 program.

Results and Discussion

The number of emerged plants

Between 2016 and 2018, in the control variant, which did not treat of the seed and no treatments were applied in vegetation, the number of emerged plants was smaller, from 3.65 to 3.85 pl/m^2, by comparison with other variants. For the variants that used seed treatment with neem oil, the emerged plants were, in average 5.92 pl/m^2, for all three years of experimentation. Results of 5.67 pl/m^2 were also recorded in Spinosad variant treatments in vegetation, and also for seed treatment with *Bacillus turingiensis*, with 5.08 pl/m^2.

Under the conditions of year 2016, it was found that the maize plant density at emergence was low for the untreated variant (3.70 pl/m^2). In the other experimental variants, the maize plant density, at emergence, was between 4.0 and 6.0 pl/m^2.

In 2017, the maize plant density had the lowest value of 3.85 pl/m^2 in the control variant, and the largest for the seeds treatment and vegetation variants with the neem oil, 5.92% and also for spinosad in vegetation, 5.67 pl/m^2. For 2018, the efficacy of seed treatment with neem oil was confirmed again, with a density of 6.00 pl/m^2. Regarding vegetation treatmant, it was noticed spinosad with 5.75 pl/m^2 and *Bacillus turingiensis* cu 5.50 pl/m^2 (Table 3).

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Table 3. Number of emerged plants (pl/m^2) (2016-2018)

Treatment application	Active substance/commercial product	Years			Average
		2016	2017	2018	
Untreatment plot	Control	3.70	3.85	3.65	3.73
Seed treatment	Neem oil, 2.5 mL/250 g	6.00	5.75	6.00	5.92
	Spinosad, 2.5 mL/250 g	4.00	4.30	4.10	4.13
	54% *Bacillus thuringiensis*, 0.01%	5.50	5.25	4.50	5.08
Vegetation treatment	Neem oil, 250 mL/ha	5.50	5.75	5.00	5.42
	Spinosad, 250 mL/ha	6.00	5.25	5.75	5.67
	54% *Bacillus thuringiensis*, 0.01%	5.00	4.75	5.50	5.08
LSD P=.05		0.300	0.300	0.275	0.395
Standard Deviation (SD)		0.202	0.202	0.185	0.266
Variation coefficient (CV)		3.960	3.960	3.720	5.390
Replicate F		1.937	1.937	0.965	0.706
Replicate Prob (F)		0.1598	0.1598	0.4308	0.5606
Treatment F		83.349	83.349	60.480	43.757
Treatment Prob (F)		0.0001	0.0001	0.0001	0.0001

*values that do not have common letters differ significantly for a statistical assurance level of 5% ($P \leq 0.05$)

Insects density

Insect's density was high in each year of experiment, ranging from 3.5 to 15.9 insects/m^2. Due to the fact that the experience was done in maize after maize and experimental plot had pea strips (plant with repellent effect for maize leaf weevil), the maximum number of insects was about 3 times higher than the economic damage threshold for *Tanymecus* (5 insects/m^2) (Table 4). As a result, there is a direct correlation between the application of insecticides, and the number of insects per square meter. The smallest number of insects present was registered for neem oil treatment. An intermediate value was recorded for the other two variants of the seed treatment. For vegetation treatments, the average values were high, between 9.6 and 10.55 insects/m^2, close to the control variants. This was due in particular to the high temperatures of the last few years of spring without the precipitation and rotation of maize after maize, which was favorable for the development of the pest.

Table 4. Density of *Tanymecus dilaticollis* (insects/m^2) (2016-2018)

Treatment application	Active substance/commercial product	Minimum	Maximum	Average
Untreatment plot	Control	5.9	15.9	10.9
Seed treatment	Neem oil, 2.5 mL/250 g	3.5	9.3	6.4
	Spinosad, 2.5 mL/250 g	4.2	12.1	8.15
	54% *Bacillus thuringiensis*, 0.01%	5.2	12.9	9.05
Vegetation treatment	Neem oil, 250 mL/ha	5.5	15.6	10.55
	Spinosad, 250 mL/ha	5	14.3	9.65
	54% *Bacillus thuringiensis*, 0.01%	5.5	13.7	9.6

Attack intensity

The lowest number of insects was recorded in seed treatment with neem oil, so the intensity of the attack was the lowest of 3.72. By comparison, the highest intensity of the attack was recorded in *Bacillus thuringiensis* treated on seed, where mean values was similar to the control variant, of 5.50. At the same time, it is noted that the highest values of the attack intensity were recorded in the years 2017 and 2018. These years were favorable for *Tanymecus dillaticolis* attack, by high temperatures and without precipitation in April-May.

Table 5. Attack intensity (2016-2018)

Treatment application	Active substance/commercial product	Years			Average
		2016	2017	2018	
Untreatment plot	Control	5.80	6.20	5.80	5.90
Seed treatment	Neem oil, 2.5 ml/250 g	3.70	3.85	3.60	3.72
	Spinosad, 2.5 ml/250 g	4.80	5.75	5.55	5.37
	54% *Bacillus thuringiensis*, 0.01%	5.80	5.05	5.05	5.30
Vegetation treatment	Neem oil, 250 ml/ha	4.75	6.00	5.75	5.50
	Spinosad, 250 ml/ha	5.50	5.00	5.50	5.33
	54% *Bacillus thuringiensis*, 0.01%	5.40	5.20	5.40	5.33
LSD P=.05		0.333	0.333	0.351	0.350
Standard Deviation (SD)		0.224	0.224	0.237	0.236
Variation coefficient (CV)		4.390	4.390	4.660	4.500
Replicate F		0.695	0.695	0.648	1.404
Replicate Prob (F)		0.5668	0.5668	0.5945	0.2741
Treatment F		45.297	45.297	43.069	41.940
Treatment Prob (F)		0.0001	0.0001	0.0001	0.0001

*values that do not have common letters differ significantly for a statistical assurance level of 5% (P≤0.05)

Analyzing the data in Table 5, it was found that under the conditions of 2016, the lowest attack of *T. dilaticollis* was recorded in the case of the seed treated with neem oil and also vegetation treatment.

In the climatic conditions of 2017, in the experimental field at INCDA Fundulea, it was found that under the conditions of a moderate attack of *Tanymecus dilaticollis*, there are no statistical differences between the variants treated in vegetation with spinosad and *Bacillus turingiensis* (P <.05).

In 2018, the *T. dilaticollis* attack on untreated plants was moderate (I = 5.8). With the exception of the single dose variant with neem oil, among the other variants there were no statistically differences of the attack intensity (P <.05).

Analyzing the three-year data (2016-2018), in all three years of experimentation, the lowest attack was in the case of neem oil apllyed on seeds.

Percentage of saved plants

Regarding the percentage of saved plants, in the year 2016, in the experimental field at NARDI Fundulea, it was found that the seeds treatments variants was higher at neem oil treatment (82.78%) (Table 6).

Table 6. Saved plants (%) (2016-2018)

Treatment application	Active substance/commercial product	Years			Average
		2016	2017	2018	
Untreatment plot	Control	52.78e	65.00e	71.68d	63.15
Seed treatment	Neem oil, 2.5 mL/250 g	82.78a	79.44a	81.69a	81.30
	Spinosad, 2.5 mL/250 g	81.67a	78.89ab	77.39c	79.31
	54% *Bacillus thuringiensis*, 0.01%	67.78d	78.89ab	78.27c	74.98
Vegetation treatment	Neem oil, 250 mL/ha	72.78c	70.00d	77.44c	73.40
	Spinosad, 250 mL/ha	79.78b	77.44bc	79.75b	78.99
	54% *Bacillus thuringiensis*, 0.01%	78.67b	76.89c	77.63c	77.73
LSD P=.05		1.459	1.459	1.459	1.383
Standard Deviation (SD)		0.982	0.982	0.982	0.931
Variation coefficient (CV)		1.33	1.33	1.33	1.24
Replicate F		1.328	1.328	1.328	0.119
Replicate Prob (F)		0.2964	0.2964	0.2964	0.9479
Treatment F		470.786	470.786	470.786	141.763
Treatment Prob (F)		0.0001	0.0001	0.0001	0.0001

*values that do not have common letters differ significantly for a statistical assurance level of 5% (P≤0.05)

This variant for all tree years of experiment has the highest level of statistical significance, the differences from the untreated variant being significant. In the variants where treatments were applied in the vegetation, although there are statistical differences from the control variant. The differences are smaller compared to those recorded in the treatments applied to the seed and compared to the control variant.

In 2017, the percentage of saved plants in the control variant was 65.00%, higher than in the control variant in 2016. The largest statistically differences were recorded between the seeds treated with neem oil and the untreated variant, followed by the variant where the seeds were treated with spinosad and *Bacillus turingiensis* in vegetation ($P < .05$).

In 2018, in the control variant, the percentage of saved plants was 71.68%. These differences, compared to those recorded in 2016, were due to the excess rainfall registered in 2018, especially in June. This year, the largest statistical difference compared to the control was recorded for the variant where the seeds were treated with neem oil, followed by the variant with Spinosad and *Bacillus turingiensis* in vegetation. The variants with spinosad and *Bacillus turingiensis* applied to seeds had the same level of statistical significance, but the differences from the untreated control were smaller than in other cases. High values were also obtained in the treatment with neem oil at seed and vegetation (78.99 to 79.31%).

In all three years of experimentation, the most stable significant difference from the untreated control was recorded in using of neem oil treatment.

In the climatic conditions of 2016, the correlation between the intensity of the *T. dilaticollis* attack and the percentage of saved plants was negative (Figure 1).

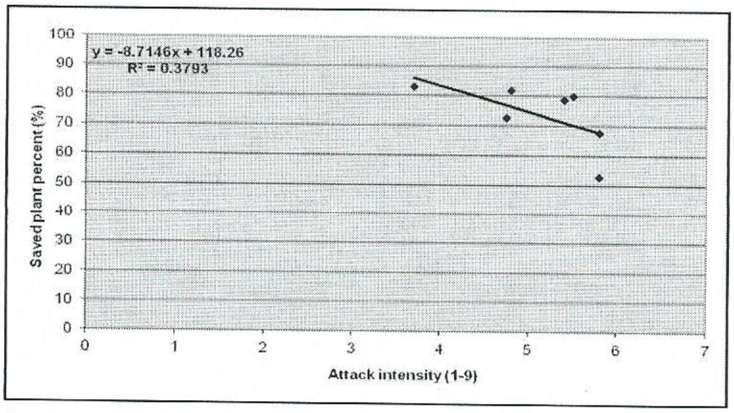

Figure 1. Correlation between attack intensity and number of saved plants in 2016.

A similar situation was recorded in the climatic conditions of 2017, while in 2018, although the correlation was negative, the relationship between the intensity of the attack and the percentage of the saved plants was not so tight (Figure 2 and Figure 3).

In the case of attack intensity, the percentage of lost plants is directly and significantly influenced when the number of insects increases. It is increasing directly in proportion to the increase in intensity attack.

It is worth noting that the number of insects under control was 3 times higher (15.9 insects/m^2) than the economic damage threshold, for this pest (5 insects/m^2). The density of insects was high, very close to the control, and in the case of vegetation treatment with neem oil (15.6 insects/m^2). The best efficiency, significant, was achieved by applying this product to the seed.

The difference between the two graduations taken in monitoring (treated seeds, respectively untreated seeds) is provided statistically.

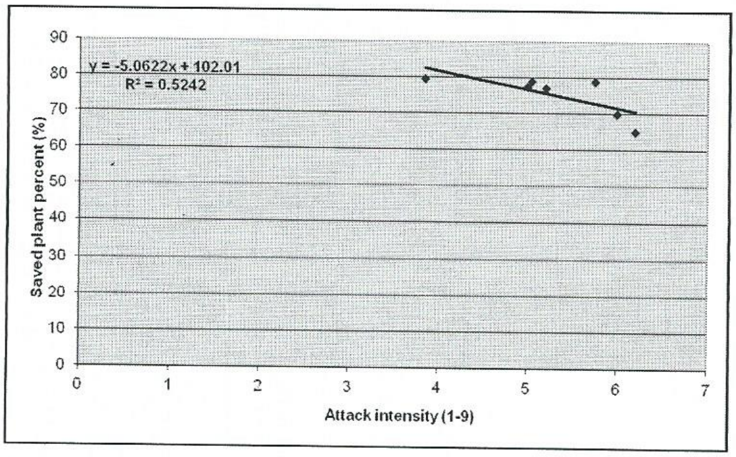

Figure 2. Correlation between attack intensity and number of saved plants in 2017.

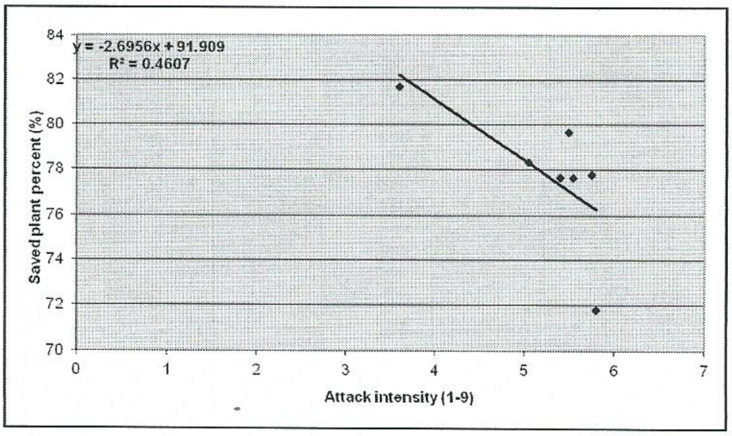

Figure 3. Correlation between attack intensity and number of saved plants in 2018.

Conclusion

Due to large areas, maize is commonly grown on the same plot many years, sometimes 4-5 years, which may increase the multiplication of pest populations, including *Tanymecus dilaticollis*, considered to be the most harmful pest for maize crops (but also for sunflower or sugar beet).

As a result, to reduce the damage caused by this pest, it is necessary to treat the seeds with insecticides before sowing and sometimes treatment interventions are necessary at the beginning of the vegetation period.

But, in organic agriculture the solutions of maize leaf weevil control are limited, according by legislation.

