



Research on the Productive Performance of Some Romanian Pea Varieties in Ecological and Conventional Systems

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RESEARCH ARTICLE

Abstract

Pea is one of the most important crop plants (second after soybean) in the Fabaceae family (Shanthakumar et al., 2022) being considered a safe and cheap source of protein, starch, fiber, vitamins and minerals, low-fat, gluten-free, and low-allergenic (Munialo et al. 2014). Leaving the field early and leaving the soil enriched in nitrogen thanks to the symbiosis between the pea roots and *Rhizobium spp.* bacteria creates ideal conditions for the plants that follow in the rotation. The present paper, we aimed to test the influence of the biological cultivation method on the productivity elements of native yellow pea varieties in the eco-pedological conditions of Transylvania, elaboration of recommendations regarding the applied technology on some morphological and productivity elements in autumn peas. Pea crops were placed in two different locations (SDE Cojocna and private farm in Fundatura), under the same pedoclimatic conditions. In the organic farming system, the Olguța variety showed a reduced number of pods/plants, number of grains in the pod and the highest value of the MMB. In the organic farming system, the most productive pea variety was Ghittia with a production of over 2300 kg/ha and in the conventional farming system Olguța with 5000 kg/ha yield.

Keywords: Peas; yield; protein; farming system.

INTRODUCTION

Pea is one of the most important crop plants (second only to soybean) in the Fabaceae family (Shanthakumar et al., 2022, Tulbek et al., 2017). Yellow pea seeds contain about 60-65 carbohydrates of which 35-40% starch, 23-30% protein, 1-2% lipids and smaller amounts of minerals, vitamins depending on the variety, growing conditions and stage of maturity of grains at the time of harvest (Lam et al., 2018; Bogahawaththa et al., 2019; Lu et al., 2020; Saurel, 2020). In addition to starch, its carbohydrates also contain dietary fiber (10-15% insoluble part and 2-9% soluble part), as well as cellulose, sucrose and oligosaccharides (Lam et al., 2018; Hoover et al., 2010, Tulbek et al., 2017).

Currently, there is a tendency of the world's population towards a vegan diet, which leads to the growth of the European market for vegetable proteins. Diet-related diseases such as obesity, type 2 diabetes, heart disease and some cancers can result from excessive consumption of animal-based foods, while plant-based protein, fibre, vitamins, minerals are often linked to the benefits for health, increasing the demand for vegetable proteins in the European market.

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Peas are a potential source of vegetable protein, having about 25% protein (Taylor et al., 2021). The protein content of field peas can vary between 18-31% depending on the variety, climatic conditions and other factors (Kumar & Pandey, 2020). Canadian scientists have created field pea varieties with an increased protein content of about 30% (Lu et al., 2020; Shen et al., 2016). Soy, peanuts and lupine have a higher protein content, approximately 35-42% (Kumar & Pandey, 2020) but they have some drawbacks such as food allergies caused by their consumption.

Pea culture is particularly important from an agronomic point of view (Roman et al. 2015). It leaves the field early and leaves significant amounts of organic matter and nitrogen in the soil. It also leaves the land clean of weeds, without plant debris. Due to these aspects, peas are a very good precursor for many crops, especially for winter wheat (Muntean et al., 2014).

Worldwide, the areas cultivated with peas were fluctuating: 10.33 million ha in 1962, 8.7 million ha in 1990, 6 million ha in 2000, 6.60 million ha in 2010 and 7.21 million ha in 2020. In 2022, peas are cultivated on about 7.15 million hectares with an average production of 1978.5 kg/ha (Figures 1 and 2).

