BIOLOGICAL AND PEST CONTROL CHARACTERISTICS IN SUGAR BEET CULTIVATION AND ECONOMIC EFFICIENCY ANALYSES BASED ON BUDGETING

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Abstract. The experiments to determine the biological efficiency of the Boxer Starker preparation were carried out in 2024, in accordance with the program and the cooperation agreement between the State Center for Certification and Approval of Phytosanitary Products and the Technical University of Moldova. The report includes data on the current state of sugar beet protection, the need to carry out scientific work related to testing new preparations is argued. The report includes the scheme of the experiments, the name of the variants and their content, the characteristics of the pedoclimatic conditions during the testing work, budget planning and analyze of efficiency, the results obtained, conclusions and recommendations. To study the influence of abiotic factors on beneficial and harmful organisms, weather station data for 2024 were analyzed. The weather conditions were favorable both for the growth and development of sugar beet plants, and for the spread and development of the main pests of this crop.

Keywords: Sugar beet, pests control, biological efficacy, efficiency, profit, budget, cost, cash flow.

INTRODUCTION

Sugar beet cultivation has a long-standing tradition in Moldova, dating back to the 17th century. In the period following the First World War, the areas cultivated with sugar beet did not expand significantly. Sugar beet is cultivated for its roots, from which sugar is obtained as the main product through processing, while molasses and beet pulp are obtained as by-products, used for animal feed and for producing ethyl alcohol. Sugar beet requires deep, fertile soils rich in humus, well-structured, with high water retention capacity. The most suitable soils are sandy loam soils, chernozems, and brown forest soils, with the groundwater table located at a depth of 2-4 meters.

For the successful protection of sugar beet crops against pests, a series of preventive and therapeutic measures must be implemented during each vegetation period of the year. The Republic of Moldova is located in a zone highly favorable for the development of a wide range of sugar beet pests. All plant protection measures should be aimed at reducing pest population density. Among preventive measures for controlling sugar beet pests, agro-technical methods have proven to be the most effective [1, 2, 3].

It should be noted that the aforementioned methods do not always ensure a reduction of pest populations below the economic damage threshold. However, the chemical method of pest control requires continuous study and updating of plant protection products.

Based on the above, the purpose of the present research was to study the biological efficacy of the insecticide Boxer Starker (acetamiprid, 200 g/L + lambda-cyhalothrin, 150 g/L) in controlling sugar beet pests. To achieve this objective, the following tasks were established: determining the phytosanitary status of sugar beet fields and selecting the plot for research; studying the influence of abiotic factors on the development of the main pest species of sugar beet; setting up experimental trials; applying chemical treatments; determining the biological efficacy of two doses of the insecticide Boxer Starker in controlling sugar beet pests.

MATERIALS AND METHODS

Experiments aimed at determining the biological efficacy of the preparation Boxer Starker were conducted in 2024 in sugar beet fields at the agricultural enterprise SRL "AGRO-PAPUROS" in the village of Marandeni, Fălești District, located in the northern region of the Republic of Moldova. The crop was sown in the first decade of April. In selecting the appropriate plot for the trials, methodological requirements for insecticide testing were observed.

The trials for testing Boxer Starker included four variants: V_1-untreated control; V_2-standard, insecticide Pirimor 50 WG, application rate 0.35 kg/ha; V_3-insecticide Boxer Starker, application rate 0.15 l/ha; V_4 -insecticide Boxer Starker, application rate 0.2 l/ha.

The experiments were arranged in four replications, with a plot area of 100 m². Each plot had a rectangular shape, including 22 rows with an inter-row spacing of 0.45 m and a row length of 10 m. The layout was compact and randomized, with rows and plots oriented from north to south. Between experimental plots, protective strips 0.45 m wide (one row) were left. Thus, the total area of experimental plots was 1,600 m², while the overall experimental site covered 1,700 m².

Based on the testing and evaluation of the results, the group of authors developed a budget of income and expenses for sugar beet cultivation and economic efficiency analyses for an area of one hectare.

RESULTS AND DISCUSSIONS

From plant protection practice, it is well established that overwintering adults of *Tanymecus palliatus F.* emerge in April-May and attack sugar beet crops in the seedling stage or at the 2–4 leaf stage [1, 3]. Therefore, in 2024, chemical treatment was applied on April 25.