These results demonstrate a moderate efficacy of some alternatives insecticides for organic agriculture on *Tanymecus dilaticollis* pest control for using in Romania.

Insecticides applied to the seed, based on neem oil, provided a good protection for maize plants against *T. dilaticollis*, with an average of 81.30% saved plants.

Also, the vegetation treatments are noted for the application of spinosad with 78.99% and *Bacillus turingiensis* with the percentage of plants saved 78.00%.

In conclusion, under variable climatic conditions from one year to another, these results demonstrate the a moderate efficacy of some alternatives insecticides for organic agriculture on *Tanymecus dilaticollis* pest control for using in Romania, especially neem oil that can be used for seed treatment.

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SOME ASPECTS OF BAKERY INDUSTRY QUALITY FOR ORGANIC AND CONVENTIONAL WHEAT

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Abstract

The objective of these researches was to analyze the quality for bakery industry of some organic and conventional wheat samples on the agricultural market in Romania. Analysis was performed on grains, flour and bread of the organic wheat by comparison with the conventional wheat. For wheat grains we tested: moisture, gluten, starch, proteins, Zeleny index, ash and fiber. For integral wheat flour we performed the following: organoleptic examination; wet gluten content; the index of gluten deformation; gluten index; Falling Number. For bread, we analysed: organoleptic examination; the ratio height/diameter; crumb porosity; crumb elasticity. The chemical composition of organic wheat grains was: 10.73% moisture; 13.25% proteins; 66.27% starch; 1.53% fibre; 1.87 ashes; 35 Zeleny Index. By comparison, for conventional wheat grains were: 11.52% moisture; 12.96% proteins; 67.12% starch; 2.31% fibre; 1.62 ash; 32 Zeleny Index. The results of integral wheat flour include: specific color of wheat milled grist, with smell pleasant, not specific smell of mold, hot or other special smell; the taste was normal, slightly sweet, not bitter or sour, with no mineral impurities; the wet gluten content varied between 30.74% for organic flour and 27.12% for conventional; deformation index was between 5 for organic flour and 3 for conventional flour; 56.43 gluten index was for organic flour and 50.07 for conventional; Falling Number was 247 seconds for organic flour and 234 seconds for conventional flour. Another aspect that was highlighted by determinations organoleptic bread quality assessment where it obtained 23 points for conventional bread and 30 points for organic bread. Thus, the bread obtained good fall into the category (18.1 ... 24 points) for conventional bread and very good, especially in terms of smell and taste for organic bread.

***Key words**: wheat, bakery industry, organic agriculture, yields quality, chemical composition.*

INTRODUCTION

Bread is a commonly consumed grain product in numerous countries and societies. Nowadays, there is a great variety of organic and "natural" breads, along with conventional ones. Can choose from white bread, wheat, whole or sprouted wheat, multi-grain, and gluten-free (Kucińska, 2012).

A clear understanding of the relationships between farming systems and crop nutritional quality is very important for designing agricultural management strategies which enhance environmental quality and sustainability while improving consumer's health.

Agricultural production systems may differ greatly in terms of amount and sources of fertilisers, crop protection strategies and crop rotation. As such, a relationship between food quality and farming systems could be expected (Mazzoncini et al., 2007).

Introduction European policy to promote quality food products is an important component of the current Common Agricultural Policy (CAP). By this policy, European Union encourages farmers in order to obtain the agricultural products with superior quality. Currently, while the initial goal was achieved (in many agricultural products European Union provides the use of domestic over 100%), CAP was shifted to the qualitative aspect of food products, rather than to the quantity (Toader, 2008).

Grain quality at the mill is the result of the interaction of genotype with environmental conditions from sowing to delivery to the mill, and this interaction is potentially different for

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each aspect of grain quality (Cauvain, 2003). The baking potential of wheat flours is influenced by many factors, most notably protein content (MacRitchie, 1987). Protein content is in turn influenced mainly by nitrogen fertilization, while the protein quality is determined primarily by the wheat genotype (Samaan et al., 2006). On the other hand, both the quality and the content of the wheat protein are affected by the climatic conditions during wheat maturation (Huebner, 1999). Vitreousness is considered to be related to the endosperm microstructure whereas hardness is suggested to influence the adhesion forces between starch granules and protein matrix (Greffeuille et al., 2006).

EU quality policy on the products obtained in the organic farming system is part of wider agricultural product quality policy. This policy meets the demand for specific products, increasingly stronger European consumers towards standardization in the development of conventional products. Producers are allowed if their products meet the conditions imposed by European regulation, to engage in a quality approach to enable better marketing. In order to qualify, depending on the geographical area will be enhanced, two indications: protected designation of origin and protected geographical indication. There is also the possibility that products produced using traditional methods to obtain certification of specificity (under endorsement traditional specialty guaranteed) (www.organic-europe.net).

This means that modern organic products, are not only fresh, delivered straight from the farm, but they also cover products every day involving sophisticated methods of processing products including wine, beer, pasta, yoghurt, prepared meals, cheeses etc. Like their counterparts from conventional agriculture, organic farmers and processors monitor trends in food consumption to ensure their products keep up with any changes in consumer tastes or demand, with the guarantee system certification on these products.

As a result of fewer irrigation practices and no synthetic fertilizers and pesticides being used in crops' growth, a higher amount of significant health-promoting nutrients, minerals, vitamins, and antioxidants can be found in organic grains. Eating organic bread can also lower your exposure to pesticides. Organic farming is significantly reflected not only in quality and safety of grain and grain-based products; it also has a great impact on our environment.

Furthermore, wheat is the most important cultivated plant, which is obtained mainly bread, staple food for about 40% of world population. The wheat flour is used for the preparation of various bakery products and manufacturing of pasta, etc. The grains of wheat are included in mixtures for breakfast cereals. Wheat grains are used in animal feed as such or ground, for the production of starch, gluten, alcohol, spirits (vodka, whiskey) beer, biofuel (ethanol). Straw have multiple uses, such as raw material in the pulp and paper industry; bedding; roughage; organic fertilizer into the soil after harvest incorporation or composting; producing energy by burning ends in fiery heat recovery.

In Romania there are favorable conditions for wheat cultivation and its role in food security strategy is determined by the possibilities of conservation inexpensively compared to other foods, cold chains unnecessary or costly installation (Roman et al., 2012).

MATERIALS AND METHODS

The main objective of this research was to determine the chemical composition and yield quality for organic and conventional wheat from the market of agricultural products in Romania. At the same time, there were tested samples of wheat flour for bakery industry quality. The material includes 20 of wheat samples, 10 for each type, organic and conventional. For results we present the average results.

Chemical analyses were performed to Yield Quality Laboratory of Crops Sciences Department of the Faculty of Agriculture, University of Agronomic Sciences and Veterinary Medicine of Bucharest, in 2017.

The devices used for analyses of wheat grains was spectrophotometer infrared NIR Inframatic 9200 Product Instalab-Analizer (Figure 1). For wheat grains we tested: moisture, gluten, starch, proteins, Zeleny index, ash and fibre.

For integral wheat flour performed according the STAS Methods (SR 877-95-Wheat Flour), the following: organoleptic examination; wet gluten content; the index of gluten deformation; gluten index; Falling Number (Figure 2).

For bread, we analysed: organoleptic examination; the ratio height/diameter; crumb porosity; crumb elasticity (Table 1, Figure 3).

Figure 1. NIR Inframatic 9200 Product Instalab-Analizer (Yield Quality Laboratory of Crops Sciences Department)

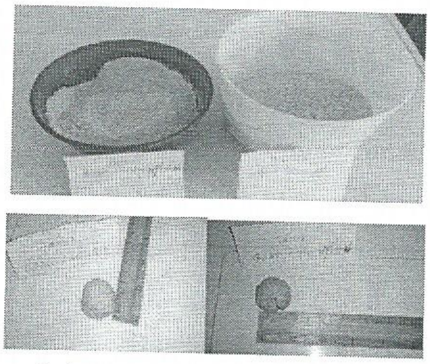

Figure 2. Aspects of gluten index deformation analysis (Yield Quality Laboratory of Crops Sciences Department)

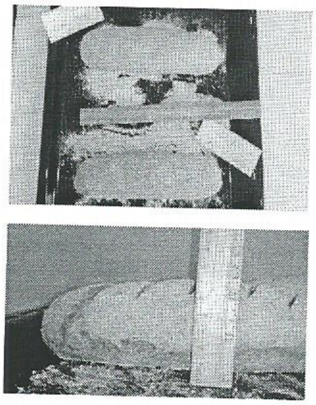

Figure 3. Aspects of bread analysis (Yield Quality Laboratory of Crops Sciences Department)

Table 1. Descriptive vocabulary and definitions used by assessors to evaluate bread

Attribute	**Definition**
Appearance	
Crust colour	Degree of colour darkness in the crust ranging from pale to dark brown
Crumb colour	Degree of colour darkness in the crumb ranging from creamy to white
Crumb appearance	Degree of porosity and its uniformity from non uniform to uniform
Odour	
Yeasty	Odour associated with aromatic exchange from yeast fermentation
Grainy	An aromatic impression of cereal derived products like wheat, barley and corn
Texture	
Manual	Force required snapping sample by hand
Oral	Force required biting completely through sample placed between the molars
Flavour	
Sweet	Fundamental taste sensation of which sucrose is typical
Salt	Fundamental taste sensation elicited by sodium chloride
Sour	Fundamental taste sensation evoked by acids

RESULTS AND DISCUSSIONS

Results of wheat grains chemical compositon. Knowing, the moisture content plays an important role in storage of wheat grains. Moisture percentage is very important in the practice of obtaining and preserving agricultural products, as increased moisture favors grains firing and infestation. In Romania, the STAS moisture for wheat seeds is 14% (SR ISO 13548:2013).

According to the moisture content, a higher amount of dry matter was obtained from organic wheat, about 90% compared with conventional wheat which had a value of about 88% (Table 2).

Table 2. Comparative analysis on chemical composition of conventional and organic wheat seeds

Compounds (%)	Conventional wheat	Organic wheat
Moisture	11.52	10.73
Dry matter	88.38	89.27
Proteins	12.96	13.25
Starch	67.12	66.27
Fibre	2.31	1.53
Ash	1.62	1.87
Zeleny index (number)	32	35

Regarding the biochemical content of other components, one can highlight content slightly higher in proteins, over 13% for organic wheat, compared with conventional wheat samples.

Because minerals are distributed mainly to the periphery of the grain, the degree of extraction of the flour is higher, the higher ash content and flour is darker but richer in minerals, fibre and enzymes. Ash content for organic wheat flour had a value of 1.87%. For conventional wheat flour ash content was 1.62%. The starch was higher of conventional wheat, respectively 67.12%, by comparison with organic wheat.

Results on flour (whole meal). Organoleptic examination of the flour was: appearance (colour), smell and taste of flour for bakery.

Both types of flour (organic and conventional) had the characteristics of healthy product. After infestation determination, it was observed that after about an hour, the cone made with a funnel did not collapse, and there were no signs indicating the presence of mites or other insects on the surface for any of the analyzed samples.

The obtained results showed an ash content falling standards for integral flours in Romania for both types of sample. The wet gluten and proteins contents have the main role in the production of bread from wheat flour. Sufficiently flexible and extensible gluten ensures well-developed, smooth, uniform porosity with thin walls. In our experiments, wet gluten content varied between 30.74% for organic wheat and 27.12% for conventional wheat (Table 3). Thus, the obtained values frame the organic wheat and the conventional wheat in the Romanian standards (22-32%) for high quality flour for bakery. It highlights the wheat flour made from organic wheat, where gluten was over 30%.

The deformation of gluten index indicates the proteolytic activity of the flour. The deformation of the gluten is high if it exceeds 15 mm. If gluten deformation is below 5 mm, proteolytic activity is very low, gluten is highly elastic, and flour requires amelioration with proteolytic or reducing enzymes. For baking flours Standards, gluten deformation index ranges from 3 to 25 mm. In this experiment it was obtained 3 mm for conventional wheat flour and 5 mm of organic wheat flour.

Gluten index calculated for the two types of flour ranged between 50.07 in the case of conventional wheat flour and 56.43 respectively for organic wheat flour. The standards gluten index ranges oscillated between 40 and 50.

The nutritional content of breads is related to the chemical composition of the bread, hence protein content and starch composition are of importance when considering the dietary impact of breads.

Table 3. Comparative analysis on flour of conventional and organic wheat

Compounds	Conventional wheat	Organic wheat	Standards Values
Organoleptic examination	Product specific healthy	Product specific healthy	Product specific healthy
Wet gluten (%)	27.12	30.74	22
Deformation index (mm)	3	5	3-15
Gluten index	50.07	56.43	40-50

Falling Number test was determined in laboratory by Falling Number device, according to standard ISO 3093-2005. In these circumstances it was 228 seconds organic flour and conventional flour was 247 seconds (Table 4). This index measuring amylase activity involved in starch degradation, which can be excessive in the presence of germinating seeds or emerging germination. The method is widely used commercially to measure the germination of grain. The results show the two types of flour are suitable to use in bakery industry.

Table 4. Falling Number of conventional and organic wheat flour

Values			Quality of flour
Conventional wheat flour	Organic wheat flour	Standards Values	
-	-	< 120 seconds	Unusable
-	-	120- 180 seconds	Satisfactorily
228	247	180- 260 seconds	Suitable
-	-	>260 seconds	Usable with the addition of enhancers

Results on bread. Organoleptic characteristics after 4 hours of rest from cooking were following:

- Type of product: bread analyzed has regular shape at both flour types, and volume was sufficiently developed and flattened to any of the samples.

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• Bark:
- Appearance: shell surface was matt (has cracks on upper and side shell surface over 1 cm long, the skin is crispy, slightly soft to hear a sound hitting its open, clean).
- Color: nice browned crust was yellowish-gold coloration is uniform and attractive.

