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EFFICACY OF INSECTICIDES ON SEED ALFALFA IN THE SECOND YEAR OF LIFE

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Abstract

The aim of the study was to study the effectiveness and provide an economic assessment of the use of various insecticides against pests on alfalfa seed crops in the second year of the grass stand. The research was conducted during 2019–2021 at the experimental field of the Institute of Irrigated Agriculture of the NAAS. Treatment with insecticides was carried out: the first – in the phase of the beginning of budding, the second - before the beginning of flowering. The use of insecticides reduced the number of pests on the grass stand. The most effective in the fight against pests (with the exception of Aphis craccivora Koch) was the preparation with the active substances Chlorpyrifos, 500 g/l and Cypermethrin, 50 g/l and the consumption rate of 1.00 l/ha. The highest seed yield was obtained in the first treatment with an insecticide preparation with the active substances Chlorpyrifos, 500 g/l and Cypermethrin, 50 g/l and the consumption rate of 1.00 l/ha, and in the second treatment with preparations with the active substances Chlorantraniliprole, 200 g/l and Lambda-cyhalothrin, 50 g/l at a rate of 0.17 and 0.15 l/ha, respectively. When irrigated with this variant, the seed productivity was 635.2 kg/ha, which was higher than the control variant by 115.3 kg/ha. Under conditions of natural moisture, the seed yield was 452.5 kg/ha, and was higher than the control by 74.3 kg/ha. The lowest cost price of 0.66 €/ha and the highest conditional net profit of 1702.87 €/ha was obtained on the option: the first treatment - Chlorpyrifos, 500 g/l and Cypermethrin, 50 g/l, the second – Chlorantraniliprole, 200 g/l and Lambda-cyhalothrin, 50 g/l.

Key words: *alfalfa, seeds, insect, irrigation, economic efficiency*

INTRODUCTION

The main purpose of agriculture is the cultivation of crops, the production of food products for human consumption and domestic animals. With the increase in the population in the world and in order to meet its needs, it is necessary to increase the productivity of plants. However, unfortunately, there are pests that reduce the yield of crops intended for human consumption [6, 8, 20]. It is believed that the world produces enough agricultural products to meet the needs of the population, but the damage caused by pests of agricultural crops leads to severe economic consequences [11]. For example, in alfalfa, one of the factors that determines its seed productivity is the presence and number of insect pests. Depending on the different conditions that exist in each specific case on the grass stand, seed yield losses can reach 30–50%, and in some cases even more. However, the yield can be significantly increased by timely prevention of losses from diseases, pests and weeds [21]. Overall crop losses from insect damage have increased, largely due to changes in agricultural practices and growing technologies. Effective control of crop pests is very important to minimize damage and, as a result, economic losses, especially in recent years with an increase in the number of warm winters, which are favorable conditions for overwintering and development of pests [10]. The use of various agricultural methods, sometimes even with the use of resistant varieties, does not always provide the desired level of plant protection, and thus additional control measures in the form of the use of synthetic chemicals are necessary [2].

