IMPROVING THE EFFICIENCY OF PEAS PROTECTION AND IMPROVING THE COMPETITIVENESS OF ITS PRODUCTION

ÎMBUNĂTĂȚIREA EFICIENȚEI PROTECȚIEI DE MAZĂRE ȘI ÎMBUNĂTĂȚIREA COMPETITIVITĂȚII PRODUCȚIEI ACESTEIA

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Abstract.
Annual leguminous crops, and peas in particular, are of great economic importance, used both as food for humans and for feed of farm animals. Pea crops are often damaged by various pests, the most dangerous of which are Acyrthosiphon pisum Harr., Kakothrips robustus Uzel, Sitona lineatus L., Sitona crinitus Hrbst., Bruchus pisorum L., Cydia nigricana Fabr., and Ceramica pisi L.
To more effectively utilize this crop, additional research is needed on cultivation technology, including the use of various chemical plant protection products. In the fight against the main pests of peas, the most effective is the insecticide with active substance cypermethrin with application rate of 0.15 l/ha, which provides a reduction in the number of green pea louse by 98.89–9.,91%, and pea beetle by 98.94–92.46%, within 7–12 days after treatment.
The authors analyzed, based on the income and expenditure budget, what the level of competitiveness is and how it can be optimized.
Key words: peas, pests control, biological efficacy, budget, cost.

Rezumat.
Culturile leguminoase anuale, și în special mazărea, au o mare importanță economică, fiind utilizate atât ca hrană pentru oameni, cât și pentru animale. Culturile de mazăre sunt adesea afectate de diverși dăunători, dintre care cei mai periculoși sunt Acyrthosiphon pisum Harr., Kakothrips robustus Uzel, Sitona lineatus L., Sitona crinitus Hrbst., Bruchus pisorum L., Cydia nigricana Fabr. și Ceramica pisi L.
Pentru a utiliza mai eficient această cultură, sunt necesare cercetări suplimentare privind tehnologia de cultivare, inclusiv utilizarea diferitelor produse chimice de protecție a plantelor. În lupta împotriva principalilor dăunători ai mazărei, cel mai eficient este insecticidul cu substanța activă cipermetrină, cu o doză de aplicare de 0.15 l/ha, care asigură o reducere a numărului de păduchi verzi ai mazărei cu 98.89–92.91% și a gândacului mazărei cu 98.94–92.46%, în decurs de 7–12 zile

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de la tratament. Autorii au analizat, pe baza bugetului de venituri și cheltuieli, care este nivelul de competitivitate și cum poate fi optimizat acesta.

Cuvinte cheie: mazăre, combaterea dăunătorilor, eficacitate biologică, buget, cost.

INTRODUCTION

As early as the early 19th century, it was believed that legumes absorbed nitrogen directly from the air through their leaves, enriching the soil. At the end of the same century, attention was drawn to the nodules located on the roots of legumes. It turned out that these are specialized root nodule bacteria that live on the roots and capture free nitrogen from the atmosphere. Root nodule growth begins at a temperature of 5 °C, and the assimilation of atmospheric nitrogen begins at temperatures above 10 °C (optimum 24-26 °C). To more effectively utilize this crop, additional research is needed on cultivation technology, including the use of various chemical plant protection products.

As already noted, annual leguminous crops, and peas in particular, are of great economic importance due to the high protein content of their grains, which is used both in human and livestock feed. Equally important are peas, which are intended for canning in their green form. However, this crop is often susceptible to attack by various pests, the most dangerous of which are the following species: *Acyrthosiphon pisum Harr., Kakothrips robustus Uzel, Sitona lineatus L., Sitona crinitus Hrbst., Bruchus pisorum L., Cydia nigricana Fabr., Ceramica pisi L.* [Panuţa S., Croitoru N., Bodescu C., Lăcătuşu O., 2018, Panuţa S., Croitoru N., Timuş A., 2010].