• Core:
- Sectional appearance: the product was sufficiently ripe, fairly uniform crumb porosity, cracks vertical, lateral or horizontal core.
- Colour: crumb feature was the assortment of bread.
- Consistency: pressing with the finger slowly enough bread crumb returns to its original state and cutting the slice of bread, knife remains clean, it is not crumbles core was wet and tacky to the touch, and elastic.
- Smell: the product was especially pronounced flavor of organic wheat flour.
- Taste: product has a satisfactory taste.
- The total number of points by scoring method (Table 5) was 23 points for the conventional bread by comparison with organic bread (30).

Quality bread falling in the good category (18.1-24 points) for conventional bread and very good for organic bread, especially in terms of smell and taste.

Table 5. Organoleptic quality assessment by method points of bread

Organoleptic characteristics	Maximum points for conventional bread	Maximum points for organic bread
Product form	4	5
Crust:		
aspect	3	3
colour	3	3
Crumb:		
sectional appearance	3	3
colour	3	3
consistency	3	3
Smell	2	5
Taste	3	5
Total score	23 points	30 points

Besides other issues as determined by organoleptic examination, little can comment on defects in, namely:
- Cracks in the shell, even if they were not large, were determined through gas outlet fermentation of the dough, giving it specifies that poor aesthetics and a low volume, so once the output of these gases fermentation were lost and some the flavour substances of bread.
- The core was wet, probably due to elastic baking at elevated temperature, a short time.

The evolution of the core and shell after 24 hours storage. Bread immediately after cooling began to aging, the first signs appeared after 10-12 hours. Bark has become matt, it was first soaked, then it became hard core was brittle. Flavor and aroma of fresh bread disappeared, replaced by a bland taste, especially stale bread from conventional wheat. The core brittle occurred due to insufficient gelatinisation of starch. Taste of the core and shell fad after 24 hours of storage arose due to insufficient fermentation and leaven dough.

To remember is that not all defects importance for the quality of bread. Very important are: ripeness, volume, porosity, taste and smell. They can decide the acceptability of bread as the final product.

CONCLUSIONS

The concept of organic farming is aimed to produce food with the taste, texture and authentic qualities and attractive corresponding to culinary preferences and skills of the modern consumer.

The production of certified organic wheat allowed to maintain a premium price compared with the conventional market.

Consumers are increasingly aware of social issues and the environment related to food production as evidenced by the significant increase in sales of food certificates, both in stores and in natural food supermarket chains.

All these values are exponent climatic conditions and culture technology applied for the two types of wheat analyzed and reveal their importance on the chemical composition or the quality of the harvest.

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TESTING OF SOME INSECTICIDES ALLOWED IN ORGANIC FARMING AGAINST *Tanymecus dilaticollis* ATTACK OF MAIZE CROPS

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Abstract

This paper present the results obtained about the effectivess of some insecticides agaist Tanymecus dilaticollis atack in maize crops at NARDI Fundulea. These products are allowed in organic farming by Anexx 2 of Commission Regulation (EC) No 889/2008 for the implementation of Council Regulation (EC) No 834/2007 on organic production and labelling of organic products with regard to organic production, labelling and control. The insectisides used in the maize seeds tratament were: Neem-TS, Laser 240-TS and Bactospeine DF-TS in dose of 2.5 g/250 grams of seeds. In vegetation it were used: Neem-TV and Laser 240-TV in dose of 150 ml/ha. The used maize hybrid was Olt variety obtained at NARDI Fundulea. Also, it performed productivity elements and seeds yields and chemical compozition on Laboratory of Yields Quality of Crop Sciences Department, Bucharest Faculty of Agriculture. The insecticides effectiveness fluctuated between 5.5 when it was applied Laser 240-TS (2.5 ml/250 g. s.) and 6.12 when it was applied Laser 240-TV (150 ml/ha). The density of crop maize ranged between 98.5 plants/plot of Laser 240-TV apllied on seeds by comparison with the same product applied in vegetation. The largest yields was of 6676 kg/ha at insecticide variant with the best effectiveness Laser 240-TS (2.5 ml/250 g. s.). The chemical composition of seeds, in average, was: 12.27% protein; 70.83% starch; 4.41% oil; 1.26% ash; fibre 1.77%. These results showed that there was no influence of insecticides on yield quality.

***Key words**: insecticides, maize, Tanymecus dilaticollis, organic agriculture, productivity.*

INTRODUCTION

Care and awareness of the world population on the environment, the dangers to health of the synthetic pesticides using and chemical fertilizers excessively and consumer preference for food produced safely and free of danger are major factors that lead to increased interest of everyone involved in alternative forms of agriculture in the world, as organic farming. Organic production systems are based on specific standards for food production and aims to produce them in a sustainable way both socially and materially. This system should be regarded as an integral part of sustainable development strategies as a viable alternative to conventional agriculture (Nastase and Toader, 2016). According to recent studies of Research Institute of Organic Agriculture FIBL and International Federation of Organic Agriculture Movements (IFOAM), the organic farming area is around 37.4 million ha, being recorded about 2 million of organic farms and the market of organic products means about $ 73.8 billion. In Romania, organic farming summarizes around 290,000 ha and of these, over 100,000 ha are cereals.

In Romania, organic farming has great opportunities for development and the legal basis for the organization of production and sale of organic products has been shaped by the following national and EU legal norms.

The Romanian legislation is up-to-date and follows EU Regulation (EC) No 834/2007 on organic production and labelling of organic products and repealing Regulation (EEC) No 2092/91 and Commission Regulation (EC) No 889/2008 laying down detailed rules for the implementation of Council Regulation (EC) No 834/2007 on organic production and labelling of organic products with regard to organic production, labelling and control. Organic producers must be certified by one of the accredited control and inspection bodies. There is a national logo for organic products, which is owned by the Ministry of Agriculture

and Rural Development. It can be used for products that comply with the Romanian Organic legislation.
On the other hand, maize is an important crop being cultivated on large areas in the world (over 160 million ha), also in Romania (2.5 million ha annually) because it is used in human nutrition, feed production and raw material for many other products (starch, alcohol, biofuel, etc.). In organic farming, the maize is cultivated over 50% from total surface. This importance derives from the fact that maize is mainly intended for animal feed. Also, according to organic farming rules, organic livestock must be fed with fodder crops obtained by organic farming rules.
But as is well known, the maize crop has many advantages, among which we can mention, great production potential, full mechanization, high ecological plasticity.
However, maize has some limited elements of production including pests that attack in the early stages of vegetation as gray maize weevil (*Tanymecus dilaticollis* Gylll.). They feed on young leaves from the leaf margin, and most damage occurs before the 4-leaf stage (BBCH 14). Drought and higher temperatures enhance feeding (Popov, 2006). *Tanymecus dilaticollis* has one generation per year and overwinters as adult in the soil (Paulian, 1972).
Therefore, where maize is cultivation in organic farming conditions, should be adhered to rules imposed by law. This means that to combat various pests in crop production to by maintaining of crop health using preventative measures, such as the choice of appropriate varieties resistant to pests and diseases, appropriate crop rotations, mechanical and physical methods and the protection of natural enemies of pests.
All synthetic insecticides are prohibited.
They may be used only products corresponding to Annex 2 of the Regulation (EC) No 889/2008.
In this context, it is very difficult to find a solution to combat this dangerous pest of maize crop.
This paper present the results obtained about the effectiveness of allowed insecticides in organic farming against *Tanymecus dilaticollis* attack of maize crops at NARDI Fundulea.

MATERIALS AND METHODS

Experience was conducted in the experimental field at Plant Protection Collective (NARDI Fundulea), in 2016.
The biologic material of maize crops was Olt variety, obtained of NARDI Fundulea. The insectisides used in the maize seeds tratament were: Neem-TS (natural neem oil) (2.5 ml/250 g. s.), Laser 240-TS (spinosad 240 g/l active substance) (2.5 ml/250 g. s.) and Bactospeine DF-TS (*Bacillus thuringiensis* subsp. *Kurstaki)* (2.5 g/250 g. s.). In vegetation it was used: Neem-TV (150 ml/ha) and Laser 240-TV (150 ml/ha) (Figures 1 and 2).

Figure 1. Insecticides used for seeds sowing, 2016) (NARDI Fundulea Experimental Field)

Figure 2. Aspects of seeds preparation and sowing (NARDI Fundulea Experimental Field, 18th of May 2016)

Experimental plots have 42 m^2 (10 m length, 4.2 m width (6 rows), 0.7 m distance between rows) by randomized blocks, in four repetitions. The maize seeds were sowed manually with a planter, at a 35 cm distance between seeds on the row. This low density has the purpose to concentrate maize leaf weevil on the emerged maize plants to evaluate effectiveness of the insecticides used for the seed treatment. To avoid migration of maize leaf weevil adults from one plot to another, the experimental plots were laterally isolated with a 2 m wide strip sown with pea, a plant repellent to this insect (Paulian et al., 1972; Voinescu and Barbulescu, 1998).

We analyzed 20 of plants from each plot and we removed the plants from marginal rows of the plot.

The attack intensity of the *T. dilaticollis* were assessed when plants arrive at four leaf stage (BBCH 14), using a scale from 1 to 9, elaborated and improved by Paulian (1972). According this scale attack intensity ranged from 1 (unattached plant) to 9 (plant complete destroyed): x Note 1: plant not attacked; x Note 2: plant with 2-3 simple bites on the leaf edge; x Note 3: plants with bites or clips on leaf edge; x Note 4: plants with leafs chafed in proportion of 25 %; x Note 5: plants with leafs chafed in proportion of 50 %; x Note 6: plants with leafs chafed in proportion of 75 %; x Note 7: plants with leafs chafed almost at the level of the stem; x Note 8: plants with leafs completely chafed and beginning of the stem destroyed; x Note 9: plants destroyed, with stem chafed close to soil level (Toader et al., 2016).

Figure 3. *Tanymecus* attack on maize plant (NARDI Fundulea Experimental Field, 13rd of May, 2016)

After 30 days from plant emergence, the saved plants percentage was evaluated by counting all the emerged plants from a plot and comparing them with the sowing seeds number/plot.

On the other hand, chemical analyzes were performed to see if there have been changes in the chemical composition depending on the insecticide applied.

RESULTS AND DISCUSSIONS

Data from figures 4 and 5, demonstrate that, climatic conditions from spring period of the year 2016, at NARDI Fundulea, were medium favourable for maize leaf weevil attack. Monthly and annual average temperatures for the year 2016 compared to the annual average is presented in Figure 4.

Examination of the data, it can be seen that the average temperature for April was 14.0°C, with 2.9°C higher than the multiannual temperature (11.1°C).

For May, they were recorded average monthly temperature values by 0.8°C higher than the multiannual average (16.1).

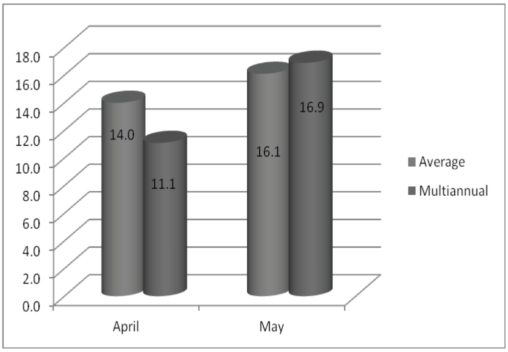

Figure 4. Evolution of the air temperatures in spring, at NARDI Fundulea, in 2016

2016 was characterized in April and May with a surplus of rainfalls. The largest amount fell in April, 73.7 mm, 14.7 mm more than the multiannual average. In May, the difference was only 8.9 mm by comparison with multiannual average (Figure 5).

These climatic conditions, from second decade of May, when maize plants were in first vegetations stages (BBCH 10-14) were mediu favourable for pest attack.

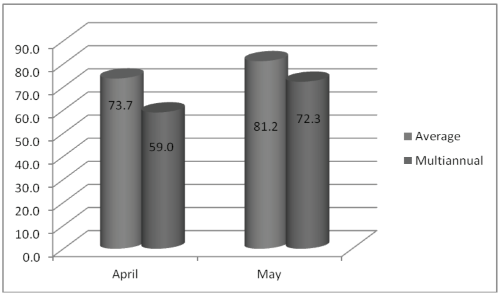

Figure 5. Evolution of the rainfalls in spring, at NARDI Fundulea, in 2016

Figure 6 presents the evaluation of *Tanymecus dilaticollis* attack intensity of maize plants, on a scale from 1 (not attacked plant) to 9 (complete destroyed plants). Using the scale in phase of four leafs, it was found plants with Notes 5 and 6, with leafs chafed were affected in proportion of 50-75% (Figure 7) According the results, the lowest attack was recorded in the treated seed with Laser 240-T5 (2.5. ml/250 g.s.) of 5.5 (Figure 8). Thus, we must emphasize the seed treatment compared with the same product applied in vegetation. It also notes that the other two treatments applied to seeds, efficacy was better than for treatments performed in vegetation. The higher attack intensity was recorded at Control variant, with 6.14.

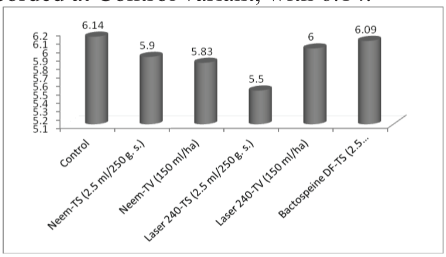

Figure 6. Attack intensity analysis
(NARDI Fundulea Experimental Field, 13rd of May)

Figure 7. x Note 5: plants with leafs chafed were affected in proportion of 50-75%
(NARDI Fundulea Experimental Field, 13rd of May)

Figure 8. Variant of seed treatment with Laser 240 (2.5 ml/250 g.s.) (NARDI Fundulea Experimental Field, 23rd of June 2016)

Regarding plant density/plots the best result was recorded in the treated variant with Laser 240-T5 (2.5. ml/250 g.s.), where it recorded 132 plant/plot. This result meaning over 77.65% of saved plants. Also, the good result obtained in case of seeds treatment with Bactospeine DF-TS (2.5 g/250 g.s.), respectively, 123.5 plant/plot and 72.65% saved plants (Figure 9).