However, successful chemical control requires a great deal of knowledge about the effects of insecticides not only on the mortality and oviposition of insect pests (especially vectors), but also on the rate at which the insecticide affects their feeding behavior [9]. The phytosanitary condition of agrocenoses, despite the measures taken, does not improve due to the implementation of zero and minimal tillage, non-observance of crop rotation, unbalanced application of mineral fertilizers, insufficient and incorrect use of pesticides, non-observance of crop cultivation technologies [12]. According to Abate T. and Ampofo J.K.O. there is a lot of evidence that pest populations and their numbers are significantly higher in monoculture crops than in crop rotation, and growing two or more crops in the same field simultaneously increases the number of entomophages and generally keeps pest numbers low [1]. Agrotechnological methods, including site selection, crop rotation, choice of variety (hybrid) and seed material, timing and method of sowing, can to some extent reduce the number of some insect pests. For example, [4] reported a decrease in the number of aphids on wheat during early sowing. Aheer G.M. etc. [16] showed that the timing of sowing affects the population of aphids and other pests of leguminous crops. In addition, the number of pests can be regulated by the width of the row spacing and the density of plants, by weed control [18]. Forbes V.E. note that the use of mulch of straw and mustard reduces the population and number of insect pests of beans by 75% [3]. Moreover, studies have established that sloping areas and forest strips reduce wind speed, complicate the migration of aphids and, accordingly, affect their spread, which reduces the degree of damage to plants by viral diseases [13]. The fight against vector insects is a serious problem, so the choice of the most effective insecticides in the fight against them in different environments is always important [7]. Insects are a huge group of living organisms, but not many of them are harmful to crops. Insecticides used in crop production do not have a selective effect and, as a rule, destroy all entomofauna [5]. Alfalfa is often called the beginning of the food chain, because it supports not only domestic animals and humans, but also many species of wild animals and birds (more than 700) and more than 1000 species of arthropods, which are very important for the Earth's ecosystem [17, 24]. Alfalfa, grown for seeds, is severely damaged by pests, both omnivorous and specialized. The duration of cultivation and the length of the growing season, its high fodder value and the presence of conditions for overwintering pests contribute to their settlement and increase in their number [22]. According to Holoborodko S.P. etc. ecological and faunal studies conducted in the Left Bank of the Lower Dnieper of the Southern Steppe of Ukraine established and systematized the species composition of the alfalfa seed biocenosis and gave them an economic assessment. 157 types of pests [23] cause complex damage to all organs of seed alfalfa. Alfalfa crops are damaged at various stages of plant development – from seed germination to crop ripening. They cause the most tangible damage to seed crops, damaging generative organs and seeds. The species composition and number of pests of seed alfalfa are affected by weather conditions that develop during the growing season and during the wintering period. Therefore, the absence or untimely implementation of protection measures sharply reduce the seed yield and its sowing quality [21].

It should be noted that the pests that severely damage grassy alfalfa in the first year of seed use are the *Adelphocoris lineolatus Goeze.*, *Tychius flavus Berck*, *Bruchophagus roddi Guss.*, *Aphis craccivora Koch* and, in some years, the *Margaritia sticticalis*. Thus, the species composition of insect pests on grassy alfalfa, their number and harmfulness change significantly both in the zonal aspect and during the life of alfalfa in one field and during the growing season [14, 19]. However, despite the sufficient study of the species composition of entomofauna on seed alfalfa, thorough information on harmfulness, ecology and integrated protection of alfalfa crops both from a complex of pests and from individual species is extremely scarce in the literature.

The aim of the study was to study the effectiveness and provide an economic assessment of the use of various insecticides against pests on alfalfa seed crops in the second year of the grass stand.

MATERIALS AND METHODS

The research was conducted during 2019–2021 at the experimental field of the Institute of Irrigated Agriculture of the NAAS. In terms of soil and climate, it is located in the steppe zone, on the Ingulets irrigated massif.