Pest monitoring was carried out by examining plants in four samples measuring 0.5×0.5 m (1 m² in each plot). All adults present on plants and soil surface were recorded, counting both live and dead/paralyzed specimens. The latter were divided equally between "dead" and "alive" categories. Monitoring was conducted before treatment and on the 1st, 3rd, 7th, and 14th day after treatment.

Analysis of the data presented in Table 1 shows that, before treatment, the density of *Tanymecus palliatus F.* adults ranged from 2.38 individuals/m² in the control to 2.88 individuals/m² in variant 4. On the first day after treatment, no pests were detected in any of the insecticide-treated variants, while in the control, the pest density reached 2.63 individuals/m².

Records taken on the third day after treatment showed that in variants 3 and 4 no pests were found, while in the standard variant the density of beet weevils was 0.23 individuals/m². On the seventh day after treatment, results indicated a reduction in the efficacy of the products; however, even in this case, only 0.19 individuals/m² were detected in variant 3, which was close to the level in variant 4 (0.14 individuals/m²). Comparing beet weevil densities with initial levels reveals that on the first day after treatment, no pests were detected in any treated variant.

Table 1

Biological efficiency of insecticide Boxer Starker, in control the species *Tanymecus palliatus* F.

Experimental variants	Application rate kg, L/ha	Number of individuals per 1 m²					Beetle density after treatment (% of initial)				Reduction in density compared to the control (%) at … days after treatment			
		Before treatment	On the .... day after treatment											
			1	3	7	14	1	3	7	14	1	3	7	14
V_1 – Control	-	2.38	2.63	2.88	3.13	4.00	110.50	121.0	131.51	168.06	0.0	0.0	0.0	0.0
V_2 -Standard, Pirimor 50 WG	0.35	2.63	0.00	0.23	0.48	1.25	0.00	8.74	18.25	47.52	100.0	92.77	83.21	62.81
V_3 - Boxer Starker	0.15	2.50	0.00	0.00	0.19	0.42	0.00	0.00	7.60	16.80	100.0	100.0	93.01	86.85
V_4 - Boxer Starker	0.2	2.88	0.00	0.00	0.14	0.37	0.00	0.00	4.86	12.84	100.0	100.0	95.53	89.95
LSD 95%					0.27	0.79			3.07	4.13			7.80	8.50

Source: developed by the group of authors

Analysis of the results in this section shows that, on the first day after treatment, variants 4, 3, and the standard achieved a complete reduction of the pest population. The trend observed earlier persisted on the seventh day after treatment. In variants 3 and 4, the biological efficacy reached 93.01% and 95.53%, respectively, and these values significantly exceeded the standard.

Results obtained on the 14th day after treatment indicate a decline in the efficacy of the products in all treated variants.

Based on the conducted research and the obtained results, it can be concluded that the insecticide Boxer Starker at an application rate of 0.2 L/ha ensures a reduction in *Tanymecus palliatus F.* density at a level of 100.00–95.53% for a period of 7–12 days after treatment, being comparable to variant 3 and significantly outperforming the standard.

Preventive records and observations conducted throughout June revealed a notably high density of the beet tortoise beetle (*Cassida nebulosa L.)* and the beet moth (*Scrobipalpa ocellatella Boyd*), with populations exceeding the economic threshold (ET) [1, 2]. Consequently, a second chemical treatment was applied on June 10.

Table 2

Biological efficiency of insecticide Boxer Starker, in control the species *Cassida nebulosa* L.

Experimental variants	Applica-tion rate kg, L/ha	Number of individuals per 1 m²				Beetle density after treatment (% of initial)			Reduction in density compared to the control (%) at … days after treatment		
		Before treat-ment	At ... days after treatment								
			3	7	14	3	7	14	3	7	14
V_1 – Control	-	2.42	2.88	3.75	5.25	119.00	154.95	116.94	0.0	0.0	0.0
V_2 -Standard, Pirimor 50 WG	0.35	2.50	0.34	0.51	1.43	13.60	20.40	27.20	88.57	84.33	59.14
V_3 - Boxer Starker	0.15	2.63	0.17	0.45	1.37	6.46	17.11	52.09	94.57	86.86	62.79
V_4 - Boxer Starker	0.2	2.75	0.13	0.37	1.32	4.72	13.45	48.00	96.03	89.67	65.71
LSD 95%			0.38	0.96	1.07	3.63	3.88	4.17	7.56	5.89	8.67

Source: developed by the group of authors

The results obtained are presented in Table 2. Data show that the number of *Cassida nebulosa L.* adults before the start of treatment ranged from 2.42 individuals/m² in the control to 2.75 individuals/m² in variant 4.