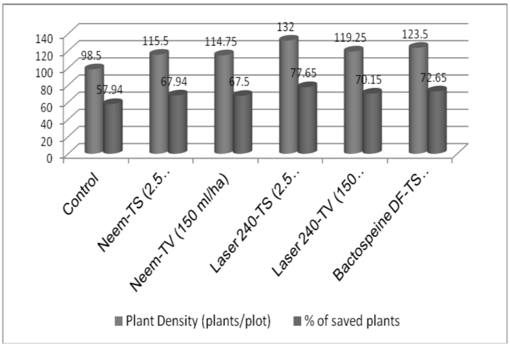

Figure 9. Density of plants at 30th of May 2016
(NARDI Fundulea Experimental Field)

These results demonstrated the effectiveness of treatments to maize seed with specific products comparative with treatments make in vegetation.

In case of the results regarding productivity elements and seeds yields, can highlight the variant of the insecticides were applied to seeds, respectively, Laser 240-T5 and Bactospeine DF-TS (2.5 ml/250 g.s.).

In these conditions, were obtained, 86.55% of grains weight/cob and TGW was 362.3 g for Laser 240-T5 and 85.58% of grains weight/cob and TGW was 336.6 g for Bactospine DF-TS (Figures 10 and 11).

Figure 10. Cobs at harvesting

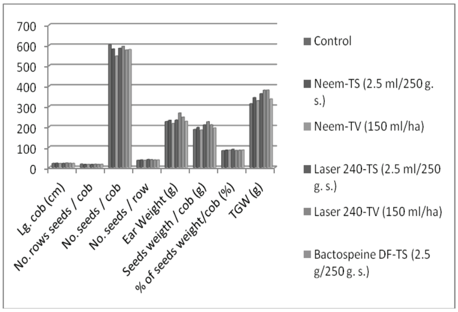

Figure 11. Productivity elements of maize at harvesting (NARDI Fundulea Experimental Field, 2016)

The main factor of yields is plants density (cob) at harvesting. Thus, the best seeds yields were recorded at two variants of insecticides applied on seeds, Laser 240-T5 (6676 kg/ha) and Bactospeine DF-TS (6447 kg/ha). The lowest values were found at Control variant, with 4899 kg/ha. Also, the low yields recorded at treatment in vegetation by comparison with the same produce in vegetation (Figure 12).

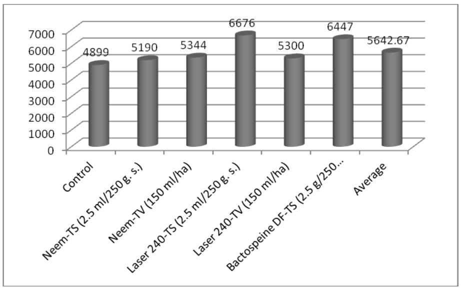

Figure 12. Yields of maize seeds (NARDI Fundulea Experimental Field)

In climatic conditions of 2016, the accumulation of reserve substances were favoured to accumulated more starch, over 70% in all variants. Content in other elements were not different from what is known in the literature about chemical composition of Olt maize variety. The amount of proteins averaged around 12%. The other compounds were, in average: starch - 70.83%; oil - 4.39%; ash - 1.31% and fibre 5.24%. According of these results can emphasis that the insecticides no influence on chemical composition of seeds at harvesting (Figure 13).

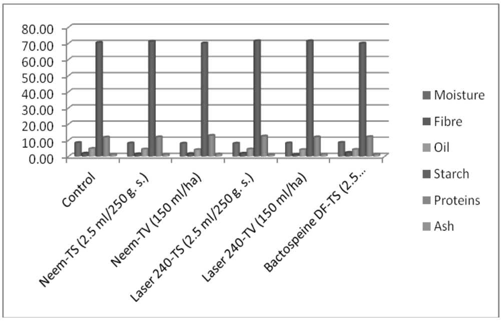

Figure 13. Chemical composition of maize seeds (NARDI Fundulea Experimental Field, 2016)

CONCLUSIONS

Regarding attack intensity, it was found that plants has Notes 5 and 6, when plants with leafs chafed were affected in proportion of 50-75%.

The best result was recorded in the treated seed with Laser 240-T5 (2.5. ml/250 g.s.) with an intensity attack of 5.5.

The higher attack intensity was recorded at Control variant, with 6.14.

Regarding plant density/plots the best result was recorded for the treated variant with Laser 240-T5 (2.5. ml/250 g.s.), with 132 plant/plot (77.65% of saved plants) and Bactospeine DF-TS (2.5 g/250 g.s.), with 123.5 plant/plot (72% saved plants).

In case of the productivity elements results, it can highlight the variant of the insecticides were applied to seeds, respectively, Laser 240-T5 and Bactospeine DF-TS (2.5 ml/250 g.s.) with TGW between 362.3 g and 336.6 g.

The best seeds yields has been obtained at same variants applied on seeds, Laser 240-T5 (6676 kg/ha) and Bactospeine DF-TS (6447 kg/ha).

The lowest values of yields seeds were found at Control variant, with 4899 kg/ha.

The low yields recorded at treatment in vegetation by comparison with the same product in vegetation.

In climatic conditions of 2016, the accumulation of reserve substances were favoured to accumulated more starch, over 70% in all variants.

Content in other elements were not different from what is known in the literature about chemical composition of Olt maize variety: proteins - around 12%, starch - 70.83%; oil - 4.39%; ash - 1.31% and fibre 5.24%.

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Original paper

The quality of maize grains in organic farming system

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Abstract

The paper present the quality of organic maize grains came from some Romanian organic farms, in 2016-2018 period. The quality analysis were performed in authorized laboratories to determine: Dry Matter and Moisture (DM), Carbohydrates (C), Crude Proteins (CP), Crude Fat (CF), Ash, Crude Fibers (CFB). Also, it has been calculated the Nutritional Unit (NU) and Gross Energy (GE) in kcal or MJ, Digestible Protein (DP), Non-Nitrogenus Extract Substances (NES) and Organic Substances (OS). The analysis included detection of harmful components on health of final consumer: pesticides residues, mycotoxins, nitrates and nitrites. The results are: 86.14% – DM; 13.86% – Moisture; 68.36% – C; 10.18% CP; 4.26% – CF; 1.36% – Ash; 2.39% – CFB; 1.25 – UN; 378.77 kcal or 1.58 MJ – GE, 65.68% – DP, 67.15% – NES and 83.98% – OS. Pesticides residues not find in any sample. Mycotoxins were found in only two farms, in 2016: Aflatoxin B1 (1.7-2 μg kg^{-1}) and Aflatoxin B1+B2+G1+G2 (2-3.7 μg kg^{-1}), Fumosin B1+B2 (786-992 μg kg^{-1}), Deoxynivalenol (DON) (0.7 -26 μg kg^{-1}); Zearlenon (1.2 μg kg^{-1}). In 2017 and 2018 years, these substances were not detected. For nitrates and nitrites, the results showed only nitrates in 2016, in tree farms (5.1-6 mg kg^{-1}). The micotoxin and nitrates values were below the limit allowed by the legislation in force. Following these results it can be appreciated that organic maize has good quality similar with EU standards and farmers respect the principles of organic agriculture.

Keywords Organic maize, quality, pesticides residues, mycotoxins, nitrates and nitrites.

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Introduction

Maize is one of the most important crops, with 193.7 million ha area harvested in the world, in 2018 year (OECD/FAO [39]). Maize grains are widely used in human nutrition, industry and animal feed (MATEI [32]).

In 2016-2018, approximately 1.7 billion tons of agricultural commodities were used as livestock feed, mainly maize and other cereals, and protein meals derived from oilseeds (OECD/FAO [39]). Around 13% of the total feed intake consisted of cereals, a value which corresponded to almost one-third of global cereal production. In this context, the maize grain is a major feed grain and a standard component of livestock diets where it is used as a source of energy (OECD/FAO [39]).

Maize is the main source of concentrates used in the feeding of animals as pigs, cattle, sheep representing up to 80% of the total concentrates, in birds up to 70% of the concentrates, and in the other categories up to 30% (youth from all species and working animals) (NICOLAE, SONEA [37]). Also, maize is one of the most versatile emerging crops having wider adaptability under varied agro-climatic conditions (KLING [30]).

One the other hand, organic production is an overall system of farm management and food production that contributes to the preservation of natural resources and applies high standards of animal welfare (WILLER & al [46]). The EU surface reached 12.6 million ha in 2017, which represents 18% of the global organic area and 7% of total EU agricultural land. Further organic area is devoted to green fodder (17%), cereals (16%) and permanent crops (11%). Regarding organic livestock, in EU, 4.85 million bovines, 5.9 million sheep and goats, almost 1.4 million pigs, and 56.5 million poultry were registered (WILLER & al [46]).

For Romania, in 2018, organic farming means about 327 thousand ha and 9008 farmers (MARD [33]). Among the crops, cereals with about 115 thousand predominate, followed by industrial crops with over 80 thousand ha. In Romania, according to the data provided by Eurostat, in 2016, there were registered over 56 thousand ha of organic maize, respectively 48% from total organic area with cereals (EUROSTAT [7]).

Organic animals must ensure their nutritional needs in good quality organic feed and in a form that allows them to manifest their natural behavior (IFOAM [21]).

The aim of this research was to study the quality and nutritional value of maize grains produced in organic farming and which could be used for human consumption, but especially, in organic animal feed. This quality analysis included both the determination of the chemical composition of maize grains and whether there are possible contaminations with certain substances such as pesticide residues, mycotoxins, nitrates and nitrites that may endanger the health of animals and consumers. Among the arguments for the importance of this research is the fact that animals fed with certified organic feed benefit from a balanced diet, without chemicals, without additives, preservatives or synthetic dyes, without genetically modified organisms and without pesticide residues. In this way, the animals produce better quality of milk or/and meat, eggs, in which the animal welfare standards are met. In addition, the positive effects without environmental pollution are particularly important for both humans and animals. Thus, organic farms, through clean technologies for plants and animals, without contaminating water sources, habitats, soil, can create long-term sustainability. Also, the quality of organic maize grains may also depend on the conditions of cultivation, harvesting and storage. In conditions of high humidity, with many foreign bodies, mold fungi can produce mycotoxins, with risk to health of human and animals. Nitrate pollution is a current problem that affects the quality of agricultural products and thus animal feed, which can complete the overall quality of maize grains produced in organic system. Accordingly, investigations should be made into the sources of formation of these substances and identifying the administrative measures to be taken to prevent, as far as possible, their occurrence.

Materials and Methods

The design of the experiment

The research was conducted during 2016-2018 period. The analyzed samples came from four organic certified farms in Romania, from different agricultural areas: Vaslui (Vetrisoaia village, Moldova Plateau), Teleorman (Merenii de jos village, Glavacioc Valley), Arad (Pecica village, Mures Valley) and Bihor (Santimreu village, Barcau Valley). These farms were chosen because they manage large areas cultivated with maize (over 100 ha) in organic system, apply innovative cultivation technologies regarding fertiliser system and control of pest and diseases and selling the maize production grains on the Romanian market. Also, the farms have, for the most part, the same characteristics of the climate: temperate-continental climate, with maximum temperature value in July-August, in last years of 34.7^{o}C and minimum value in January of -18.5^{o}C and very uneven rainfall regime between 450 and 550 mm, dry periods alternating with the rainy ones, with a increasing frequency of torrential rains.

Regarding the suitability of soils for maize crop, the farms have about the same types of soil, cambic chernozem, except for the farm from Vaslui county, where the soil type was the podzolite soil (Moldova Plateau).

In terms of maize cultivation technology, it was the same in all four farms by an agreement with farmers. It was a classic technology, which included the main technological links. Thus, after harvesting the previous plant, which for each year was wheat, a plowing was carried out in August, followed by soil disking in september. In March, there was a disc harrow and then preparing the bed germinating. Prior to the preparation of the germination bed, some products were applied that stimulate the mechanisms of inducing the plants resistance against the attack of pathogens, help to mineralize the organic substances in the soil and to improve the root system of plants. These products are: Biofos soft phosphate rock (contains phosphorus, magnesium, calcium, iron) – 250 kg ha^{-1}; Fielder + Biofertilizer (contains *Trichoderma asperellum*) – 250-750 g ha^{-1}; P soil (containing *Bacillus megaterium*) – 2 l ha^{-1}. The maize seeds were treated with Raykat Enraizador Start product – 1 l t^{-1} of seed (contains amino acids, polysaccharides, total nitrogen and trace elements), for strong stimulation of root development and increase of nutrients absorption, especially in the germination phase. These products correspond to Annex II of the Commission Regulation (EC) No 889/2008 [14] laying down detailed rules for the implementation of Council Regulation (EC) No 834/2007 [12] on organic production. Weed control was performed by two mechanical weeding in May and one mechanical weeding in early of June. The hybrid used for sowing was DK5182, FAO group 400-450, with good tolerance to drought, heat and break and high capacity of adaptability in different growing conditions.

The density was 72,000 germinating grains ha^{-1}, the distance between rows was 70 cm, at sowing depth of 4-5 cm. The sowing was carried out in the optimal period, April 20-25, for each year of experimentation and was harvested by combine, between September 15-20. The yields productions varied between 6,300-6,800 kg ha^{-1}.

Chemical analysis and nutrition value

The chemical analysis was validated in accordance with the Quality Assurance System, ISO 17025/2005, and SANTE/11813/2017 Standards (ISO 17025 [27]; SANTE 11813 [42]). Sampling for chemical analysis was performed in accordance with the requirements of ISO 17065/2013 – Conformity Assessment, respectively, Requirements for bodies certifying products, processes and services [26] and with the requirements of Regulations (EC) 834/2007 [12] and Regulations (EC) 889/2008 [14] specifics to organic agriculture, in accredited laboratories from: Czech Republic for the various biochemical compounds (dry matter and water (moisture), carbohydrates, crude protein, crude fat, ash, crude fibers, gross energy in kcal and MJ); Germany for pesticides, mycotoxins and nitrate and nitrite residues. Samples were identified clearly and indelibly, in a way to ensure the traceability.

The results are presented by comparison with reference values of INRA (L'Institut National de Recherche pour l'Agriculture, France) standards Feeds (the most used International Standard) [23] and Order No. 369 of June 27/2019 of Romanian Ministry of Agriculture and Rural Development (MARD [34]).