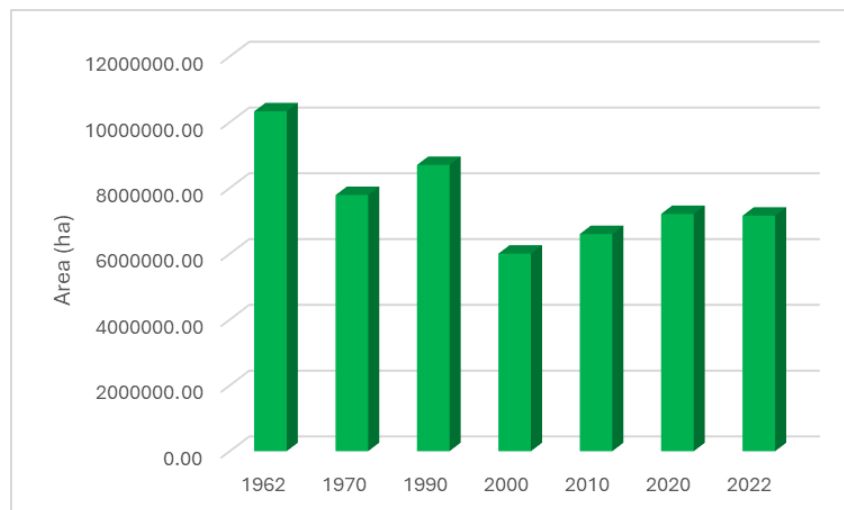


Figure 1. The area cultivated with peas worldwide. (<https://www.fao.org/faostat/en/#data/QCL>)

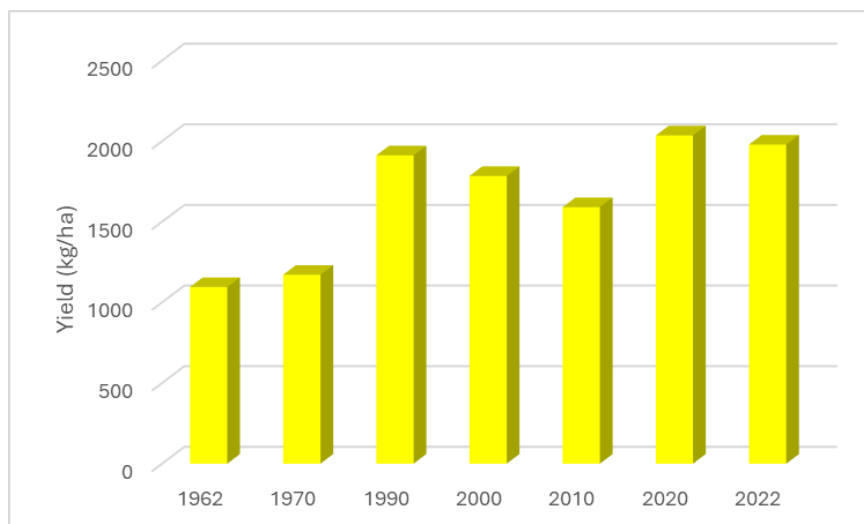


Figure 2. Average global pea yield. (<https://www.fao.org/faostat/en/#data/QCL>)

According to FAO data, in 2023 the largest areas cultivated with peas were registered in Europe, 2.6 million hectares. The average production recorded in Europe in 2022 was 2293 kg/ha (Figures 3 and 4).

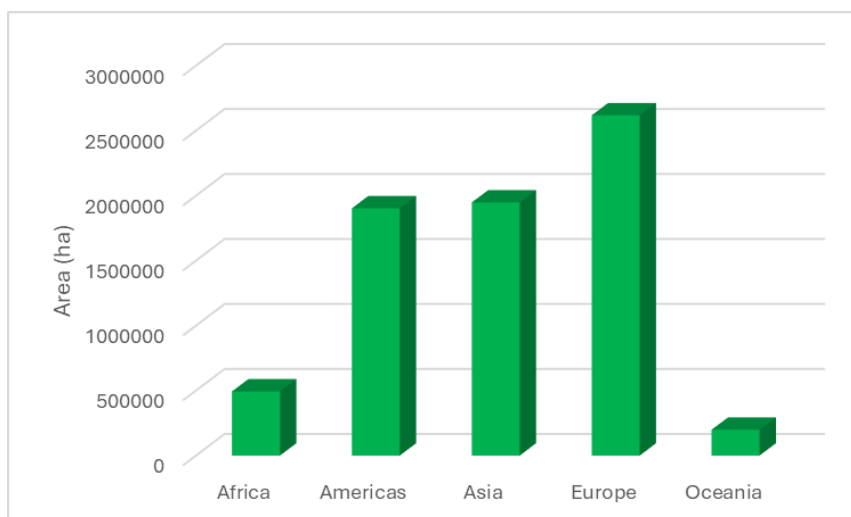


Figure 3. The area cultivated with peas on the continents in the year 2022. (<https://www.fao.org/faostat/en/#data/QCL>)