To successfully combat the main pea pests, a comprehensive set of integrated methods is used, with agronomic measures being the primary focus. Good results are achieved in controlling the pea armyworm by using the parasitic egg-eater *Trichogramma evanescens Westw* during the mass egg-laying period, releasing 50.000 exemplars per hectare twice, 6-8 days apart. Pheromone traps are also used to determine the level of pea moth population development and determine the optimal timing for chemical treatments.

Chemical control measures are applied only when the economic threshold (ET) of harmfulness is exceeded, which is 20-25 beetles per 1 m², and in dry years – 10-15 beetles per 1 m² for tuber weevils. The economic threshold of harmfulness for the pea weevil is 150-200 beetles per 100 sweeps of an entomological net.

The first chemical treatment is applied during the period of pea seedling emergence – against tuber weevils. To combat the pea weevil, three chemical treatments are recommended: the first – during the budding phase – the beginning of flowering; the second – after flowering and at the beginning of pod formation (if more than 20-25 eggs per 100 pods are detected); the third – 10-14 days after the second.

Initially, edge treatments are used, and when the economic threshold for damage is exceeded, continuous chemical treatments are carried out. Based on the above, the objective of this study was to evaluate the biological efficacy of the insecticide with active substance cypermethrin 500 g/L, in controlling the main pea pests.

MATERIAL AND METHOD

Research testing of the insecticide with active substance cypermethrin 500 g/l, for pea pest control was conducted in 2024 in the fields of the Moroz Alla agricultural firm in the village of Sarata Galbena, Hincesti District, in quadruplicate. The plots were 10 x 10 m in size, with each plot measuring 100 m². The plots were compactly arranged and randomized. The plots were square. 1 m of space was left between the plots as isolation strips. The total area of all experimental plots was 1,600 m², and the total area, including isolation strips, was 1,840 m². To extend the harvesting period, peas were sown at different times. This allowed us to select a plot with the highest pest infestation based on the time and stage of crop development. The seeding pattern was 15 x 8–10 cm, leaving two gaps 30–40 cm wide for equipment to pass through during the growing season [Croitoru, N., Magher, M., Panuța, S., Pește anu, A., 2022; Croitoru N., Panuţa S., Magher M., 202].

Before establishing the field plot experiment, net sweeps were conducted to determine the general and phytosanitary condition of the fields and various sites and to select the most suitable site for the study.

The experiment included four treatment options: 1. Control without treatment; two doses (0,1 and 0,15 l/ha) of insecticide with cypermethrin 500 g/L. Insecticide with cypermethrin 250 g/:, at a rate of 0.3 L/ha, was proposed as the standard.

Throughout the study period, chemical treatments were applied manually using a portable knapsack sprayer. The amount of insecticide and the volume of water required for treatment of each plot and replicates of each treatment were calculated based on the application rates of the insecticides and water per hectare.

Counts to determine the phytosanitary condition were conducted by mowing with an entomological net. The number of tuber weevils was determined by counting adult individuals per square meter during seedling emergence. For this purpose, 0.25 x 0.25 m areas were marked with a ruler at 16 locations in each plot and the number of beetles was counted before, and on the 3rd, 7th, and 14th days after treatment. The numbers of green pea aphids, pea weevils, and pea moths were determined by sweeping with an entomological net, calculating the number of insects per 100 sweeps. The influence of abiotic factors on the development of entomological fauna during the growing season was studied by analyzing meteorological data from 2024.

RESULTS AND DISCUSSIONS

In the southern region of the Republic of Moldova, including at SRL „Moroz Alla", Sarata Galbena village, Hincesti district, climatic conditions were relatively favorable for pea growth. Counts and observations conducted at the beginning of the emergence of pea shoots identified adult of *Sitona lineatus L., Sitona crinitus Hrbst.,* but their numbers were well below the economic threshold. Therefore, chemical treatment was not carried out against this group of pests.