Determination of Dry Matter (DM%) by Gravimetric method was in according with ISO 712/1998 [24] standards. Grains Moisture is the amount of water, expressed as a percentage that is removed from a grains sample by drying in a drying stove, at a certain temperature to the constant weight of the sample (ISO 712 [24]).

Method used for determination of Carbohydrates (C%) was High Performance Liquid Chromatography (HLPC), with refractive index detection (RID). Operational parameters of chromatographic system were: column: modified Alltima Amino 100Å, 5 μm, 250 x 4.6 mm; mobile phase flow: 1.3 ml/min; mobile phase: acetonitrile/ water (75/25; v/v); column temperature: 30ºC; injection volume: 20 μl; separation time: 60 min (JOHANSEN & al [29]).

According to ISO 16634-2/2009 the crude protein (CP%), calculated as N (nitrogen) x 6.25, where N is the nitrogen obtained by mineralisation through the Dumas methods (ISO 16634 [25]).

The Crude Fat (CF%) content was determined by gravimetric methods according to AOAC 945.38F; 920.39C Gravimetric (ether extraction) (AOAC [1]).

The Ash content (%) of foods was determined by gravimetric methods, according to AOAC 923.03. The maize grains were burnt at 550ºC to constant weight and the ash was determined by weighing (AOAC [1]).

The enzymatically method was used for determination of Crude Fibres (CFB%) content. It used the commercial set Megazym according to AOAC Method 985.29 and 991.43 (AOAC [1]).

Nutritional Units (NU) and Digestible Protein (DP) was made according to Order no. 369 of June 27/2019 of Romanian Ministry of Agriculture and Rural Development for approving the nutritional composition of the fodder used to feed cows, buffaloes, sheep and goats, as well as their nutritional requirements. Maize has the following nutritional composition: 866 DM g kg^{-1}, 1.25 Nutritional Units (NU) and 66 g kg^{-1} Digestible Protein (DP%) (MARD [34]). The results obtained in these experiments were reported at these values.

Indirectly, the Gross Energy (GE) (kcal or MJ) can be determined by knowing the crude content of nutrients and the caloric coefficients of them (FAO/WHO [18]). The caloric coefficients were following: 4.1 kcal g^{-1} for Carbohydrates (C), 5.7 kcal g^{-1} for Crude Protein (CP) and 9.5 kcal g^{-1} for Crude Fat (CF). The Gross Energy was calculated according to formula: GE=4.1*C%+ 5.7*CP%+9.5*CF%, where, GE – Gross Energy (kcal kg^{-1}); C – Carbohydrates (%), CP – Crude Protein (%), CF – Crude Fat (%) and 1 kilocalorie = 0.004184 Megajoules (FAO/WHO [18]).

Organic substances (OS) are synthesized by plants following the process of photosynthesis and represent the main component of feed. The organic substances (proteins, lipids, carbohydrates and non-nitrogenous extractive substances) in the fodder during their calcinations at 550°C are destroyed, as a result they can be calculated as the difference between Dry Matter (DM) (%) and Ash (%): OS% = DM% – Ash% (AVARVAREI [3]).

Non-nitrogenous extractive substances (NES) (%) are heterogeneous substances represented mainly by starch, soluble sugars, pectin, tannins, etc. This group could be determined by formula: NES% = OS% - (CB% + CF% + CFB%), where OS – Organic Substance (%), CP – Crude Protein (%), CF – Crud Fat (%); CFB – Crude Fiber (%) (AVARVAREI [3]).

The tested pesticides were over 250 of types. In our table we will present only 5 groups: glyphosat, glufonisat, acid aminomethylphosfonic, clormequat and mepiquat.

The using method was according the EU Standard-SANTE/11945/2015 (SANTE 11945 [40]). Determination of residues of pesticides was made by GC-MS and/or LC-MS/MS after extraction/partition with acetonitrile and purification by the QuEChERS (Quick, Easy, Cheap, Efficient, Rugged and Safe) dispersive method. QuEChERS extraction was performed according to the official AOAC method 2007.01 using Waters DisQuE™ Dispersive Solid Phase Extraction (d-SPE) product (AOAC [2]).

The method of mycothoxins analysis was the High Performance Liquid Chromatographic (HPLC) with UV (Ultraviolet) detection (Photodiode Array (PDA) detector), with purification on the immunoaffinity column (FCC [20]). The analysed mycotoxins were: B1 Aflatoxin, B1+B2+G1+G2 Aflatoxin complex, B2 Fumonisin, Deoxynivelanon (DON, vomitoxin) and Zearalenone.

For determination of nitrates and nitrites contents, the laboratory has developed and accredited its own method. High Performance Liquid Chromatography (HPLC) with UV (Ultraviolet) detector was used. The UV-Vis (Ultraviolet Visible) photodiode detector detected nitrates and nitrites ions at an absorption of 212 nm (FCC [20]).

All chemical analyses were performed in three replicates and the results were statistically analysed by the Fisher's least significant differences (LSD) test.

Results and Discussion

Chemical composition and nutrion value

The moisture content of the maize grains is a very important criterion for evaluating its quality from several points of view. Maize grains, according to the reference value (INRA [24]), must be a maximum of 14%. The storage of maize depends largely on its moisture. If the humidity exceeds 14%, a series of chemical processes related to the acceleration of respiration with heat and water production appear, followed by complex fermentation processes that lead to the alteration of the grain mass (TOADER & al [44]). The high moisture content during storage encourages the appearance of certain yeasts, molds and harmful bacteria.

Our research showed that for all samples, the average moisture values was 13.86%. It can be noticed, the samples that came from Vaslui county, that for both 2017, exceed by 1.6%, the reference value. The dry matter (DM) resulted from the difference from 100 minus moisture. These ranged in 2016-2018 period from 85.2% for farm from Vaslui to 87.8% of farm from Bihor county. The best value of moisture (12.2%) was registered in 2017, by the farm from Bihor, which exceeded the average with a distinctly significant value (Table 2).

Maize grains are generally known to be high in carbohydrate. Marta et al, in 2017, founded the content of 69.6-75.68%, for different hybrids (MARTA et al, 2017). In these research, carbohydrates had an average value of 68.38% for all four locations which expresses a value very close to reference value (69%). The value of 70.4 from 2017, obtained by the farm from Bihor county, stands out. This exceeded the experience average by 2%, which meant a very distinctly significant value compared to the average. Compared to the reference value, the value obtained for organic corn was slightly lower, by about 0.5%.

The minimum protein content of maize grains according to reference value is 8.9%. Toader at all found the protein content between 10.13 and 13.27% on organic maize grains in Fundulea Experimental Field (TOADER at al, 2017). In 2011, Imbrea and al at the Research of Experimental Field in Timisoara, foud a protein content of maize around 8.2% (average value) (Imbrea et al, 2011). By comparisons with INRA standards our results are over this. In 2016, protein content variated between 9.3% in Vaslui are and 11% in Bihor county. In all the years of experimentation, the contents of the maize from Bihor County significantly exceeded the average per experiment, but also the reference value. It can also be seen that in all cases, the reference value has been exceeded. As a result, it can be highlighted that the maize obtained in organic farming conditions has a good quality in terms of protein content, being comparable to the values known for toothed maize hybrids.

In research of Suriady at all, crude fat content ranged from 2.48% up to 4.80% (SURIADY at al, 2017). The INRA standards recommends a content of 4.1%. In our research, the values of CF were slightly above the standard value, respectively between 4.0% and 4.7%. The value of 4.7, the best value, exceeded the average very distinctly, and also exceeded the reference value. This value was obtained by the farm in Teleorman, in 2018. The farm in Bihor County also obtained a good value, 4.5%, which significantly exceeded the average crude fat (CF) content.

Crude Fibre (CFB) component is one of the most important nutritional and technological factors of the maize grains. The content is directly related to digestibility, so the more feed cellulose contains, the lower the digestibility of the organic matter and vice versa. As is known, the fibre content of maize grains is between 1.4% - 3%, depending on the hybrid and growing conditions. The crude fibre of maize based on study of BeMiller at all was 1.11-4.15% (BEMILLER & al [4]) and INRA standards recommended a content of 2.6%. During this experiment the CFB oscilated on 1.8 and 2.8%, this means an average of 2.3%.

Maize grains are the basic concentrated feed for all animal species and the nutritional value according Romanian legislation is 1.25 Nutritional Units per 1 kg of grain (MARD [34]). In this research, the Nutritional Unit (NU) and Gross Energy (GE) of organic maize were in average: 1.25 NU kg^{-1} of grains, respectively 378.88 kcal or 1.58 MJ. The value from 2018 can be highlighted, when it exceeded the average by over 10%. Among the locations, the farm from Bihor County led to obtaining values higher (390.3 kcal or 1.63 MJ), in 2016, than the reference value

(372.6 kcal or 1.56 MJ), both for 2017 and 2018 (around 381 kcal or 1.59 MJ).

In case of these experiments, the digestible protein (DP) was approximately equal to reference value, which means that organic maize grains can provide rations corresponding to the needs of animal growth and development depending on the category for which the feed is produced. The value from Bihor County is highlighted again, with 66.9% for 2017, when it significantly exceeded the average per experiment.

In the case of the other two determinations, both NES and OS values has been below the reference value. However, the organic maize samples from Telorman and Bihor Counties were noticed, with values that exceeded the average by 1-2%. The results of 2016-2018 period showed the following values: NES%: 64.4-69.4% and OS%: 82.5-82.7%. These values demonstrate that in the optimal rations of the different categories of animals must be supplemented with other types of feed, which cover the necessary requirements of the reference value.

All results regarding the chemical composition and nutritional value and statistical processing are included in Table 1 and Table 2. The level of significance (DSL5%, 1%, 0.1%) from Table 1 has based the values of Table 2.

Table 1. Results of chemical composition and nutritional value for organic maize in 2016-2018 period

Index quality	Farm 1 (Vaslui county)	Farm 2 (Arad county)	Farm 3 (Teleorman county)	Farm 4 (Bihor county)	Average	References values of INRA and Romanian Standards
2016						
Dry matter (DM) (%)	84.7^{**}	86.7	87.1^{o}	86.6	86.28	86.6
Moisture (%)	15.3^{oo}	13.3	12.9^{*}	13.4	13.7	13.7
Carbohydrats (C) (%)	68.1	68.1	68.8	70.4***	68.9	69
Crude protein (CP) (%)	9.3^{oo}	10	10.1	11*	10.1	8.9
Crude fat (CF) (%)	4.2	4.5*	4.4	4.1	4.3	4.1
Crude fibre (CFB) (%)	2.6	2.8*	2.2	$2,0^{o}$	2.4	2.6
Ash (%)	1.7***	1.3	1.6**	1.4	1.5	1.2
Nutritional Unit (UN) (g/kg)	1.23	1.26*	1.26*	1.25	1.25	1.25
Gross Energy (kcal)	372.1^{o}	379.0	381.5	390.3***	380.7	372.6
Gross Energy (MJ)	1.56^{o}	1.58	1.59	1.63***	1.59	1.56
Digestible Protein (DP) (g/kg)	64.55^{oo}	66.38*	66.38*	66.00	65.83	66
Non-Nitrogenous Extractive Substances (NES) (%)	66.9	66.6	68.2	67.5	67.3	74.4
Organic Substances (OS) (%)	83.0^{o}	83.9	84.9*	84.6	84.10	87.1
2017						
Dry matter (DM) (%)	85.7	86.8	85.4	87.8^{oo}	86.4	86.6
Moisture (%)	14.3	13.2	14.6	12.2^{**}	13.6	13.7
Carbohydrats (C) (%)	67.8	68.2	68.0	68.3	68.1	69
Crude protein (CP) (%)	9.1^{o}	10.8*	9.8	10.9*	10.2	8.9
Crude fat (CF) (%)	4.1	4.0^{o}	4.2	4.1	4.1	4.1
Crude fibre (CFB) (%)	1.8	2.1	2.2	2.1	2.1	2.6
Ash (%)	1.3	1.3	1.2o	1.4	1.3	1.2
Nutritional Unit (UN) (g/kg)	1.24	1.26*	1.24	1.27**	1.25	1.25
Gross Energy (kcal)	368.8^{oo}	379.2	374.6	381.1	375.9	372.6
Gross Energy (MJ)	1.54^{oo}	1.58	1.57	1.59	1.6	1.56
Digestible Protein (DP) %)	65.31	66.15	65.09	66.91**	65.9	66
Non-Nitrogenous Extractive Substances (NES) (%)	69.4**	67.8	67.0	68.6*	68.2	74.4
Organic Substances (OS) (%)	84.4	84.7	83.2	85.7***	84.5	87.1
2018						
Dry matter (DM) (%)	85.20^{*}	86.70	85.70	85.30^{*}	85.7	86.6
Moisture (%)	14.80^{o}	13.30	14.30	14.70^{o}	14.28	13.7
Carbohydrats (C) (%)	68.40	68.30	68.40	67.50^{o}	68.2	69
Crude protein (CP) (%)	9.80	10.80*	9.80	10.80*	10.3	8.9
Crude fat (CF) (%)	4.00	4.30	4.70***	4.50*	4.4	4.1
Crude fibre (CFB) (%)	2.60	2.80*	2.70	2.80*	2.7	2.6
Ash (%)	1.20^{o}	1.20^{o}	1.50	1.20^{o}	1.3	1.2
Nutritional Unit (UN) (g/kg)	1.23	1.26*	1.24	1.24	1.24	1.25
Gross Energy (kcal)	374.30	382.44	380.95	381.06	379.7	372.6
Gross Energy (MJ)	1.56	1.60	1.59	1.59	1.59	1.56
Digestible Protein (DP) %)	64.93	66.08	65.31	65.01^{o}	65.3	66
Non-Nitrogenous Extractive Substances (NES) (%)	67.60	66.00	65.80^{o}	64.40^{ooo}	66.0	74.4
Organic Substances (OS) (%)	84.00	83.90	83.00^{o}	82.50^{oo}	83.4	87.1

Table 2. Statistical results of chemical composition and nutritional value for organic maize in 2016-2018 period

Statistical Index	DM (%)	Moisture (%)	C (%)	CP (%)	CF (%)	CFB (%)	Ash (%)	UN (g/kg)	GE (kcal)	GE (MJ)	DP (%)	NEF (%)	OS (%)
Average	86.14	13.86	68.36	10.18	4.26	2.39	1.36	1.25	378.77	1.58	65.68	67.15	83.98
Sample variance	0.87	0.87	0.52	0.43	0.05	0.13	0.03	0.00	31.85	0.00	0.54	1.83	0.874
Standard deviation	0.93	0.93	0.72	0.66	0.22	0.36	0.17	0.01	5.64	0.02	0.73	1.35	0.935
Sd	0.38	0.38	0.29	0.27	0.09	0.15	0.07	0.01	2.30	0.01	0.30	0.55	0.382
CV%	1.08	6.72	1.05	6.46	5.25	15.07	12.34	1.08	1.49	1.49	1.11	2.01	1.113
DSL 5%	0.84	0.84	0.65	0.59	0.20	0.32	0.15	0.01	5.07	0.02	0.66	1.21	0.840
DSL 1%	1.18	1.18	0.91	0.83	0.28	0.46	0.21	0.02	7.17	0.03	0.93	1.72	1.187
DSL 0.1%	1.69	1.69	1.31	1.19	0.41	0.65	0.30	0.02	10.23	0.04	1.33	2.45	1.695

Results of pesticides residues

Establishing that a plant protection product poses a low risk to human and animal health is of paramount importance in order to successfully register and market the product on a global basis (MORGERA & al [35]).