Records taken on the third day after treatment showed a slight increase in pest numbers in all experimental variants. In variants 4 and 3, beetle density amounted to 0.13 and 0.17 individuals/m², respectively, matching the level recorded in the standard.

Results from the subsequent two assessments demonstrated a decline in insecticide efficacy across all experimental variants. Comparing the experimental variants, it can be seen that on the seventh day after treatment, pest density in variants 4 and 3 was 0.37 and 0.45 individuals/m², respectively, which corresponded to the standard. On the 14th day after treatment, differences between variants 4, 3, and the standard were not significant.

Based on obtained results, it was established that the insecticide Boxer Starker, applied at rates of 0.15–0.2 L/ha, ensures a reduction in the numerical density of *Cassida nebulosa L.* ranging between 94.57–86.86% and 96.03–89.67% over a period of 7–10 days, performing at the level of the standard treatment.

According to long-term scientific data, it is well established that under the conditions of the Republic of Moldova, the population dynamics of the beet moth (*Scrobipalpa ocellatella Boyd*) are relatively stable and rarely exceed the economic damage threshold (EDT). Observations on the development dynamics of the beet moth population in 2024 showed that the first larvae in the experimental plot were detected in the second decade of June. Therefore, the second chemical treatment was also targeted against the beet moth larvae.

Table 3 shows that the density of *Scrobipalpa ocellatella Boyd* before treatment was relatively uniform, ranging from 2.57 individuals per plant in the control to 3.32 individuals per plant in variant 4. Observations made on the third day after treatment demonstrated the presence of beet moth larvae in all variants, with the lowest density recorded in variant 4 at 0.12 individuals per plant, comparable to variant 3 and the standard. In the control, the density was 2.88 individuals per plant.

Table 3

Biological efficiency of insecticide Boxer Starker, in control the species *Scrobipalpa ocellatella* Boyd.

Experimental variants	Application rate kg, L/ha	Larvae density, specimens per plant				Pest density, % relative to initial level			Reduction in larvae density relative to untreated control, % at ... days after treatment		
		Before treatment	At ... days after treatment								
			3	7	14	3	7	14	3	7	14
V_1 – Control	-	2.57	2.88	3.13	3.63	112.06	121.78	141.24	0.00	0.00	0.00
V_2 -Standard, Pirimor 50 WG	0.35	3.07	0.23	0.36	0.72	7.49	11.72	23.45	93.31	89.21	79.78
V_3 - Boxer Starker	0.15	2.82	0.17	0.34	0.70	6.02	12.05	24.82	94.62	88.91	78.60
V_4 - Boxer Starker	0.2	3.32	0.12	0.21	0.63	3.61	6.32	18.97	96.77	94.18	83.64
LSD 95%			0.14	0.23	0.61	3.96	5.89	6.13	2.09	3.15	6.25

During the next two assessments, a slight increase in pest density was noted; however, only variant 4 maintained the minimal value. In the standard and variant 3, pest density ranged from 0.36 to 0.72 and 0.34 to 0.70 individuals per plant, respectively.

In the control variant, pest density on the 14th day after treatment reached 3.63 individuals per plant, which is 1.41 times higher than the pre-treatment level.