In the second and third ten-day periods of May, of all the pests identified, the highest numbers were observed for pea aphids and pea beetle, whose populations exceeded the economic threshold. Therefore, a field trial was conducted against this group of pests. Chemical treatment was carried out on May 20, 2024. Counts were carried out before chemical treatment and on the 3rd, 7th and 14th day after treatment [Panuţa S., Croitoru N., Bodescu c., Lăcătuşu Oana., 201; Panuţa S., Croitoru N., Timuş Asea., 2010; Кроитору Н., Пануца С., Тимуш Ася., 2010; Пануца С., Кроитору Н., Тропоцел Д., 2014].

The results obtained are presented in table 1. Counts conducted before chemical treatment indicate that pea aphid populations in the experimental plot were quite high, ranging from 143.64 individuals/100 mowings with entomological net in the third treatment to 152.89 individuals/100 mowings with entomological net in the fourth treatment. This indicates a fairly balanced pest population.

Counts conducted on the third day after treatment revealed that complete pest suppression was not achieved in any of the treatments. The best results were obtained in the fourth treatment (1.86 individuals/100 mowings with entomological net) and the standard (2.03 individuals/100 mowings with entomological net). The third treatment yielded 12.54 specimens/100 specimens, which is 6.18 and 6.74 times higher than the standard and fourth treatments, respectively. However, comparing the results obtained in the third treatment with the control shows that this treatment significantly reduced pest numbers. Counts conducted on the 7th and 14th days after treatment indicate a decrease in the discrepancies between the third treatment and the standard and fourth treatments, but these differences remain significant.

Comparing the calculated aphid populations relative to the initial values, it is clear that the best results were achieved in variant 4 (1.21%) and the standard (1.37%), with insignificant differences between them. In Variant 3, this figure was 8.73%, significantly lower than the other experimental variants.

Comparing the results of the counts conducted seven days after treatment, it is clear that variant 4 does not differ significantly from the standard. In variant 3, this figure was 15.75%, which is 8.33 times lower than the control, but significantly higher than the standard and variant 3. The same pattern was observed in subsequent counts. The most convincing results are those calculated for aphid population reduction, compared to the control. The highest results were obtained in the fourth and standard treatments, where the pest population reduction was 98.89% and 98.74%, respectively, and the differences between them were insignificant. In the third treatment, aphid population reduction above 90,0% was achieved only during the first count (92.03%).

On the seventh day after treatment, population reductions above 90,0% were achieved only in the fourth treatment (92.91%) and the standard (92.59%). In these treatments and on the 14th day after treatment, biological effectiveness was quite high (87.08% and 86.41%), while in the third treatment, the aphid population reduction was 86.84%–75.67%.

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Thus, it can be concluded that of all the tested options, the most effective insecticide with cypermethrin 500 g/L, applied at a rate of 0.15 L/ha. It provides effective reduction in pea aphid populations for 7-12 days after treatment and is comparable to the standard. The same product, applied at a rate of 0.1 l/ha, only reduces the pest population in the first few days after treatment.

Pre-blooming surveys revealed that, along with pea aphids, pea weevil beetles had appeared in the pea field, including the experimental plot. The numbers ranged from 17.55 to 19.43 adult individuals per 100 mowings with entomological net. Therefore, we conducted research on this pest. Counts were conducted by mowing with an entomological net, 10 sweeps per plot. The biological efficacy of insecticide with cypermethrin 500 g/L against pea beetle was calculated using the formula above. The results are presented in table 2. The table shows that the pea weevil population was fairly even, as evidenced by the surveys conducted before chemical treatment. It should be noted that pest numbers in all experimental treatments exceeded the economic threshold for damage. Counts conducted on the third day after treatment indicate a sharp reduction in beetle numbers in all treatments, while in the control treatment, the number of beetles increased to 21.25 individuals.