Restrictions on the use of chemicals or other substances are a key requirement for organic production methods (ZANG and BERKELEY [45]). Residue testing can provide evidence, when there is uncertainty, about the use of unauthorized substances, such as banned pesticides, genetically modified organisms, food additives or medicinal substances. Residue testing is one of the tools available to control bodies to ensure that organic production rules, as specified in the various regulations, are in line with the principles of organic farming (IFOAM [21]).

The applicable regulations do not provide for a minimum number of laboratory tests, but only the obligation to perform these tests when there are suspicions that unauthorized products have been used in organic production or the production is marketed. Traceability is mentioned as one of the important elements in ensuring consumer.

It makes it possible to verify whether all operators involved in all stages of production, preparation and distribution apply the EU requirements for organic production (REG. (EC) 834 [12]).

When non-compliance is identified, traceability makes it possible to identify the source and isolate the problem, thus preventing the products in question from reaching consumers. At EU level, no criteria are set for pesticides to be included in these checks or the sensitivity of the methods (EU COMMISSION [13]).

Maximum pesticide residue limits (MRLs) that specify the maximum concentration of a pesticide in conventional products have been regulated by many countries in order to promote good agricultural practice guidelines (GAPs) (EU COMMISSION [13]).

Pesticide residue testing is an aspect of official controls on organic production (SANTE 8986/2006 [41]). The control authorities or control bodies must take and analyse samples for detecting products not authorised for organic production, for checking production techniques not allowed under organic production rules or for detecting possible contamination by products not authorised for organic production (SANTE 8986/2006 [41]). The number of samples to be taken and analysed by the control authority or designated control body every year shall correspond to at least 5% of the number of operators under its control (REGULATION (EC) NO 889 [14]).

In the case of our research, as shown in the following table, was not detected any pesticide residue in any sample of organic maize. These results confirm that farmers comply with the rules and principles of organic farming and only products that meet the standards approved by the legislation in force are used in maize cultivation technology.

Table 3. Results of pesticides residues for organic maize grains (mg kg^{-1}), in 2016-2018 period

Pesticides residues	Farm number 1 (Vaslui county)	Farm number 2 (Arad county)	Farm number 3 (Teleorman county)	Farm number 4 (Bihor county)	Maximum residue levels for conventional products (EU Pesticides Databases)
Glyphosate	Not detected	Not detected	Not detected	Not detected	1.0
Glufosinate-ammonium (sum of glufosinate, its salts, 1-methyl-4-phenylpyridinium (MPP) and NAG (N-Acetyl-Glufosinate) expressed as glufosinate equivalents)	Not detected	Not detected	Not detected	Not detected	0.1
Acid Aminomethylphosphonic	Not detected	Not detected	Not detected	Not detected	0.5
Chlormequat (sum of chlormequat and its salts, expressed as chlormequat-chloride)	Not detected	Not detected	Not detected	Not detected	0.01
Mepiquat (sum of mepiquat and its salts, expressed as mepiquat chloride)	Not detected	Not detected	Not detected	Not detected	0.02

Results of mycotoxins

Our research has followed the contamination of mycotoxins, over a period of three years, in organic maize samples collected at the harvest of some location with favorable conditions for the maize growing.

According to the scientific literature, the main pathogens producing mycotoxins of maize grains are: *Aspergillus* spp. and *Fusarium* spp. (DEI [6]). The mycotoxins produced by these fungi are: B_1 Aflatoxin produces by *Aspergillus flavus* and *A. parasiticus* produces complex of B_1, B_2 and G_1 and G_2 Aflatoxins; Fumonisins, Deoxynivalenol (DON) (Vomitoxin) and Zearalenone produces by several species of *Fusarium* spp., as *Fusarium graminearum*, *F. culmorum* and *F. verticillioides*, *F. proliferatum*. The maximum risk level of B_1 Aflatoxin in animal feeds is 5-50 µg kg^{-1}, set by the EU standards (EU DIRECTIVES, [15]). The maximum risk level of Fumonisin in maize grain or flour is 2000-4000 µg kg^{-1} (FAO/WHO [16]). Droughts, supply of nutrients, monoculture or insect attack are favorable causes for the development of these very dangerous pathogens that can cause serious harm to consumers (FAO/WHO [16]). High temperatures and high humidity of maize grains after harvesting could favor the development of the fungus (ROMAN & al [38]).

The results present in Table 4 showed that no compounds were detected in the organic maize samples of Teleorman and Arad counties, in any year of research. For 2016 year, for Vaslui County farm, it was detected: B_1 Aflatoxin (2 µg g^{-1}) and B_1+B_2+G_1+G_2 Aflatoxin (2 µg g^{-1}), B_1+B_2 Fumonisin (992 µg g^{-1}), Deoxynivalenol (DON) (0.7 µg g^{-1}). Also, in 2016 year, the farm from Bihor county was detected all five types of mycotoxins: B_1 Aflatoxin – 1.7 µg g^{-1}, B_1+B_2+G_1+G_2 Aflatoxin - 3.7 µg g^{-1}, B_1+B_2 Fumonisin – 786 µg g^{-1}, Deoxynivalenol (DON) – 26 µg g^{-1}, and Zearalenone – 1.2 µg g^{-1}. The content of these mycotoxins no exceeded of the EU limits, and values have been very low. In 2017 and 2018, there are some discussions with farmers by causes which led to these results and possible measures to prevent and reduce risk of the fungi appearance. Par example, more care for: crop rotation, soil tillage and introduction into the soil of the vegetal residues with risk of contamination from the previous crops; treatment of seeds; balanced fertilisation; insect attack control; appropriate harvesting; controlling the mold infestation by cultivation technologies of maize, before harvesting, storage and processing of grains.

Table 4. Results of mycotoxins for organic maize grains (µg/kg), in 2016-2018 period

The mycotoxin	Farm number 1 (Vaslui county)	Farm number 2 (Arad county)	Farm number 3 (Teleorman county)	Farm number 4 (Bihor county)	Maximum level of mycotoxins (Commission Regulation (EC) No 1058/20 of 19 December 2006)
2016					
Aflatoxin B_1	2	Not detected	Not detected	1.7	2.0*
Aflatoxin B1+B2+G1+G2	2	Not detected	Not detected	3.4	4.0*
Fumonisin B1+B2	992	Not detected	Not detected	786	4000**
Deoxynivalenol (DON)	0.7	Not detected	Not detected	26	1750**
Zearlenon	Not detected	Not detected	Not detected	1.2	350**
2017					
Aflatoxin B_1	Not detected	Not detected	Not detected	Not detected	2.0*
Aflatoxin B1+B2+G1+G2	Not detected	Not detected	Not detected	Not detected	4.0*
Fumonisin B1+B2	Not detected	Not detected	Not detected	Not detected	4000**
Deoxynivalenol (DON)	Not detected	Not detected	Not detected	Not detected	1750**
Zearlenon	Not detected	Not detected	Not detected	Not detected	350**
2018					
Aflatoxin B_1	Not detected	Not detected	Not detected	Not detected	2.0*
Aflatoxin B1+B2+G1+G2	Not detected	Not detected	Not detected	Not detected	4.0*
Fumonisin B1+B2	Not detected	Not detected	Not detected	Not detected	4000**
Deoxynivalenol (DON)	Not detected	Not detected	Not detected	Not detected	1750**
Zearlenon	Not detected	Not detected	Not detected	Not detected	350**

*All cereals and all products derived from cereals, including processed cereal products, with the exception of foodstuffs

**Unprocessed maize with the exception of unprocessed maize intended to be processed by wet milling

Results of nitrate and nitrite

Another group of contaminants analysed in organic maize samples were the nitrates and nitrites contents, which consists of the components in the excessive use of fertilizers.

Nitrates have low toxicity, but they, in the human body, following the activity of the enzyme nitrate reductase, are converted into nitrites and nitrosamines, highly toxic compounds with carcinogenic action, mutagenic and embryo toxic (EU COMMISSION [11]). According to the FAO, the amount of nitrate tolerated by the adult human is a Maximum Risk Level (MRL) of 50 mg kg^{-1} body weight day^{-1} (FAO [17]). Ezeagu, in 2006, tested the level of nitrates and nitrites in three varieties of food grains, including maize grains. The results demonstrated the presence in the amount of 1000.0 mg kg^{-1} nitrate, and 0.106 mg kg^{-1} nitrite in maize grains (EZEAGU [8]). The source of nitrate pollution of agri-food products, which have as raw material vegetable production, are mineral fertilizers and also, organic manure, with a high nitrogen (the main element in the composition of nitrates) content. These substances, which are considered the main nutrients for plants, when used irrationally, pollute products and endanger human health (BLUMENTHAL & al [5]).

Compliance with maximum levels of nitrates can be reasonably obtained by compliance good agricultural practices. In order to ensure safety, food products with excesses of MRL cannot be admitted to the market as such, no mixed with other products, no used as ingredients in food.

The nitrates and nitrites contents in the maize grains tested in the 4 regions of the country are shown in Table 5. It can be seen, only in 2016, in tree farms recorded nitrates values between 5.1 and 6 mg kg^{-1}. No nitrates or nitrites were detected in the other samples, in 2017 and 2018. This shows that organic farmers generally comply with the rules for the application of fertilizers in organic farming, but better management of soil nitrogen must be considered, taking into account the dynamics of this nutrient in the agricultural ecosystem of which the soil and crops are parts.

Table 5. Results of nitrates and nitrites content of organic maize grains, 2016-2018 period

Nitrates/nitrites content	Farm number 1 (Vaslui county)	Farm number 2 (Arad county)	Farm number 3 (Teleorman county)	Farm number 4 (Bihor county)	Maximum Allowed Limit (EU Nitrates Directive 91/676/EEC and WHO, 1998)
2016					
Nitrates (mg kg^{-1})	5.1	5.1	6.0	Not detected	50 mg kg^{-1}
Nitrites (mg kg^{-1})	Not detected	Not detected	Not detected	Not detected	1 mg kg^{-1}
2017					
Nitrates (mg kg^{-1})	Not detected	Not detected	Not detected	Not detected	50 mg kg^{-1}
Nitrites (mg kg^{-1})	Not detected	Not detected	Not detected	Not detected	1 mg kg^{-1}
2018					
Nitrates (mg kg^{-1})	Not detected	Not detected	Not detected	Not detected	50 mg kg^{-1}
Nitrites (mg kg^{-1})	Not detected	Not detected	Not detected	Not detected	1 mg kg^{-1}

Conclusion

This research has demonstrated the comparable quality of organic maize from Romania with international standards in the field.

It was also found that farmers comply with the rules imposed by the organic cultivation of maize, regarding the use of chemical fertilizers and plant protection products.

At the same time, in some years (high humidity at harvest, repeated fertilization), some aspects related to the maximum limits allowed for some harmful substances, such as mycotoxins, nitrates or nitrites, are reported. All values resulting from these substances have been shown to be much lower than industry standards. However, in the future, more attention is needed in preventing these problems and monitoring them permanently. As a result, organic corn can be successfully included in animal and human rations.

The high protein content is noticeable, which makes organic maize grains a valuable raw material that can be successfully included in animal and human nutrition.

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CHEMICAL COMPOSITION AND YIELD QUALITY OF PSEUDOCEREALS UNDER ROMANIAN AGRICULTURAL CONDITIONS

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Abstract The object of this paper was to study the chemical composition and yield quality of pseudocereal species: amaranth (*Amaranthus cruentus, A. hypochondriacus, A. caudatus*), quinoa (*Chenopodium quinoa*), and buckwheat (*Fagopyrum esculentum*), grown on the South Romanian Plain. Analyses of the chemical composition and yield quality of different *Amaranthus* species gave the following values: for *Amaranthus cruentus* - proteins 15.37-15.80%; starch 60.87-61.70%; lipids 6.00-6.14%; fibre 2.22-2.24%; minerals 2.61-2.68%; for *A. hypochondriacus* - proteins 15.84-16.95%; starch 61.32-62.02%; lipids 5.41-5.56%; fibres 4.13-4.68%; minerals 2.80-3.67%; for *A. caudatus* - proteins 14.43-14.60%; starch 59,97-60,50%; lipids 6.24-6.50%; fibres 3.16-5.55%; minerals 2.9-4.76%. The richness in proteins and lipids should be noted for all the *Amaranthus* species, the contents being higher in comparison with those of cereal crops. For quinoa grains, the average chemical composition was as follows: proteins 14.70-16.71% (superior to cereals); starch 60.40-65.44%; lipids 5.31-5.80%; fibres 2.11-2.18%; minerals 2.09-2.89%. The chemical composition of buckwheat grains was: 14.32-16.03% proteins; 63.56-67.87% starch; 3.18-3.95% lipids; 9.84-10.37% fibres; 2.08-2.58% minerals. It should be pointed out for all pseudocereals that the protein contents (over 14.3%, and over 16% for the best variants) were superior to those of cereals (10-14%) and that the lipid contents were also higher (over 5%) by comparison with cereals (1.5-2%).