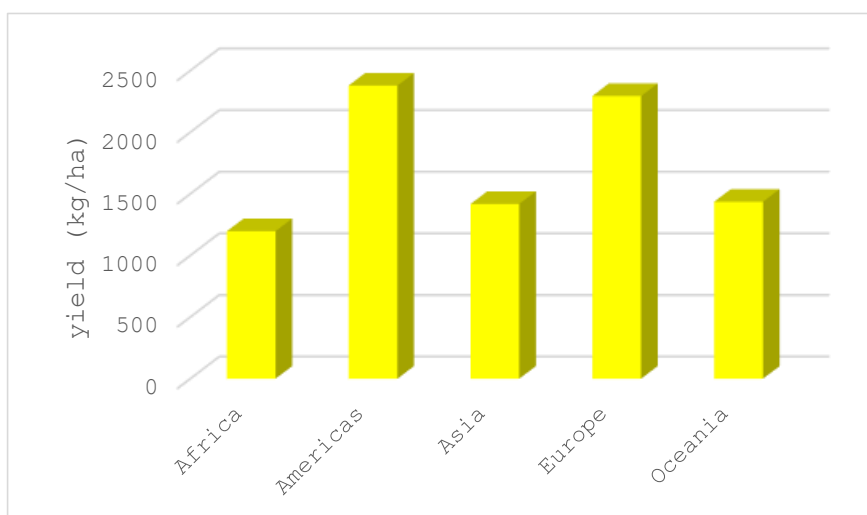


Figure 4. Average pea yield by continent in 2022. (<https://www.fao.org/faostat/en/#data/QCL>)

In Europe, large areas cultivated with peas are in Russia (1.6 million ha), France (133.49 thousand ha), Ukraine (125.7 thousand ha), Spain (122.51 thousand ha), Germany (106, 9 thousand ha). Yield above 3000 kg/ha were obtained in Germany. In the year 2022, in Europe, Romania occupied the 7th place with the areas occupied by peas (Table 1).

Table 1. Area and production of peas in the main growing countries in Europe (2022)

Country	Cultivated area (ha)	Average yield (kg/ha)
Estonia	37.260	2545,9
Cehia	40.630	2833,9
Marea Britanie	57.236	2800,0
Romania	68.060	1605,1
Lituania	71.460	2130,8
Germania	106.900	3017,8
Spain	122.510	1110,2
Ucraina	125.700	2065,7
Franța	133.490	2995,8
Rusia	1.611.745	2443,6

MATERIALS AND METHODS

Plant materials and field experiments

In the autumn of 2022, two experiences were established: one at SD Cojocna (Figure 5) and one in a private farm in Fundatura, Cluj County (Figure 6).

In the experience at Cojocna, the organic farming system was applied, and at the one at Fundatura, the conventional system. In both locations, three autumn pea varieties were studied: Ghittia, Andrada and Olguța purchased from NARDI Fundulea.

The autumn pea varieties Ghittia, Olguța and Andrada are considered significant innovations in pea culture, being the result of research and genetic selection carried out by the Fundulea National Agricultural Research and Development Institute (NARDI Fundulea). These varieties are promising for modern agriculture because they offer multiple advantages compared to traditional spring varieties.

The defining aspects of these autumn pea varieties are their ability to efficiently utilize winter moisture, reduced vulnerability to spring droughts and a longer vegetation period that determines a higher production (Bărbieru, 2022).



Figure 5. Location of the experience at SD Cojocna.