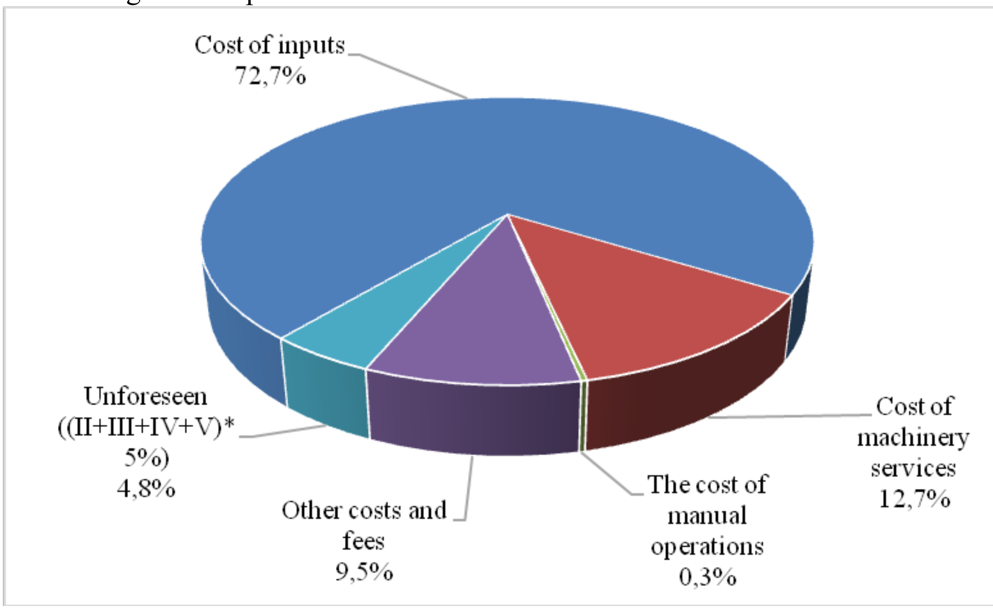
Analysis of *Scrobipalpa ocellatella Boyd* larval density relative to initial values revealed that both the standard and variant 4 showed a reduction in this index, from 23.45% to 7.49% and from 18.97% to 3.61%, respectively, with deviations being statistically insignificant. Variant 3 performed slightly worse than variant 4 but remained at the level of the standard.

It is noteworthy that the maximum reduction on the seventh day after treatment was observed in variant 4, surpassing both the standard and variant 3. The biological efficacy in variant 3 was consistent with the standard level.

Generalizing the obtained results, it can be concluded that the most effective insecticide for controlling the sugar beet moth larvae *Scrobipalpa ocellatella* is Boxer Starker, applied at a rate of 0.2 l/ha. This treatment ensures a pest reduction level of 96.77–94.18% over a period of 10–12 days, significantly outperforming both the third variant and the standard treatment. The same preparation, applied at 0.15 l/ha, provides a reduction of 94.62–88.91% during 7–10 days after treatment, but its efficacy decreases substantially thereafter, reaching the level of the standard.

Research based on testing and evaluation of results allowed the group of authors to develop a budget of income and expenses for sugar beet cultivation and analyze economic efficiency for an area of one hectare.

Based on the research conducted for sugar beet crop and the calculated income and expenditure budget, it was possible to determine the economic efficiency, which profit is a minimum of 893.9 euros/ha, with a minimum economic profitability of 53.5% and a unit cost of 1 ton of sugar beet of 33.4 euros/t, which requires the farmer to ensure impeccable agro-technological discipline to achieve these results.



Source: Developed by the group of authors [4, 5]

Figure 1. Structure of direct costs per hectare for sugar beet cultivation by cost items, %

The sugar beet crop is characterized by good economic efficiency (especially in the agricultural year with uniform rainfall throughout the months of the year), due to high direct costs, namely: material resources 72.7%, other costs (the main one is the rent payment) 9.5% and the cost of mechanized services 19.5%, which is very risky in the current agricultural conditions and with the application of the conventional farming system.