Key words: pseudocereals, chemical composition, nutritional value.

Introduction

At present, researchers' attention is focused on the exploitation of alternative crops or underutilized species - pseudocereals - for different uses. These crops have an important role in the development and diversification of agricultural products and food, and for the development of a sustainable agriculture which is a priority trend for Romanian Agriculture in the context of European and world agriculture.

Pseudocereals belong to other botanical family as cereals: amaranth (*Amaranthus cruentus, A. hypochondriacus, A. caudatus*), to *Amaranthaceae* Family, quinoa (*Chenopodium quinoa*), to *Chenopodiaceae* Family, buckwheat (*Fagopyrum esculentum*) – to *Polygonaceae* Family, but the utilization of their grains is the same as for cereals.

These species requirements for growing conditions, are not exigent (for fertilization, tolerance of pests and insects), and so they need low inputs. As they can survive and produce in areas of less favourable conditions, these crops can be a solution for organic agriculture. Their high content in proteins, essential aminoacids, and minerals leads to an improved dietary composition of the processed products, and their nutritional value is beneficial to human health. Either alone or as mixture with other cereals, they can improve the technological or use qualities. Generally, they have promising nutritional, economic and industrial importance for a variety of purposes for humankind.

Materials and methods

This research has been focused to determine the chemical composition and yield quality of some pseudocereals - amaranths species, quinoa and buckwheat by comparison with two major cereals - wheat and maize. All grains come from Moara Domneasca Experimental Field of the Bucharest Field Crops Department situated in the South Part

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of Romanian Plain. Chemical analyses were made in the Yield Quality Laboratory of the Field Crops Department, Faculty of Agriculture, University of Agronomic Sciences and Veterinary Medicine Bucharest, with a spectrophotometer NIR, Instalab 600. This equipment uses the infrared technology for determination of different chemical compounds of grain product. The calibration of spectrophotometer was effectuated by the Metron Group Laboratory from Novi Sad. There were performed following chemical analysis: starch, proteins, lipids, fibre and minerals.

Results and discussion

Table 1 shows the chemical composition of pseudocerals regarding main components comparated to wheat and maize grains. Some components are higher in content that those of cereals species, of which wheat and maize are given as the main reprezentive. Nutrional value of pseudocerelas is thus very high.

Table 1. Chemical compositions of amaranthus, quinoa, and buckwheat compared to wheat and maize (% dry mass)

Crops	Starch	Proteins	Lipids	Fibre	Minerals
Amaranthus cruentus	60.87-61.70	15.37-15.80	6.00-6.14	2.22-2.24	2.61-2.68
A. hypochondriacus	61.23-62.02	15.84-16.95	5.41-5.56	4.13-4.68	2.80-3.67
A. caudatus	59.97-60.50	14.43-14.60	6.24-6.50	3.16-5.55	2.9-4.76
Chenopodium quinoa	60.40-65.44	14.70-16.71	5.31-5.80	2.11-2.18	2.09-2.89
Fagopyrum esculetum	63.56-67.87	14.32-16.03	3.18-3.95	9.84-10.37	2.08-2.58
Triticum aestivum	60.45-63.31	12.01-12.20	1.37-1.39	1.85 – 2.09	1.21-1.68
Zea mays	65.4-67.77	9.17-9.57	3.78-4.14	1.10-1.22	0.69-1.77

The carbohydrates are a source of energy for human and animal organisms. In the present research, starch content was found in the following values: for winter wheat 61-63%, for maize 65.4-67.77%, and for pseudocereals: amaranth 60-62%, quinoa 60-65%, buckwheat 63-65%, therefore, the content was at the same level as in the cereals grains.
The protein content for pseudocereals was over 14% and over 16% for the best variants by comparison with cereals content, 12% for winter wheat and less than 10% for maize. So, the protein content of pseudocereals was higher than cereals species. But important is the quality of the protein too. In this respect, as other research reported pseudocereals have an higher content of some essential aminoacids by comparasion with cereals (i.e. lysine, over 5%) (Koziol, 1997). On the other hand, as they contain only a very low amount of prolamins in comparison with wheat grains, pseudocereals are suitable for the diets of persons suffering from celiac disease (Berghofer, Schoenlenchner, 2007)
Pseudocereals are richer in lipids than the cereals. So the values of the lipids content were about 5% for quinoa, 5-6% for amaranth, by comparation with 1.8-2.6% for wheat.
In additions, the minerals (Ca, Mg, K, Fe) of pseudocereal grains have a higher value than in cereals grains (i.e. pseudocereals 2-10%, respectively, winter wheat and maize 1-2%).

Conclusions

As a consequence of our research regarding of chemical composition of pseudocereals, following conclusions may be emphasized as important:

There are remarked the superior values of the protein content for pseudocereals - over 14% and over 16% for the best variants, in comparison with cereals (9.17-12.20%). The lipids content was higher (over 5%) by comparison with cereals (1.37-4.14%) and, also, the minerals content of pseudocereals was higher too (2.08-4.47%) comparated to winter wheat and maize grains (0.69-1.77%). In this way, in a more wider vision, they can contribute to food nutrional value and may become more attractive for consumers.

In conclusion, the pseudocereals may have a positive contribution by increasing the food nutrional value, the diversity of the farm's income base, spreading out risks, reducing weaknesses in the farm system, or broadening the base of operations.

Pseudocereals species, strongly promoted by scientific trends which support biodiversity and organic agricultural system may contribute to the diversification of agricultural crops and agroalimentary products, with a source of food rich in proteins, lipids and minerals.

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CHEMICAL COMPOSITION AND NUTRITIONAL VALUES OF SOME ALTERNATIVE CROPS PROMOTED IN ORGANIC AGRICULTURE

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Keywords: *alternative crops, chemical composition, nutritional values*

Abstract

The paper present the results of the research made in 2007-2009 period regarding chemical composition and nutritional value of some alternative crops promoted in organic agriculture: pseudocereals (amaranthus, quinoa, and buckwheat), grain legumes (faba bean, chickpea, and lentil) and oil seeds (safflower, camelina, and oil flax).

In average, the chemical composition of these crops cultivated in Moara Domneasca Training and Experimental Farm was the following: for pseudocereals – 64.32-66.87% glucides; 16.03-16.71% proteins; 3.53-4.91% lipids; 2.31-2.89% minerals; for grain legumes – 33.29-63.90% glucides; 21.23-22.18% proteins; 3.03-4.40% lipids; 3.41-5.85% minerals; for oil crops – 26.41-36.27% glucides; 12.60-22.56% proteins; 28.38-34.10% lipids; 3.60-5.25% minerals. It is important to point out the nutritional values of tested alternative crops as mean to supplement and to diversify the common human diet: pseudocereals as sources rich in glucides and proteins (and lipids too); the grain legumes as sources rich in proteins, glucides (and minerals too); oil crops as sources rich in lipids and proteins (and glucides too).

INTRODUCTION

Some various factors have stimulated interest of specialists in crop diversification in recent years: instability of commodity prices decreased or eliminated farm subsidies, increased pesticide-resistance in damaging organisms, and losses in genetic biodiversity. At the same time, consumer dietary changes have generated new markets for alternative food products [2].

Risk reduction through diversification (related to climatic and biotic factors, particularly in fragile ecosystems and commodity fluctuations) by expanding locally adapted or introducing new species and related production systems, will contribute to improved food security and income generation for resource poor farmers and protect the environment.

To increase income the farmer needs a higher value product that can be obtained by adding value to primary or secondary products. Fruits, vegetables, herbs and spices, flavourings, natural colourants, medicinal plants and others all offer an opportunity for farmers to produce higher value products. Nevertheless, introducing new crops on their own is unlikely to be successful as the whole technological and commercial package needs to be introduced at the same time.

Alternative field crops are categorized as: pseudocereals and less common cereals (amaranth, quinoa, buckwheat, teff, finger millet, pearl millet, foxtail millet, wild rice); grain legumes (varieties of dry beans and dry peas, faba bean, chickpea and lentils); oilseeds (camelina, canola, crambe, cuphea, jojoba, lesquerella, meadowfoam, perilla, sesame, safflower); industrial crops (euphorbia, fanweed, gopher plant, vernonia); and fiber crops (kenaf, milkweed) [2].
Feasibility of a specific crop depends on a number of factors including the suitability of the crop for local growing conditions. Climate, soil characteristics, and pest problems affect crop productivity.
Alternative crops could play a huge role in the world's food supply. They may be less important in comparison to the major crops but they offer much needed nutritional value and variety needed in the diet. Studying of nutritional value of the alternative crops in organic farming conditions arising from the very special role it occupies at present this system of agriculture and these plants in the world, Europe and Romania, both in the development of biodiversity, environmental protection, and food diversification.

MATERIAL AND METHODS

The alternative crops that have been investigated are the following: pseudocereals (amaranthus, quinoa, and buckwheat), grain legumes (faba bean, chickpea, and lentil), oil seeds (safflower, camelina, and oil flax).
The biologic material for studies comes from Moara Domneasca Experimental Field in the years 2007-2009.
The biochemical compounds (glucides, starch, proteins, lipids and minerals) have been determinated by using the common chemistry laboratory methods: for glucides, Bertrand Method; for proteins, Kjeldahl Method; for lipids, Soxhlet Method; for minerals, Spectrophotometrie Method.

RESULTS AND DISCUSSION

After their role in metabolism, useful substances in food, the human body needs, is divided into several groups: substances with energy by oxidation in the body which provide necessary heat and energy expenditure due to life processes work, such substances are mainly fat and glucides; substances with plastic, regenerative cells and tissues, such as proteins; substances with a catalytic role, such as vitamins and minerals; substances sensory role, which impresses the senses.
In the scientific literature in the fields of biochemistry and food hygiene, food technology and merceology, nutritional value is often presented as percentage of chemical composition, underlining the presence of one or other of component (glucides, proteins, lipids, minerals, etc.) or/and sometimes accompanied by the potential energy expressed in kcal/100 g product [5].

Chemical composition and nutritional value of pseudocereals. The glucides content of pseudocereals grains oscillated between 64.32% at quinoa and 66.86% at amaranthus. On protein content, as can be seen in table 1, all three crops had similar content, over 16%, higher content in comparison with safflower (12.6%). There are remarked the higher values of lipids content (over 3.5%) and over 5% for the best variants, in comparison with grain legumes (3-4%). The average energy value of pseudocereals was around 376 kcal/100 g, similar with the grain legumes (340 kcal/100 g).

Table 1

Nutritional values of alternative crops
(Moara Domneasca Experimental Field, 2007-2009)

Alternative crops	Species	Glucides (g/100g)	Proteins (g/100g)	Lipids (g/100g)	Minerals (g/100g)	Energy value (kcal/100 g)
Pseudocereals	Amaranthus spp.	66.87	16.47	4.91	2.61	389.97
	Quinoa	64.32	16.71	5.80	2.89	389.06
	Buckwheat	65.50	16.03	3.53	2.31	351.05
Grain legumes	Faba bean	63.90	21.50	4.40	5.85	396.58
	Chickpea	56.20	21.23	4.31	3.41	360.95
	Lentils	33.29	22.18	3.03	4.00	259.60
Oil crops	Safflower	26.41	12.60	28.38	3.60	426,73
	Camelina	36.27	20.43	31.75	4.28	532.02
	Oil Flax	27.73	22.56	34.10	5.25	528.56

Chemical composition and nutritional value of grain legumes. About content in glucides, lower content was analyzed at lentils, only 33.23% compared with the other two legumes species, faba bean and chickpea, which had 63.90%, respectively 56.20%. Protein contents were around 21%, comparatively with two alternative oil crops, flax and camelina. The lipids content oscillated between 3.03% at lentil and 4.40% at faba bean. The highest minerals content was analyzed at faba bean (5.95%), and the lowest at chickpea (3.41%). According with these results, the highest energy value registered at faba bean, with 396.58 kcal/100 g.

Chemical composition and nutritional value of oil crops. After analyzing the chemical composition of oilseed species, lowest glucides content was recorded in the safflower (26.41%), and higher values were determined at camelina (over 36%). The highest proteins content found at flax seeds with 22.56% and lowest values were determined at safflower seeds with 12.60%. Camelina had

intermediate contents of 20.43%. The lipid content varied between 28.38% and 34.10%, the average being 31.24%. The lowest content was indentified at safflower, and the higher at flax. Minerals content varied between 3.60% at safflower and 5.25% at oil flax.
The nutritional value of oil crops seeds was as follows: 426.73 kcal/100 g at safflower, 528.56 kcal/100 g at camelina and 532.02 kcal/100 g at oil flax.

CONCLUSIONS

1. After research carried on Moara Domneasca Farm, the results of pseudocereals chemical composition are as follows: 64.32-66.87% glucides; 16.03-16.71% proteins; 3.53-4.91% lipids; 2.31-2.89% minerals.
2. For grain legumes were recorded following data: 33.29-63.90% glucides; 21.23-22.18% proteins; 3.03-4.40% lipids; 3.41-5.85% minerals.
3. In the sames conditions, the chemical composition of oil crops was: 26.41-36.27% glucides; 12.60-22.56% proteins; 28.38-34.10% lipids; 3.60-5.25% minerals.
4. The study of the nutritional value of alternative crops in organic farming conditions evidenced the very special role which should they occupy in the development of biodiversity, environmental protection, and diversification of food.
5. Organic agriculture could ensures that agriculture's natural base remains productive and agricultural production can be competitive in the future and that farming works to promotes positive environmental impact.