The method of establishing a field experiment is split plots. Main areas (factor A) – moisture conditions (without irrigation (DL) and irrigation (I)); factor B – first treatment against pests: 1 – application of insecticide: 1 – Control (without treatment); 2 – Dimethoate, 400 g/l + Lambda-cyhalothrin, 50 g/l – at the rate of 1.00 l/ha + 0.15 l/ha; 3 – Imidacloprid, 200 g/l + Lambda-cyhalothrin, 50 g/l – at a rate of 0.20 l/ha + 0.15 l/ha; 4 – Chlorpyrifos, 500 g/l + Cypermethrin, 50 g/l – at a rate of 1.00 l/ha; 5 – Chlorantraniliprole, 200 g/l + Lambda-cyhalothrin, 50 g/l – at a rate of 0.17 l/ha + 0.15 l/ha.; factor C – second treatment against pests: 1 – Control (no treatment); 2 – Dimethoate, 400 g/l + Lambda-cyhalothrin, 50 g/l – at the rate of 1.00 l/ha + 0.15 l/ha; 3 – Imidacloprid, 200 g/l + Lambda-cyhalothrin, 50 g/l – at a rate of 0.20 l/ha + 0.15 l/ha; 4 – Chlorpyrifos, 500 g/l + Cypermethrin, 50 g/l – at a rate of 1.00 l/ha; 5 – Chlorantraniliprole, 200 g/l + Lambda-cyhalothrin, 50 g/l – at a rate of 0.17 l/ha + 0.15 l/ha. Wide-row sowing with 70 cm between rows. The area of the sowing area is 60 m^2, the area of the accounting area is 50 m^2, repetition three times. Alfalfa variety Elehiia. Herbaceous plant of the second year of life (spring sowing), seeds obtained from the first cutting. The species composition of harmful insects was detected during surveys, their number and the ratio of different stages were associated with the phases of plant development and weather conditions (temperature, air humidity and precipitation) using an entomological net (10 sweeps). The evaluation of the effectiveness of the terms and the frequency of chemical treatments was determined according to the method of S.O. Tribel and taking into account the economic thresholds of harmfulness [15]. Treatment with insecticides was carried out: the first – in the phase of the beginning of budding, the second - before the beginning of flowering with a mounted sprayer OH-600 with a consumption of working fluid of 250 l/ha. Statistical processing of experimental data was carried out by AgroSTAT, XLSTAT, Statistica (v. 13).

RESULTS AND DISCUSSIONS

It is known that a complex of pests is found on alfalfa crops, which differ in the features of development and the nature of plant damage. When examining the alfalfa grass stand in the second year of life (in the budding phase) before treatment with insecticides, the average number of pests was: *Adelphocoris lineolatus Goeze* – 3.0 specimens/10 sweeps of the net, *Aphis craccivora Koch* – 20.0, *Margaritia sticticalis* – 3,0, *Phytonomus transsylvanicus Petri*. (beetle/larva) – 1.0/3.0 and *Tychius flavus Berck* – 1.0 specimens/10 sweeps of the net (Table 1). It is known that the effectiveness of various insecticides against rodent and sucking pests is not the same, therefore there was a need to study the effectiveness of universal and binary mixtures of insecticides against a complex of pests.

The use of the first insecticide treatment reduced the number of pests on the grass: *Adelphocoris lineolatus Goeze* – by 70.0–93.3%, *Aphis craccivora Koch* – 93.0–97.5, Margaritia sticticalis – 80.0–96.7, *Phytonomus transsylvanicus Petri*. (beetle/larva) – 60.0–90.0/73.3–93.3 and *Tychius flavus Berck* – 76.0–94.0%, depending on the insecticide.

The use of the second insecticide treatment helped to reduce the number of pests on the grass stand. The most effective was the preparation with the active substances Chlorpyrifos, 500 g/l and Cypermethrin, 50 g/l and the consumption rate of 1.00 l/ha. This reduced the number of pests: *Adelphocoris lineolatus Goeze* – by 85.0–91.7%, *Aphis craccivora Koch* – 85.0–91.7, *Margaritia sticticalis* – 97.5, Tychius flavus Berck – 88.2–92.3 and *Bruchophagus roddi Guss* – by 92.5–96.7%, depending on the use of insecticide during the first treatment.