(Source: <https://www.google.com/maps>)

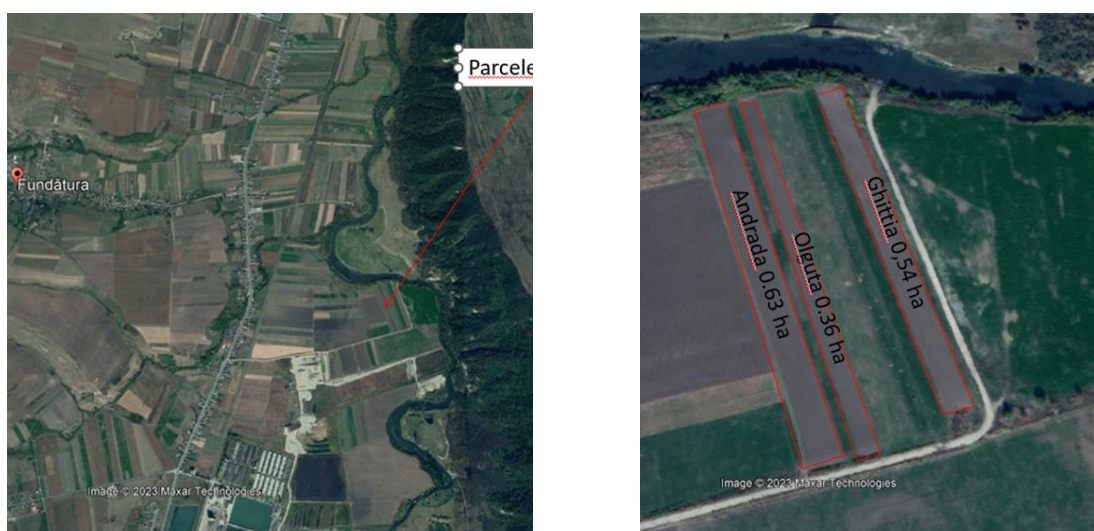


Figure 6. Location of the experience at Fundatura.

(Source: <https://www.google.com/maps>)

The production potential of these varieties is impressive. Ghittia and Olguța stand out with a production potential that consistently exceeds 5000 kg/ha, while Andrada has a production potential of over 4800 kg/ha (<https://www.incda-fundulea.ro/>). These impressive figures highlight the ability of these varieties to provide excellent yields, thereby contributing to increased agricultural productivity and profitability.

Figures 7, 8 and 9 show the pea varieties studied.



Figure 7. Autumn pea variety Ghittia.
(Source: original)



Figure 8. Autumn pea variety Andrada.
(Source: original)



Figure 9. Autumn pea variety Olguța.
(Source: original)

Soil conditions

According to the chemical analyses carried out at the Agrochemistry discipline of the Faculty of Agriculture, the soil from Cojocna is characterized by: pH 7, humus 6.3%, a very good supply of P (107.64 ppm), a good supply of K (189 ppm) and a high supply of N (total N 0.25%) and the soil from Fundatura is characterized by: pH 7.4, humus 3.17%, a very good supply of P (195.4 ppm), a good supply of K (172.8 ppm) and an average supply of (total N 0.195%).

The thermal regime

At Cojocna, the average temperature during the growing season of the pea crop was over 9°C. Between November 2022 and July 2023, the winter months were mild with no negative average temperatures, which favored the growth and development of the pea crop. The lowest temperature was recorded in February and the highest in July (Figure 10).