Comparing the experimental variants, it is clear that the best results were achieved in variant 4 and the standard, where the beetle counts were 0.25 and 0.32 specimens/10 mowings with entomological net, respectively. In Variant 3, the number of remaining live beetles was 1.92 specimens/10 sweeps, which is 6.00 times higher than in the standard and 7.68 times higher than in Variant 4. The same pattern was observed in the subsequent two counts.

Comparing the percentage of detected live beetles with the initial counts, it is clear that Variant 4 and the standard again achieved the best results. Thus, on the third day after treatment, the number of live beetles was 1.28 and 1.72%, respectively, and the differences between them are not significant. In the third variant, during this period, the beetle population was 10.67%, which is 11.35 times lower than the control. However, the results obtained were significantly lower than both the standard and the fourth variant. The same trend was observed in the subsequent two counts.

Table 1

Biological efficacy of the insecticide cypermethrin 500 g/l, in the control of *Acyrthosiphon pisum* (2024)

Experimental variants	Application rate, L/ha	Aphid count per 100 sweeps of an entomological net				Aphid density in %, compared to initial, on…day after treatment			Reduction in aphid numbers, compared to control, in %, on …day		
		Before treatment	On ...day after treatment								
			3	7	14	3	7	14	3	7	14
V_1 – control	-	144.39	158.23	189.46	216.24	109.58	131.21	149.76	0.0	0,0	0,0
V_2 – standard, cypermethrin, 250 g/L	0.3	147.39	2.03	13.07	22.86	1.37	8.86	15.50	98.74	92.59	86.41
V_3 - cypermethrin, 500 g/L	0.1	143.64	12.54	22.63	39.89	8.73	15.75	27.77	92.03	86.84	75.67
V_4 - cypermethrin, 500 g/L	0.15	152.89	1.86	12.98	22.54	1.21	8.48	14.74	98.89	92.91	87.08
LCD, 95%, p-5%			3.15	4.57	5.89	3.25	4.63	5.88	3.54	4.75	5.63

Table 2

Biological efficacy of the insecticide cypermethrin 500 g/l, in the control of Bruchus pisorum (2024)

Experimental variants	Application rate L/ha	Number of beetles per 10 sweeps of an entomological net				Number of beetles in %%, compared to the initial, on…day after treatment			Reduction in the number of beetles, compared to control, in %%, on …day		
		Before treatment	On ...day after treatment								
			3	7	14	3	7	14	3	7	14
V_1 – control	-	17.55	21.25	23.63	27.88	121.08	134.64	158.86	0.0	0.0	0.0
V_2 – standard, cypermethrin, 250 g/L	0.3	18.59	0.32	1.71	2.88	1.72	9.19	15.49	98.58	91.73	86.87
V_3 - cypermethrin, 500 g/L	0.1	17.98	1.92	3.25	7.38	10.67	18.07	41.04	91.18	83.74	65.21
V_4 - cypermethrin, 500 g/L	0.15	19.43	0.25	1.63	2.75	1.28	8.38	14.15	98.94	92.46	88.00
LCD, 95%, p-5%			1.54	1.49	4.37	4.63	5.25	5.89	4.56	6.99	7.34

Calculations of beetle population reduction compared to the control indicate that on the 3rd day after treatment, this figure was 98.94% and 98.58%, respectively, in the 4.th and 98,58% variants, with insignificant differences, while in the 3rd variant, this figure reached 91.18%.

Counts conducted on the 7th day after treatment revealed that, in the 3rd variant, the beetle population reduction dropped sharply to 83.74%. In the 4th variant and 91.73% variant, this figure was significantly higher, reaching 92.46% and 91.73%, respectively.

Counts conducted on the 14th day after treatment revealed an overall decrease in the percentage of population reduction in all experimental variants, although even during this period, the 4th variant significantly outperformed the 3rd variant and remained at the same level as the standard.