Table 1. The number of pests before and after the application of insecticides and their effectiveness on grass alfalfa seeds in the second year of life

Variant	The number of pests, specimens/10 sweeps of the net												Reduction of pest population, %					
	Adelphocoris lineolatus Goeze		*Aphis craccivora Koch*		*Margaritia sticticalis*		*Phytonomus transsylvanicus Petri.* (beetle/larva)		*Tychius flavus Berck*		*Bruchophagus roddi Guss*		*Adelphocoris lineolatus Goeze*	*Aphis craccivora Koch*	*Margaritia sticticalis*	*Phytonomus transsylvanicus Petri.* (beetle/larva)	*Tychius flavus Berck*	*Bruchophagus roddi Guss*
	before	after	before	after	before	after	before	after	before	after	before	after						
first insecticide treatment																		
1		4.0		25.0		4.0		2.0/5.0		2.0		0.0	-	-	-	-	-	-
2		0.9		0.5		0.6		0.4/0.8		0.3		0.0	70.0	97.5	80.0	60.0/73.3	70.0	-
3	3.0	0.5	20.0	1.4	3.0	0.4	1.0/3.0	0.2/0.4	1.0	0.2	0.0	0.0	83.3	93.0	86.7	80.0/86.7	80.0	-
4		0.2		0.8		0.1		0.1/0.2		0.1		0.0	93.3	96.0	96.7	90.0/93.3	90.0	-
5		0.3		1.0		0.3		0.2/0.3		0.2		0.0	90.0	95.0	90.0	80.0/90.0	80.0	-
second insecticide treatment																		
1-1		2.1		10.0		2.0		0.0/0.0		3.8		4.7	-	-	-	-	-	-
1-2		0.8		0.2		0.8		0.0/0.0		1.0		0.9	60.0	98.8	80.0	-	66.7	77.5
1-3	2.0	0.6	17.0	0.7	4.0	0.1	0.3/0.0	0.0/0.0	3.0	0.7	4.0	0.6	70.0	95.9	97.5	-	76.7	85.0
1-4		0.3		0.3		0.1		0.0/0.0		0.3		0.3	85.0	98.2	97.5	-	90.0	92.5
1-5		0.4		0.5		0.1		0.0/0.0		0.5		0.4	80.0	97.1	97.5	-	83.3	90.0
2-1		1.4		2.1		0.2		0.0/0.0		2.9		3.7	-	-	-	-	-	-
2-2		0.5		0.0		0.0		0.0/0.0		0.5		0.7	58.3	100.0	100.0	-	70.6	80.0
2-3	1.2	0.3	3.3	0.1	0.6	0.0	0.0/0.0	0.0/0.0	1.7	0.4	3.5	0.4	75.0	97.0	100.0	-	76.5	88.6
2-4		0.1		0.0		0.0		0.0/0.0		0.2		0.2	91.7	100.0	100.0	-	88.2	94.3
2-5		0.2		0.0		0.0		0.0/0.0		0.3		0.3	83.3	100.0	100.0	-	82.4	91.4
3-1		1.3		3.9		0.1		0.0/0.0		2.0		3.5	-	-	-	-	-	-
3-2		0.4		0.0		0.0		0.0/0.0		0.4		0.6	60.0	100.0	100.0	-	71.4	80.6
3-3	1.0	0.2	5.4	0.2	0.4	0.0	0.0/0.0	0.0/0.0	1.4	0.3	3.1	0.3	80.0	96.3	100.0	-	78.6	90.3
3-4		0.1		0.1		0.0		0.0/0.0		0.1		0.2	90.0	98.1	100.0	-	92.9	93.5
3-5		0.2		0.2		0.0		0.0/0.0		0.2		0.3	80.0	96.3	100.0	-	85.7	90.3
4-1		1.0		3.4		0.0		0.0/0.0		1.6		3.0	-	-	-	-	-	-
4-2		0.3		0.0		0.0		0.0/0.0		0.3		0.5	62.5	100.0	100.0	-	70.0	81.5
4-3	0.8	0.1	3.6	0.0	0.1	0.0	0.0/0.0	0.0/0.0	1.0	0.2	2.7	0.3	87.5	100.0	100.0	-	80.0	88.9
4-4		0.1		0.0		0.0		0.0/0.0		0.1		0.2	87.5	100.0	100.0	-	90.0	92.6
4-5		0.1		0.0		0.0		0.0/0.0		0.1		0.2	87.5	100.0	100.0	-	90.0	92.6
5-1		1.2		3.5		0.0		0.0/0.0		1.7		3.3	-	-	-	-	-	-
5-2		0.4		0.0		0.0		0.0/0.0		0.4		0.6	60.0	100.0	100.0	-	69.2	80.0
5-3	1.0	0.2	4.0	0.2	0.3	0.0	0.0/0.0	0.0/0.0	1.3	0.3	3.0	0.4	80.0	95.0	100.0	-	76.9	86.7
5-4		0.1		0.0		0.0		0.0/0.0		0.1		0.1	90.0	100.0	100.0	-	92.3	96.7
5-5		0.1		0.1		0.0		0.0/0.0		0.2		0.3	90.0	97.5	100.0	-	84.6	90.0