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Comparative Study on Productivity, Chemical Composition and Yield Quality of Some Alternative Crops in Romanian Organic Farming

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***Abstract*—**Crops diversity and maintaining and enhancing the fertility of agricultural lands are basic principles of organic farming. With a wider range of crops in agroecosystem can improve the ability to control weeds, pests and diseases, and the performance of crops rotation and food safety. In this sense, the main objective of the research was to study the productivity and chemical composition of some alternative crops and their adaptability to soil and climatic conditions of the agricultural area in Southern Romania and to cultivation in the organic farming system. The alternative crops were: lentil (7 genotypes); five species of grain legumes (5 genotypes); four species of oil crops (5 genotypes). The seed production was, on average: 1343 kg/ha of lentil; 2500 kg/ha of field beans; 2400 kg/ha of chick peas and blackeyed peas; more than 2000 kg/ha of atzuki beans, over 1250 kg/ha of fenugreek; 2200 kg/ha of safflower; 570 kg/ha of oil pumpkin; 2150 kg/ha of oil flax; 1518 kg/ha of camelina. Regarding chemical composition, lentil seeds contained: 22.18% proteins, 3.03% lipids, 33.29% glucides, 4.00% minerals, and 259.97 kcal energy values. For field beans: 21.50% proteins, 4.40% lipids, 63.90% glucides, 5.85% minerals, 395.36 kcal energetic value. For chick peas: 21.23% proteins, 4.55% lipids, 53.00% glucides, 3.67% minerals, 348.22 kcal energetic value. For blackeyed peas: 23.30% proteins, 2.10% lipids, 68.10% glucides, 3.93% minerals, 350.14 kcal energetic value. For adzuki beans: 21.90% proteins, 2.60% lipids, 69.30% glucides, 4.10% minerals, 402.48 kcal energetic value. For fenugreek: 21.30% proteins, 4.65% lipids, 63.83% glucides, 5.69% minerals, 396.54 kcal energetic value. For safflower: 12.60% proteins, 28.37% lipids, 46.41% glucides, 3.60% minerals, 505.78 kcal energetic value. For camelina: 20.29% proteins, 31.68% lipids, 36.28% glucides, 4.29% minerals, 526.63 kcal energetic value. For oil pumpkin: 29.50% proteins, 36.92% lipids, 18.50% glucides, 5.41% minerals, 540.15 kcal energetic value. For oil flax: 22.56% proteins, 34.10% lipids, 27.73% glucides, 5.25% minerals, 558.45 kcal energetic value.

***Keywords*—**Adaptability, alternative crops, chemical composition, organic farming productivity.

I. Introduction

In global agricultural policies there is concern to find new solutions to problems created by intensively farming techniques of plant and animal growth, to reduce biodiversity related to the vagaries of climate and biotic factors particularly in fragile ecosystems, to maintain and to improve food security and income for poor farmers and subsistence farming. To increase farmers' income requires higher value products which may be obtained by adding value to primary or secondary products. Introduction in the farms of alternative crops and marketing their products can be of real help for farmers and consumers. They may be the way to get food production of high biological quality, and it can represent a special "niche" for food market [1].

In many cases, these "alternative crops" called "neglected" or "underutilised" are the only ones that can survive harsh climatic conditions, unsuitable for other crops that can assure good yields. In this way, they would contribute significantly to biodiversity and to achieve more stable agro-ecosystems [2].

Knowing the nutritional value of alternative food crops, is very important to provide decision support to producers and to motivate consumers to buy such products.

The method of cultivation (including fertilisation, weeds, pests and diseases control) is only one influence on the nutritional quality of a crop. Also known to affect the crop's quality are factors such as geographical area, soil type, soil moisture, plant variety, weather and climatic conditions, pollution, length of growing season, and post-harvest handling. As many of these factors are beyond the farmer's control, the method of agricultural practice employed emerges as a significant controllable influence on the quality of a farm's produce, though clearly other controllable factors such as variety and irrigation/soil moisture can also have significant impacts [3].

Importance of these species results from seeds chemical composition and nutrition value - high contents in proteins and essential aminoacids, mineral elements, lipids - and from the fact they do not have special claims concerning growing conditions, presenting tolerance to diseases and pests, and being able to grow in some harsher climates [4]. On other hand, an important objective of Organic Farming is to maintain and enhance the fertility of the agricultural lands. Therefore, focus is placed upon crop rotation, diversified agricultural crops, increasing pulses crops (peas, beans, soybeans, etc.) and fodder legumes acreage (alfalfa, clover, vetch+oats), increasing green-fertiliser crops (such agricultural crops as lupine, a plant whose biological yields is incorporated into the soil), the employment of the residues from agricultural crops as a source of organic matter for the soil, the

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employment of the animal waste from farms as organic fertilizers [5]. In this context, the present situation of Romanian economy and agriculture is very favorable for the extension of the Organic Farming sector. The Romanian agriculturists are interested to produce such kind of marketable agriculture products and food for domestic and external market.

II. Material and Method

The main objective of the research was to study the productivity, chemical composition and yield quality of some alternative crops and their adaptability to soil and climatic conditions of the agricultural area in Southern Romania and to cultivation in the organic farming system.

Research has been organized in 2009-2011 at Moara Domneasca Experimental Field, located on reddish preluvosoil, for some species of legumes and oil crops. The experiment was organized based on the multi-stage block method with randomized variants, in 4 replications.

The research was set up three field experiments, respectively: an experiment of 7 lentil genotypes („Beluga", „Sorte du Puy", „Laird" (Turkey), „Richlea" (France), „Masoor" (Turkey), „Eston" (Greece), local genotype „De Moara Domnească" (Romanian genotype); an experiment of five species of grain legumes (5 genotypes) (field beans, Greek genotype; chick peas, Greek genotype; adzuki bean, German genotype; black-eyed pea, Slovenian genotype; fenugreek, Romanian genotype); an experiment with four species of oil crops (4 genotypes) (camelina, Romanian genotype; oil flax, Romanian genotype; safflower, German genotype; oil pumpkin, Slovenian genotype.

Seeds came from organic crops from Romania and other European countries, and growing technology was in conformity for organic farming system.

The biochemical compounds (glucides, proteins, lipids and minerals) have been performed by using the specific chemistry laboratory methods: for glucides, Bertrand Method; for proteins, Kjeldahl Method; for lipids, Soxhlet Method; for minerals, Spectrophotometrie Method.

The results were statistically processed by variance analysis.

III. Results and Discussions

Feasibility of a specific crop depends on a number of factors including the suitability of the crop for local growing conditions. Climate, soil characteristics, and damaging organisms problems affect crop productivity [6].

Alternative crops could play a huge role in the world's food supply. They may be less important in comparison to the major crops but they offer much necessary nutritional value and diversity needed in the diet. Studying of nutritional value of the alternative crops in organic farming conditions arising from the very special role it occupies at present this system of agriculture and these plants in the world, Europe and Romania, both in the development of biodiversity, environmental protection, and food diversification [4].

Regarding to results of lentils the yields of the three experimental years illustrates in Table I, prove the suitability of natural conditions in the area and good productivity of organic lentils. Seed production was on average 1343 kg/ha, the limits of variation is 1190 kg/ha for Beluga genotype and 1468 kg/ha for Laird genotype. The most productive genotypes were found to be Richlea and Laird genotypes, who gave average yields of 1486 kg/ha and 1402 kg/ha.

Fig. 1 The lentil genotypes experiment
(Moara Domneasca Experimental Field, 2009)

TABLE I
Seeds Yields of Lentil Genotypes
(Moara Domneasca Experimental Field, 2009-2011)

Genotypes	Grain yields kg/ha	Grain yields %	Differences (kg/ha)	Significance
Beluga	1190	88.60	-153	ooo
Sorte du Puy	1310	97.54	- 33	oo
Masoor	1290	96.05	-53	ooo
Richlea	1402	104.39	59	***
Laird	1468	109.30	125	***
Eston	1386	103.20	43	***
Moara Domnească	1361	101.34	18	-
Average	1343	100.00	Control	—

$LSD_{5\%}$= 21.5 kg/ha $LSD_{1\%}$= 30.1 kg/ha $LSD_{0,1\%}$= 42.5 kg/ha

Lentil seeds (Table II) contained on average: 22.18% proteins, 3.03% lipids, 33.29% glucides, 4.00% minerals and energy value was 259.97 kcal. The higher protein content were determined in the seeds of Richlea and Laird genotypes, respectively, 22.85% and 22.67%, and protein yields ranged from 248 kg/ha to 326 kg/ha, in average 286 kg proteins/ha.

TABLE II
Lentil Seeds Chemical Composition (% D.M.)
(Moara Domneasca Experimental Field, 2009-2011)

Genotype	Proteins	Lipids	Glucides	Minerals	Energetic value (kcal %)
Beluga	21.78	3.25	32.98	4.11	259.02
Sorte du Puy	21.14	3.40	33.57	4.04	255.86
Laird	22.85	2.95	33.98	3.94	265.00
Richlea	22.67	2.81	33.21	3.91	259.77
Masoor	22.27	3.06	33.43	4.13	263.28
Eston	22.34	3.02	32.87	4.07	258.92
Moara Domneasca	22.21	2.78	33.02	3.84	256.74
Average	22.18	3.03	33.29	4.00	259.97

Lipids content ranged from 2.78% for Moara Domneasca genotype to 3.40% for Puy du Sort genotype and minerals content showed values ranging from 3.84% for Moara Domneasca genotype to 4.13% for Masoor genotype.

Research has also demonstrated that in experimental area and in organic farming system, is possible to harvest yields of 2500 kg/ha of field beans, 2400 kg/the of chick peas, 2393 kg/ha of blackeyed peas, more than 2000 kg/ha of adzuki beans, and over 1250 kg/ha of fenugreek (Table III).

TABLE III
SEEDS YIELDS OF LEGUMES
(MOARA DOMNEASCA EXPERIMENTAL FIELD, 2009-2011)

Species	Grain yields		Diferences (kg/ha)	Significance
	kg/ha	%		
Field beans	2500	118.48	390	***
Chick peas	2400	113.74	290	***
Blackeyed peas	2367	111.84	257	***
Adzuki beans	2000	94.78	-110	ooo
Fenugreeak	1250	59.24	-860	ooo
Average	2110	100.00	Control	—

$LSD_{5\%}$= 68 kg/ha $LSD_{1\%}$= 103 kg/ha $LSD_{0,1\%}$= 166 kg/ha

Fig. 2 The legumes crops experiment
(Moara Domneasca Experimental Field, 2010)

For other legumes, it can highlight that the proteins content was over 21%, the highest content was analized in blackeyed peas seeds (23.30%). The lipids content oscilated between 2.10% at blackeyed peas and 4.65% at fenugreek. Highest glucides content and energetic value were recorded at adzuki bean of 69.30% and, respectively, 402.48 kcal%) (Table IV).

The research showed that oil crops in organic farming system can produce 2200 kg/ha of oil flax, 2150 kg/ha of safflower, 1518 kg/ha of camelina, 570 kg/ha of oil pumpkin, (Table V).

Related to the chemical composition of oil crops yields (Table VI), at oil pumpkin was found a proteins content of 29.5%; this species was followed by oil flax with 22.56% proteins, and the lowest values were determined for the safflower, of 12.60%. Camelina seeds had intermediate protein contents of 20.16%. Oil content of the studied species ranged between 28.37 and 36.92%. Slightly lower oil content resulted for safflower and camelina (28.63 and 31.61%), and the highest (34.10 and 36.92%), were registered for pumpkin and flax oil.

TABLE IV
LEGUMES SEEDS CHEMICAL COMPOSITION (% D.M.)
(MOARA DOMNEASCA EXPERIMENTAL FIELD, 2009-2011)

Genotype	Proteins	Lipids	Glucides	Minerals	Energetic value (kcal %)
Field beans	21.50	4.40	63.90	5.85	395.36
Chick peas	21.23	4.45	53.00	3.67	348.22
Blackeyed peas	23.30	2.10	68.10	3.93	350.14
Adzuki beans	21.90	2.60	69.30	4.10	402.48
Fenugreeak	21.30	4.65	63.83	5.69	396.54

TABLE V
SEEDS YIELDS OF OIL CROPS
(MOARA DOMNEASCA EXPERIMENTAL FIELD, 2009-2011)

Species	Grain yields		Differences (kg/ha)	Signifi cance
	kg/ha	%		
Camelina	1518	94.32	-91.5	oo
Oil flax	2200	136.69	590.5	***
Oil pumpkin	570	35.41	-1039.5	ooo
Safflower	2150	133.58	540.5	***
Average	1609.5	100.00	Control	—

$LSD_{5\%}$= 55 kg/ha $LSD_{1\%}$= 83 kg/ha $LSD_{0,1\%}$= 133 kg/ha

Fig. 3 The oil crops experiment
(Moara Domneasca Experimental Field, 2011)

Energy values of the oil crops ranged from 423.78 kcal at safflower to 558.45 kcal for flax oil. Oil pumpkin and camelina had intermediate energy values of 540.15 kcal, 525.54 kcal respectively.

TABLE VI
OIL CROPS SEEDS CHEMICAL COMPOSITION (% D.M.)
(MOARA DOMNEASCA EXPERIMENTAL FIELD, 2009-2011)

Genotype	Proteins	Lipids	Glucides	Minerals	Energetic value (kcal %)
Camelina	20.16	31.61	36.30	4.30	525.54
Oil flax	22.56	34.10	27.73	5.25	558.45
Oil pumpkin	29.50	36.92	18.50	5.41	540.15
Safflower	12.60	28.37	26.41	3.60	423.78

IV. CONCLUSION

Research carried out in 2009-2011 have shown the adaptability of legumes species (lentils, field beans, chick peas, blacheyed peas, adzuki beans, fenugreek) and oil crops (safflower, oil pumpkin, flax oil and camelina) in terms of agricultural area in Southern Romania and possibility of these crops cultivation in organic farming system, in order to diversify the range of crops and achieve correct rotation in which legumes are particularly important as ameliorative crops. However, the introduction and these species expansion may contribute to the diversification of food and animal feeding.

In today's world, professionals are increasingly turning attention more towards the study of plants less known and less commonly grown, but are possible alternatives to species already used. Thus, some oil crops (e.g. safflower, camelina, pumpkin, etc.) and some legumes (e.g. lentils, field beans, chick peas, etc.) less cultivated in the Romania can become alternatives by the important role in developing and diversifying agricultural production, the range of foods, in general, and for a sustainable agriculture.

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