Based on experimental data obtained in 2024, it can be considered established that the most effective insecticide for controlling pea weevil beetles is insecticide with cypermethrin 500 g/L at dose of 0.15 L/ha, providing a 98.94–92.46% reduction in pest numbers within 7–12 days after treatment, comparable to the standard. A lower application rate of this same product (0.1 l/ha) is significantly inferior to both the standard and the fourth option, and provides protection to pea plants only in the first few days after treatment.

It is known that when determining the biological efficacy of insecticides against pea weevil beetles, not only the degree of effect of the product on adult pests is considered, but also the extent of damage to grains by larvae. Therefore, in addition to pea weevil beetle counts, we also conducted counts to determine the degree of grain damage before harvesting peas. To do this, 300 grains were taken from each plot, the number of damaged and undamaged grains was counted, and the degree of grain damage was then calculated. The results of these counts are presented in table 3.

The table shows that the lowest grain damage was observed in variant 4 and the standard, where this figure was 0.88% and 0.75%, respectively. Regarding variant 3, it is clear that grain damage was 6.71%, which is significantly higher than the standard and variant 4, but 11.54 times lower than the control.

Thus, the grain damage analysis results revealed that the greatest reduction in grain damage was achieved in variant 4 and the standard, while variant 3 was significantly inferior to the above-mentioned variants.

Counts and observations of pea thrips development in the experimental plot revealed that, prior to chemical treatment, the population of this pest was represented by single individuals. Number of thrips were detected in any of the post-treatment counts, demonstrating the high efficacy of the studied chemicals against this group of pests.

Table 3

Effect of chemical treatment of peas with insecticide cypermethrin 500 g/L, on grain damage by *Bruchus pisorum*

Experimental variants	Application rate, L/ha	Number of grains (pcs.)			Damage to grains; in %%
		Taken for analysis	Of these		
			Damaged	Undamaged	
V_1 – control	-	300	232.25	67.75	77.42
V_2 – standard, cypermethrin, 250 g/L	0.3	300	2.25	297.75	0.75
V_3 – cypermethrin, 500 g/L	0.1	300	20.13	279.87	6.71
V_4 – cypermethrin, 500 g/L	0.15	300	2.63	297,37	0.88
LCD. 95%, p-5%					4.96

Table 4

Budget and cash flow analysis for peas cultivation per hectare

Specification	Amount euro/ha	Consumption structure, %	Cash flow for the months of the year, euro / ha											
			January	February	March	April	May	June	July	August	September	October	November	December
Initial cash flow	**X**	**X**	**0.0**	**0.0**	**0.0**	**0.0**	**-230.1**	**-550.1**	**372.7**	**370.8**	**368.8**	**350.9**	**301.0**	**139.5**
I. Net sales	**984.6**	**X**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**984.6**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
II. Cost of inputs	477.0	56.4%	0.0	0.0	0.0	183.1	284.7	1.9	1.8	1.8	1.8	1.8	0.0	0.0
III. Cost of machinery services	162.3	19.2%	0.0	0.0	0.0	31.2	20.0	50.2	0.0	0.0	15.3	45.7	0.0	0.0
IV. The cost of manual operations	6.1	0.7%	0.0	0.0	0.0	4.9	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0
V. Other costs and fees	159.5	18.9%	0.0	0.0	0.0	0.0	0.0	5.6	0.0	0.0	0.0	0.0	153.8	0.0
VI. Unforeseen ((II+III+IV+V)*5%)	40.2	4.8%	0.0	0.0	0.0	11.0	15.2	2.9	0.1	0.1	0.9	2.4	7.7	0.0
VII. Fixed + variable cost (II+III+IV+V+VI)	**845.1**	**100.0%**	**0.0**	**0.0**	**0.0**	**230.1**	**320.0**	**61.8**	**1.9**	**1.9**	**18.0**	**49.9**	**161.5**	**0.0**
VIII: Gross margin (gross profit) (VIII-VII)	**139.5**	**X**	**0.0**	**0.0**	**0.0**	**-230.1**	**-320.0**	**922.8**	**-1.9**	**-1.9**	**-18.0**	**-49.9**	**-161.5**	**0.0**
IX: Gross margin percentage (I / VII*100%)	16.5%	X	X	X	X	X	X	X	X	X	X	X	X	X
X. Unit cost, euro/t	211.29	X	X	X	X	X	X	X	X	X	X	X	X	X
Cash flows final	**X**	**X**	**0.0**	**0.0**	**0.0**	**-230.1**	**-550.1**	**372.7**	**370.8**	**368.8**	**350.9**	**301.0**	**139.5**	**139.5**