Source: Own results.

Usually, a low number of pests, or their absence, has a positive effect on the formation of generative organs and, accordingly, on the seed productivity of plants. However, the presence of this drug with the active substances Chlorpyrifos, 500 g/l and Cypermethrin, 50 g/l of fumigation action had a negative effect on the number of pollinating insects, which reduced the formation of beans and seeds in them and subsequently affected the productivity of plants. Under conditions of natural moisture, the seed yield was 330.5–390.6 kg/ha, and it was higher than the control by 10.5–12.4 kg/ha. Under irrigation, the seed productivity of alfalfa was 437.6–536.0 kg/ha, respectively, which was higher than the control variant by 13.0–16.1 kg/ha.

The highest seed yield was obtained in the first treatment with an insecticide preparation with the active substances Chlorpyrifos, 500 g/l and Cypermethrin, 50 g/l and the consumption rate of 1.00 l/ha, and in the second treatment with preparations with the active substances Chlorantraniliprole, 200 g/l and Lambda-cyhalothrin, 50 g/l at a rate of 0.17 and 0.15 l/ha, respectively. Under irrigation with this variant, the seed productivity was 635.2 kg/ha, which was higher than the control variant by 115.3 kg/ha. Under conditions of natural moisture, the seed yield was 452.5 kg/ha, and was higher than the control by 74.3 kg/ha (Table 2).

Table 2. Seed productivity and economic assessment of the second year alfalfa seed cultivation depending on moisture conditions and insecticide application