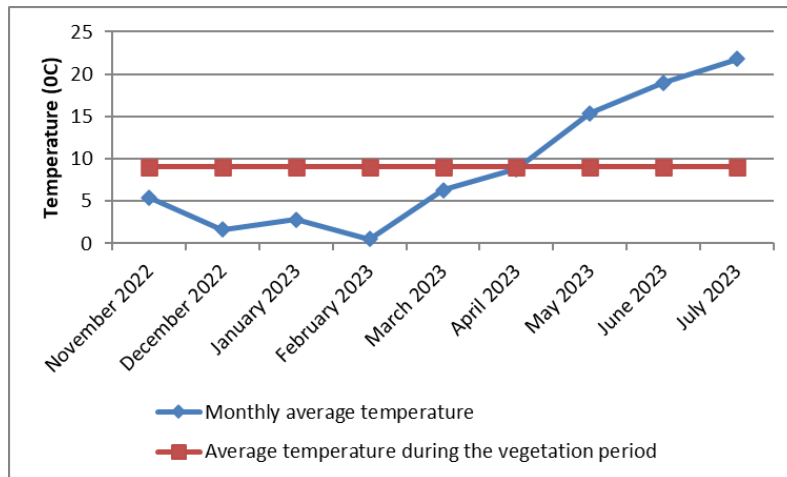


Figure 10. The thermal regime in Cojocna, Cluj county, November 2022-July 2023.

(Source: https://rp5.ru/Arhiva_meteo_%C3%AEn_Cluj-Napoca)

In Fundătura, Cluj county, the average temperature during the pea vegetation period was 8.7°C, and the lowest average monthly temperature was recorded in February, 0.3°C (Figure 11).

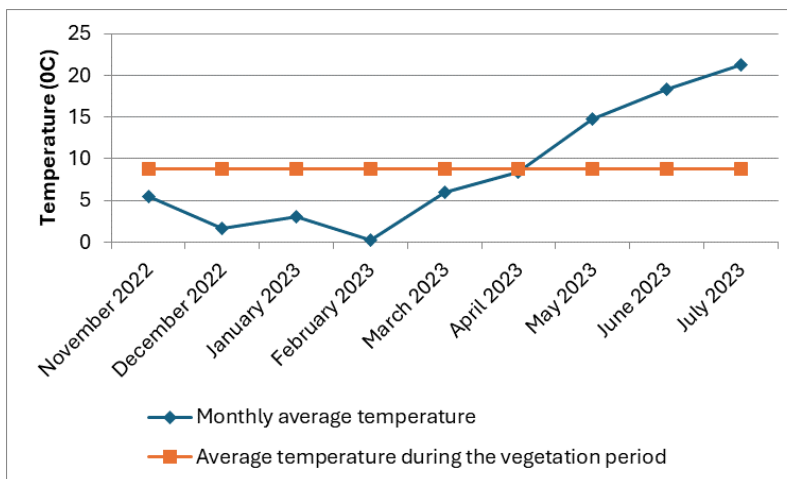


Figure 11. The thermal regime in Fundătura, Cluj county, November 2022-July 2023.

(Source: https://rp5.ru/Arhiva_meteo_%C3%AEn_Cluj-Napoca)

Rainfall regime

During the vegetation period of the pea crop in Cojocna, Cluj county, the total amount of precipitation recorded was over 440 mm. The highest amount of precipitation was recorded in June (Figure 12).

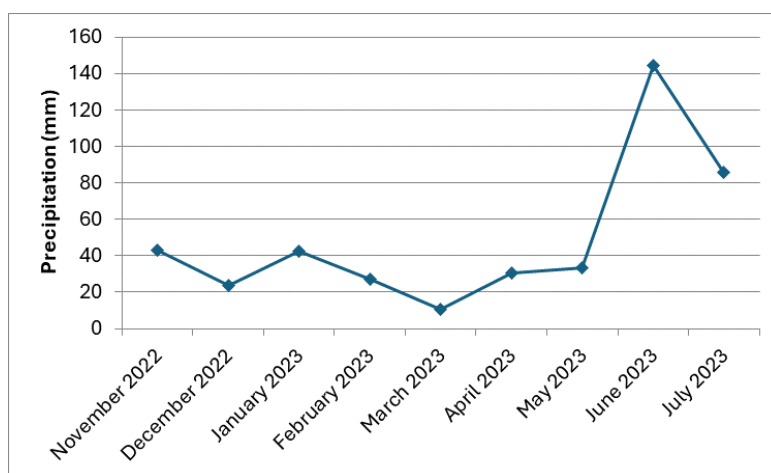


Figure 12. The thermal regime in Cojocna, Cluj county, November 2022-July 2023.