Competition is extremely important for the sustainable development of agriculture (and not only), it requires farmers to invest and develop value chains aimed at increasing the competitiveness of peas and increasing adaptation to different resilience (especially climatic and economic).

Based on the research conducted for the peas crop and the calculated income and expenditure budget, it was possible to determine the economic efficiency, which profit is a minimum of 139.5 euros/ha, with a minimum economic profitability of 16.5% and a unit cost of 1 ton of peas of 211.29 euros/t, which requires the farmer to ensure impeccable agro-technological discipline to achieve these results.

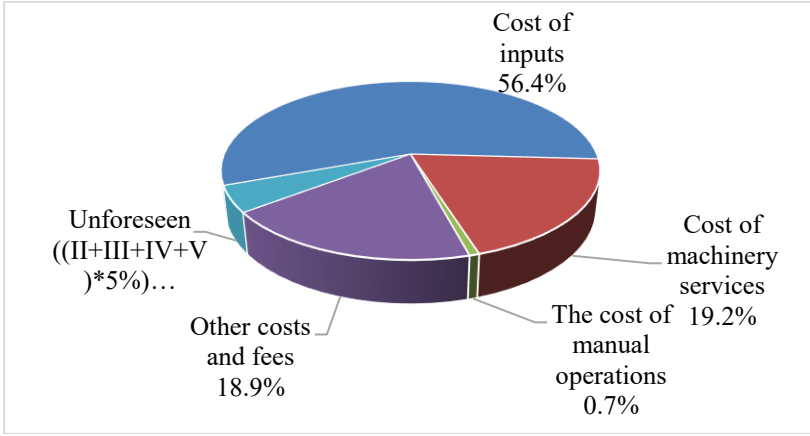

Figure 1. Structure of direct costs per hectare for peas cultivation by cost items, %
Source: Developed by the group of authors (Zbancă A., Panuţa S., Morei V., Stratan A., Fală A., Litvin A., 2017).

The peas crop is characterized by low economic efficiency, due to high direct costs, namely: material resources 56.4%, the cost of mechanized services 19,2% and other costs (the main one is the rent payment) 18.9%, which is very risky in the current agricultural conditions and with the application of the conventional farming system.

CONCLUSIONS

1. Meteorological conditions, 2024 year, contributed to the high development of pea aphids and pea beetle.
2. In the fight against the main pea pests, the most effective is the insecticide with active substance cypermethrin 500 g/L, with a application rate of 0.15 l/ha, which provides a reduction in the number of pea aphids by 98.89 – 92.91%, and pea beetle by 98.94 – 92.46%, within 7 – 12 days after treatment.

3. The insecticide with active substance cypermethrin 500 g/L, with application rate of 0.1 L/ha provides effective protection of pea plants only in the first days after treatment, and in the following days its effectiveness drops sharply and is significantly inferior to both the 4th variant and the standard.

4. Based on the conducted researches and obtained results, the insecticide with active substance cypermethrin 500 g/L, is recommended as an insecticide against pea aphids, pea beetle and other pea pests, by performing 1-2 chemical treatments, with application rate of 0.15 L/ha.

5. Pea culture is excellent as a pre-emergent and especially for the cereal seeding sectors, as it allows the production of quality seeds;

6. Pea is a fully mechanized crop, but with a difficult harvesting process and low economic efficiency, which does not facilitate its mass cultivation.

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