Variant	Seed yield, kg/ha	Saved yield, kg/ha	The cost of the obtained products, €/ha	Costs per 1 ha, €	The cost of 1 kg, €	Conditionally net profit, €/ha	Profitability level, %
DL 1-1	320.0	-	1,280.00	200.27	0.63	1,079.73	539
DL 1-2	357.7	37.7	1,430.80	224.57	0.63	1,206.23	537
DL 1-3	366.3	46.3	1,465.20	215.53	0.59	1,249.67	580
DL 1-4	330.5	10.5	1,322.00	223.17	0.68	1,098.83	492
DL 1-5	382.8	62.8	1,531.20	244.83	0.64	1,286.37	525
Average	**351.5**	**39.3**	**1,405.84**	**221.67**	**0.63**	**1,184.17**	**535**
DL 2-1	352.2	-	1,408.80	224.10	0.64	1,184.70	529
DL 2-2	393.7	41.5	1,574.80	248.70	0.63	1,326.10	533
DL 2-3	403.2	51.0	1,612.80	239.73	0.59	1,373.07	573
DL 2-4	363.7	11.5	1,454.80	247.10	0.68	1,207.70	489
DL 2-5	421.3	69.1	1,685.20	251.87	0.60	1,433.33	569
Average	**386.8**	**43.3**	**1,547.28**	**242.30**	**0.63**	**1,304.98**	**538**
DL 3-1	365.4	-	1,461.60	215.47	0.59	1,246.13	578
DL 3-2	408.6	43.2	1,634.40	240.17	0.59	1,394.23	581
DL 3-3	418.4	53.0	1,673.60	231.23	0.55	1,442.37	624
DL 3-4	377.4	12.0	1,509.60	238.43	0.63	1,271.17	533
DL 3-5	437.2	71.8	1,748.80	243.43	0.56	1,505.37	618
Average	**401.4**	**45.0**	**1,605.60**	**233.75**	**0.58**	**1,371.85**	**587**
DL 4-1	378.2	-	1,512.80	226.53	0.60	1,286.27	568
DL 4-2	422.9	44.7	1,691.60	251.30	0.59	1,440.30	573
DL 4-3	433.0	54.8	1,732.00	242.43	0.56	1,489.57	614
DL 4-4	390.6	12.4	1,562.40	249.57	0.64	1,312.83	526
DL 4-5	452.5	74.3	1,810.00	254.70	0.56	1,555.30	611
Average	**415.4**	**46.6**	**1,661.76**	**244.91**	**0.59**	**1,416.85**	**578**
DL 5-1	358.6	-	1,434.40	225.87	0.63	1,208.53	535
DL 5-2	400.9	42.3	1,603.60	250.43	0.62	1,353.17	540
DL 5-3	410.5	51.9	1,642.00	241.57	0.59	1,400.43	580
DL 5-4	370.3	11.7	1,481.20	248.77	0.67	1,232.43	495
DL 5-5	428.9	70.3	1,715.60	246.53	0.57	1,469.07	596
Average	**393.8**	**44.1**	**1,575.36**	**242.63**	**0.62**	**1,332.73**	**549**
Average	***389.8***	***43.6***	***1,559.17***	***237.05***	***0.61***	***1,322.12***	***558***
I 1-1	424.6	-	1,698.40	367.57	0.87	1,330.83	362
I 1-2	479.0	54.4	1,916.00	393.00	0.82	1,523.00	388
I 1-3	493.3	68.7	1,973.20	384.43	0.78	1,588.77	413
I 1-4	437.6	13.0	1,750.40	390.63	0.89	1,359.77	348
I 1-5	518.7	94.1	2,074.80	414.37	0.80	1,660.43	401
Average	**470.6**	**57.6**	**1,882.56**	**390.00**	**0.83**	**1,492.56**	**382**
I 2-1	474.4	-	1,897.60	392.63	0.83	1,504.97	383
I 2-2	535.2	60.8	2,140.80	418.57	0.78	1,722.23	411
I 2-3	551.2	76.8	2,204.80	410.13	0.74	1,794.67	438
I 2-4	489.0	14.6	1,956.00	415.83	0.85	1,540.17	370
I 2-5	579.7	105.3	2,318.80	423.03	0.73	1,895.77	448
Average	**525.9**	**64.4**	**2,103.60**	**412.04**	**0.79**	**1,691.56**	**410**
I 3-1	497.3	-	1,989.20	384.70	0.77	1,604.50	417
I 3-2	561.0	63.7	2,244.00	410.83	0.73	1,833.17	446
I 3-3	577.8	80.5	2,311.20	402.47	0.70	1,908.73	474
I 3-4	512.7	15.4	2,050.80	407.97	0.80	1,642.83	403
I 3-5	607.6	110.3	2,430.40	415.47	0.68	2,014.93	485
Average	**551.3**	**67.5**	**2,205.12**	**404.29**	**0.74**	**1,800.83**	**445**
I 4-1	519.9	-	2,079.60	396.50	0.76	1,683.10	424
I 4-2	586.5	66.6	2,346.00	422.83	0.72	1,923.17	455
I 4-3	604.0	84.1	2,416.00	414.47	0.69	2,001.53	483
I 4-4	536.0	16.1	2,144.00	419.77	0.78	1,724.23	411
I 4-5	635.2	115.3	2,540.80	427.53	0.67	2,113.27	494
Average	**576.3**	**70.5**	**2,305.28**	**416.22**	**0.73**	**1,889.06**	**453**
I 5-1	485.6	-	1,942.40	394.73	0.81	1,547.67	392
I 5-2	547.8	62.2	2,191.20	420.73	0.77	1,770.47	421
I 5-3	564.2	78.6	2,256.80	412.30	0.73	1,844.50	447
I 5-4	500.5	14.9	2,002.00	417.93	0.84	1,584.07	379
I 5-5	593.3	107.7	2,373.20	425.20	0.72	1,948.00	458
Average	**538.3**	**65.9**	**2,153.12**	**414.18**	**0.77**	**1,738.94**	**419**
Average	***532.5***	***65.2***	***2,129.94***	***407.35***	***0.77***	***1,722.59***	***422***