(Source: https://rp5.ru/Arhiva_meteo_%C3%AEn_Cluj-Napoca)

During the growing season of the pea crop, 481 mm of precipitation was recorded in Fundatura. The precipitation that fell in November after sowing favored the growth and development of the autumn pea crop (Figure 13).

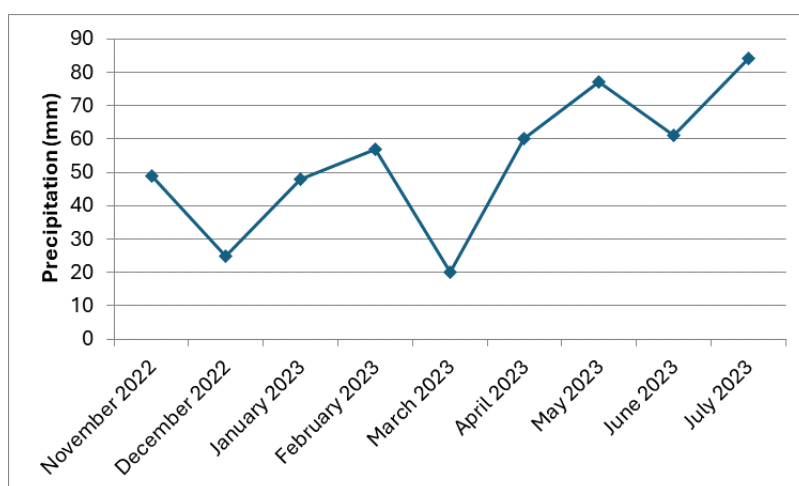


Figure 13. The thermal regime in Fundatura, Cluj county, November 2022-July 2023.

(Source: https://rp5.ru/Arhiva_meteo_%C3%AEn_Cluj-Napoca)

Before harvesting, the following determinations were made: plant height, the number of pods/plant and the number of grains in the pod, and after harvesting, the MMB was determined and samples were taken to determine the protein percentage of the grains.

RESULTS AND DISCUSSIONS

In the pedoclimatic conditions of Cojocna, Cluj County, the average height of pea plants was 92.11 cm. Compared to this, differences between cultivars in terms of plant height were small and not statistically significant either by analysis of variance or Duncan's test (Table 2).

Table 2. The size of the plants (Cojocna,2023, Cluj County)

Varieties	Height (cm)	%	Difference/Significance	The Duncan Test
Average of varieties	92.11	100.0	control	-
Ghittia	98.00	106	5.89	a

Andrada	86.57	94	-5.54	a
Olguta	91.77	100	-0.34	a

Note: LSD (p5%) 12.31

LSD (p1%) 20.37

LSD (p0.1%) 38.12.

In the pedoclimatic conditions of Fundătura, the average height of the pea varieties studied was over 100 cm. Compared to the average, very significantly positive differences were found in the Ghittia variety, very significantly negative in the Andrada variety and significantly negative in the Ghittia variety. Interpreting the results obtained by the Duncan test, significant differences are found between the studied varieties in terms of plant height (Table 3).

Table 3. The influence of the pea genotype on the height of pea plants, in a conventional system (Fundătura, 2023)

Varieties	Height (cm)	%	Difference/Significances	The Duncan Test
Average of varieties	102.22	100.0	control	-
Ghittia	114.67	112.2	12.44***	c
Andrada	92.67	91	-9.56 ⁰⁰⁰	a
Olguta	99.33	97	-2.89 ⁰	b

Note: LSD (p5%) 2.73

LSD (p1%) 4.51

LSD (p0.1%) 8.45.

Results obtained regarding the number of pods/plant

Compared to the control (average of the varieties), very significantly positive differences in the number of pods/plants were found in the Ghittia variety and very significantly negative differences in the Olguta variety. Interpreting the results obtained by the Duncan test, significant differences were found in terms of the number of pods/plant between the studied varieties (Table 4).