Table 4

Budget and cash flow analysis for sugar beet 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	-656.6	-991.7	-1,351.0	-1,352.9	-1,370.9	-1,506.7	-226.6	893.9
I. Net sales	2,564.1	X	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1,282.1	1,282.1	0.0
II. Cost of inputs	1,214.2	72.7%	0.0	0.0	0.0	563.1	272.8	301.7	1.8	1.8	71.1	1.8	0.0	0.0
III. Cost of machinery services	212.4	12.7%	0.0	0.0	0.0	60.6	44.9	34.8	0.0	15.3	56.8	0.0	0.0	0.0
IV. The cost of manual operations	4.6	0.3%	0.0	0.0	0.0	1.6	1.5	0.0	0.0	0.0	1.5	0.0	0.0	0.0
V. Other costs and fees	159.5	9.5%	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%)	79.5	4.8%	0.0	0.0	0.0	31.3	16.0	17.1	0.1	0.9	6.5	0.1	7.7	0.0
VII. Variable cost (II+III+IV+V+VI)	1,670.2	100.0%	0.0	0.0	0.0	656.6	335.1	359.3	1.9	18.0	135.9	1.9	161.5	0.0
VIII: Gross margin (profit) (VIII-VII)	893.9	X	0.0	0.0	0.0	-656.6	-335.1	-359.3	-1.9	-18.0	-135.9	1,280.1	1,120.5	0.0
IX: Gross margin (I / VII*100%)	53.5%	X	X	X	X	X	X	X	X	X	X	X	X	X
X. Unit cost, euro/t	33.4	X	X	X	X	X	X	X	X	X	X	X	X	X
Cash flows final	X	X	0.0	0.0	0.0	-656.6	-991.7	-1,351.0	-1,352.9	-1,370.9	-1,506.7	-226.6	893.9	893.9

Source: Developed by the group of authors [4, 5]

CONCLUSIONS

1. In 2024, more than 10 pest species were detected in sugar beet, including beet weevils, large beet tortoise beetles and beet moths, which exceeded the economic threshold (ET).

2. Insecticide Boxer Starker, with a aplication rate of 0.15 l/ha, ensures a reduction in the numerical density of beet leaf weevil at the level of (100.00 - 93.01%), the large beet tortoise beetle at the level of 94.57-86.86 and the beet moth at the level of (94.62-88.91%), over a period of 5-7 days.

3. The most effective in control beet pests is the insecticide Boxer Starker, with a application rate of 0.2 l/ha, which ensures a reduction in the numerical density of beet leaf weevil at the level of (100.00 - 95.53%), the large beet tortoise beetle at the level of 96.03-89.67% and the beet moth at the level of (96.77-94.18%) over 7-10 days, and these indices significantly exceed the 3rd option and the standard.

4. Based on the results obtained, the insecticide Boxer Starker can be included in the sugar beet protection system to control beet weevils, large beet tortoise beetles and beet moths, by performing 1-2 treatments, when the economic threshold (ET) is exceeded - with application rate of 0.15-0.2 l/ha.

5. The final conclusion is positive, because the research and application demonstrated profitability-increasing effects, which were based on testing and evaluation of the results, which allowed the group of authors to develop a budget of income and expenses for sugar beet cultivation and to analyze the economic efficiency for an area of one hectare.

REFERENCES

1. Croitoru N., Panuţa S., Magher M. (2021). Morfologia și biologia insectelor. Indicații metodice la lucrările de laborator pentru masteranzii de la specializarea 081. MP – protecția integrate a plantelor. Universitatea Agrară de Stat din Moldova. Chişinău, 2021, 49 p.
2. Croitoru N., Panuţa S., Herea monica., Mocanu Ionela (2018). Unele aspecte în combaterea dăunătorilor Chaetocnema spp., Atomaria linearis în cultura sfeclei-de-zahăr. In: Lucrări ştiinţifice, UASM. Chişinău, Vol. 47, p. 587-591.
3. Timuş Asea, Panuţa S (2004). Curculionide and Atelabidae species developing on economic injuri level (E.I.L.) in Republic of Moldova. In: Protecţia Plantelor. Realizări şi perspective. Chişinău, p. 71-74
4. Zbancă A., Panuța S., Morei V., Stratan A., Litvin A., Fala Iu. Bugetarea activităților din sectorul vegetal al Republicii Moldova. Ghid. UASM, Chișinău, 2017, 350 pagini, ISBN 978-9975-64-147-0
5. Zbancă, A., Balan I., Negritur Gh. Gestiunea bugetelor de venituri și cheltuieli pentru culturi agricole în sezonul agricol 2023-2024 în RM. În: Monitorul Fiscal FISC.MD. Chișinău, 2023, nr. 4 (81), p. 52-57, 0,7 c.a. ISSN-1857-3991. https://monitorul.fisc.md/gestiunea-bugetelor-de-venituri-si-cheltuieli-pentru-culturi-agricole-in-sezonul-agricol-2023-2024-in-rm/