Assessment of the significance of partial differences

$LSD_{05}(A)$	61.318
$LSD_{05}(B)$	1.118
$LSD_{05}(C)$	0.719

Evaluation of the significance of the main effects

$LSD_{05}(A)$	7.080
$LSD_{05}(B)$	0.204
$LSD_{05}(C)$	0.131

Note: The cost of 1 kg of seeds – 4.00 €. Source: Own results.

At the first treatment, the highest cost price (0.81 €/kg) and the lowest conditional net profit (1,114.93 €/ha) was obtained on the control variant without the use of insecticides. The use of insecticides, during the first treatment, reduced the number of pests and increased the yield. In variant 2-1 of the experiment, by using insecticides (Dimethoate, 400 g/l + Lambda-cyhalothrin, 50 g/l), the cost price was 0.79 €/kg and the conditional net profit was 1,244.63 €/ha, on variant 3-1 (Imidacloprid, 200 g/l + Lambda-cyhalothrin, 50 g/l) – 0.74 €/kg and 1,320.20 €/ha, respectively, and on variant 5-1 (Chlorantraniliprole, 200 g/l + Lambda - cyhalothrin, 50 g/l) – 0.78 €/kg and 1,275.97 €/ha, respectively. The lowest cost price of 0.73 €/kg and the highest conditional net profit of 1,376.07 €/ha was obtained when using insecticides with the active substances Chlorpyrifos, 500 g/l and Cypermethrin, 50 g/l - at the rate of 1.00 l/ha (variant 4-1) (Table 3).

Table 3. Seed productivity and economic efficiency of alfalfa seed cultivation in the second year depending on the application of insecticides