Table 4. Number of pods/plant (2023, Cojocna, Cluj County)

Varieties	Number of pods/plant	%	Difference/Significance	The Duncan Test
Average of varieties	10.62	100.0	control	-
Ghittia	13.10	123	2.48***	c
Andrada	10.40	98	0.22	b
Olguta	8.37	79	-2.26 ⁰⁰⁰	a

Note: LSD (p5%) 0.27

LSD (p1%) 0.45

LSD (p0.1%) 0.84.

The number of pods per plant was less influenced by the pea genotype grown under the conditions at Fundătura, the differences between the varieties being small and not statistically ensured either by the analysis of variance or by the Duncan test (Table 5).

Table 5. The influence of the pea genotype on the number of pods/pea plant, in conventional system (Fundătura, 2023)

Varieties	Number of pods/plant	%	Difference/Significance	The Duncan Test
Average of varieties	8.83	100.0	control	-
Ghittia	9.23	105	0.40	a
Andrada	8.30	94	-0.53	a
Olguta	8.97	102	0.13	a

Note: LSD (p5%) 12.11

LSD (p1%) 17.22

LSD (p0.1%) 24.93.

Results obtained regarding the number of grains in pods

In general, the number of grains in the pod is between 3 and 6 (Roman et al., 2015). Compared to the control (average of the varieties), there were significantly positive differences in the number of grains in the pod in the Andrada variety and significantly negative differences in the Olguța variety. The Duncan test shows significant differences between the varieties studied in terms of the number of grains in the pod (Table 6).

Table 6. No. grains in the pod (2023, Cojocna, Cluj County)

Varieties	No. grains in the pod	%	Difference/Significance	The Duncan Test
Average of varieties	3.54	100	control	-
Ghittia	3.56	100	0.02	b
Andrada	3.97	112	0.43*	c
Olguta	3.10	88	-0.44 ⁰	a

Note: LSD (p5%) 0.30

LSD (p1%) 0.50

LSD (p0.1%) 0.93.

The average number of grains in the pod was over 3 in the pedoclimatic conditions at Fundătura. Compared to the control, the differences in the number of grains were small and not statistically ensured by the analysis of variance. The Duncan test shows that there are significant differences between the Olguta and Andrada varieties in terms of the number of grains in the pod (Table 7).

Table 7. The influence of the pea genotype on the number grains in the pod plant, in conventional system (Fundătura, 2023)

Varieties	No. grains in the pod	%	Difference/Significance	The Duncan Test
Average of varieties	3.51	100	control	-
Ghittia	3.47	99	-0.04	ab
Andrada	3.27	93	-0.24	a
Olguta	3.80	108	0.29	b

Note: LSD (p5%) 0.45

LSD (p1%) 0.75

LSD (p0.1%) 1.40.

Results obtained regarding the MMB

In the conditions of Cojocna, the highest MMB value was found in the Olguța variety of 206 g. Similar results were obtained by Barbieru et al. (2017) There are small differences in MMB between those taken in the study, but the differences are small and are not statistically ensured either by the analysis of variance or by the Duncan test (Table 8).

Table 8. The mass of a thousand grains (2023, Cojocna, Cluj County)

Varieties	MMB (g)	%	Difference/Significance	The Duncan Test
Average of varieties	203.96	100	control	-
Ghittia	200.37	98	-3.59	a
Andrada	205.51	101	1.55	a
Olguta	206.00	101	2.04	a

Note: LSD (p5%) 12.01

LSD (p1%) 19.87

LSD (p0.1%) 37.19.

Under the conditions at Fundătura, the MMB was less influenced by the cultivated pea genotype, the differences between the varieties being small and not statistically ensured either by the analysis of variance or by the Duncan test (Table 9).

Table 9. Influence of pea genotype on MMB, in conventional system (Fundătura, 2023)

Varieties	MMB (g)	%	Difference/Significance	The Duncan Test
Average of varieties	201.07	100	control	-
Ghittia	205.20	102	4.13	a
Andrada	196.50	98	-4.57	a
Olguta	201.5	100	0.43	a

Note: LSD (p5%) 12.96

LSD (p1%) 21.45

LSD (p0.1%) 40.15.