Variant	Yield, kg/ha	Saved yield, kg/ha	The cost of the obtained products, €/ha	Costs per 1 ha, €	The cost of 1 kg, €	Conditionally net profit, €/ha	Profitability level, %
1-1	349.3	-	1,397.20	282.27	0.81	1,114.93	395
1-2	392.5	43.2	1,570.00	306.93	0.78	1,263.07	412
1-3	403.3	54.0	1,613.20	298.07	0.74	1,315.13	441
1-4	360.4	11.1	1,441.60	305.20	0.85	1,136.40	372
1-5	423.0	73.7	1,692.00	327.60	0.77	1,364.40	416
Average	**385.7**	**45,5**	**1,542.80**	**304.01**	**0.79**	**1,238.79**	**407**
2-1	387.8	-	1,551.20	306.57	0.79	1,244.63	406
2-2	435.8	48.0	1,743.20	331.57	0.76	1,411.63	426
2-3	447.8	60.0	1,791.20	322.83	0.72	1,468.37	455
2-4	400.1	12.3	1,600.40	329.60	0.82	1,270.80	386
2-5	469.6	81.8	1,878.40	335.23	0.71	1,543.17	460
Average	**428.2**	**50.5**	**1,712.88**	**325.16**	**0.76**	**1,387.72**	**426**
3-1	404.6	-	1,618.40	298.20	0.74	1,320.20	443
3-2	454.8	50.2	1,819.20	323.33	0.71	1,495.87	463
3-3	467.2	62.6	1,868.80	314.67	0.67	1,554.13	494
3-4	417.5	12.9	1,670.00	321.23	0.77	1,348.77	420
3-5	490.1	85.5	1,960.40	327.10	0.67	1,633.30	499
Average	**446.8**	**52.8**	**1,787.36**	**316.91**	**0.71**	**1,470.45**	**464**
4-1	421.4	-	1,685.60	309.53	0.73	1,376.07	445
4-2	473.6	52.2	1,894.40	334.87	0.71	1,559.53	466
4-3	486.6	65.2	1,946.40	326.10	0.67	1,620.30	497
4-4	434.7	13.3	1,738.80	332.63	0.77	1,406.17	423
4-5	510.4	89.0	2,041.60	338.73	0.66	1,702.87	503
Average	**465.3**	**54.9**	**1,861.36**	**328.37**	**0.71**	**1,532.99**	**467**
5-1	396.1	-	1,584.40	308.43	0.78	1,275.97	414
5-2	445.1	49.0	1,780.40	333.50	0.75	1,446.90	434
5-3	457.3	61.2	1,829.20	324.80	0.71	1,504.40	463
5-4	408.6	12.5	1,634.40	331.43	0.81	1,302.97	393
5-5	479.6	83.5	1,918.40	336.00	0.70	1,582.40	471
Average	**437.3**	**51.6**	**1,749.36**	**326.83**	**0.75**	**1,422.53**	**435**
Average	***432.7***	***51.1***	***1,730.75***	***320.26***	***0.74***	***1,410.49***	***440***

Note: The cost of 1 kg of seeds – 4.00 €.
Source: Own results

During the second insecticide treatment, the highest cost price of 0.85 €/kg was obtained on variant 1-4 (Chlorpyrifos, 500 g/l and Cypermethrin, 50 g/l), and the lowest conditional net profit of €1,114.93/ha was obtained on the control (variant 1-1, without the use of insecticides). The lowest cost price of 0.74 €/kg was obtained on variant 1-3 (Imidacloprid, 200 g/l + Lambda-cyhalothrin, 50 g/l), and the highest conditional net profit of 1,364.40 €/ha – by using insecticides with a.s. Chlorantraniliprole, 200 g/l and Lambda-cyhalothrin, 50 g/l (variant 1-5).

The lowest cost of 0.66 €/ha and the highest conditional net profit of 1,702.87 €/ha was obtained on variant 4-5: the first treatment -

Chlorpyrifos, 500 g/l and Cypermethrin, 50 g/l, the second – Chlorantraniliprole, 200 g/l and Lambda-cyhalothrin, 50 g/l.

CONCLUSIONS

The most effective in the fight against pests (with the exception of *Aphis craccivora Koch*) was the preparation with the active substances Chlorpyrifos, 500 g/l and Cypermethrin, 50 g/l and the consumption rate of 1.00 l/ha. But the presence of fumigation effect of this drug negatively affected the number of pollinating insects, which reduced the formation of beans and seeds in them and subsequently affected the productivity of plants, so this drug should not be used before flowering (second treatment). The highest seed yield of 635.2 kg/ha under irrigation and 452.5 kg/ha under natural moisture conditions was obtained in the variant with the first treatment with an insecticide preparation with active substances Chlorpyrifos, 500 g/l and Cypermethrin, 50 g/l, and with the second treatment with preparations with active substances Chlorantraniliprole, 200 g/l and Lambda-cyhalothrin, 50 g/l.

The lowest cost price of 0.66 €/ha and the highest conditional net profit of 1,702.87 €/ha was obtained on the variant: the first treatment – Chlorpyrifos, 500 g/l and Cypermethrin, 50 g/l, the second - Chlorantraniliprole, 200 g/l and Lambda-cyhalothrin, 50 g/l.

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