Results obtained regarding production

In the organic farming system, the most productive pea variety was Ghittia with a yield over 2300 kg/ha. Compared to the average yield, very significantly positive differences were found in the Ghittia variety, significantly negative differences in Andrada and very significantly negative differences in Olguta. The Duncan test shows significant differences in yield between the Ghittia variety and the other studied varieties (Table 10).

Table 10. Pea production (2023, Cojocna, Cluj County)

Varieties	Production (kg/ha)	%	Difference/Significance	The Duncan Test
Average of varieties	2104.19	100	control	-
Ghittia	2338.91	1111	234.72***	c
Andrada	2081.42	99	-22.77 ⁰	b
Olguta	1892.23	90	-211.96 ⁰⁰⁰	a

Note: LSD (p5%) 20.02

LSD (p1%) 33.13

LSD (p0.1%) 62.

In the pedoclimatic conditions of Fundătura, specific to the year 2023, pea yield of over 4200 kg/ha were obtained for the studied varieties. Compared to the average yield value, significantly negative differences were found in the Ghittia variety, distinctly significantly negative differences in the Andrada variety and very significantly positive differences in the Olguta variety. Interpreting the results obtained through the Duncan test, it was counted that there are no significant differences in yield in the case of the Ghittia and Andrada varieties, but only between them and the Olguta variety (Table 11).

Table 11. The influence of pea genotype on production, in conventional system (Fundătura, 2023)

Varieties	Yield (kg/ha)	%	Difference/Significance	The Duncan Test
Average of varieties	4668.63	100	control	-
Ghittia	4449.57	95	-219.05 ⁰	a
Andrada	4299.25	92	-363.38 ⁰⁰	a
Olguta	5257.06	113	588.44***	b

Note: LSD (p5%) 152.80

LSD (p1%) 252.83

LSD (p0.1%) 473.23.

Results obtained regarding the percentage of protein

The protein content of the studied varieties was over 21%. A protein content between 21 and 25.7 was obtained by Barbieru et al., 2021. The differences in protein content were small and not statistically assured by either the analysis of variance or the Duncan test (Table 12).

Table 12. Protein content (2023, Cojocna, Cluj County)

Varieties	Protein content (%)	%	Difference/Significance	The Duncan Test
Average of varieties	21.76	100	control	-
Ghittia	21.79	100	0.04	a
Andrada	21.55	99	-0.21	a
Olguta	21.93	101	0.17	a

Note: LSD (p5%) 0.94

LSD (p1%) 1.56

LSD (p0.1%) 2.92.

The protein content of the studied varieties was over 21.5%. Compared to the average protein content of the studied varieties, small differences were found and not statistically assured either by the analysis of variance or by the Duncan test (Table 13).

Table 13. Protein content (Fundătura, 2023)

Varieties	Protein content (%)	%	Difference/Significance	The Duncan Test
Average of varieties	22.09	100	control	-
Ghittia	22,71	103	0,62	a
Andrada	21,53	97	-0,56	a
Olguta	22,03	100	-0,06	a

Note: LSD (p5%) 1,71

LSD (p1%) 2,82

LSD (p0.1%) 5,29.

CONCLUSIONS

Following the research carried out, it was found that the two locations are favourable for the cultivation of autumn peas in the organic and conventional farming system. There are certain productivity elements that recorded different values in the two cropping systems: the number of pods/plants, the number of grains in the pod and the MMB. In the organic farming system, the Olguța variety showed a reduced number of pods/plants, number of grains in the pod and the highest value of the MMB. The most productive pea variety was Ghittia with a yield of over 2300 kg/ha, in the organic farming system and the Olguța variety with a yield of over 5000 kg/ha in the conventional farming system. Regarding the quality of the production, a very important element in the recommendations for the cultivation of some autumn pea varieties, it is found that in both farming systems the percentage of protein was over 21.50%, the variations in the protein content being small and not statistically ensured neither by analysis of variance nor Duncan's test.

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Conflicts of Interest

"The authors declare that they do not have any conflict of interest."

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