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Research Article

Integrated pest management of flea beetles (*Phyllotreta* spp.) in spring oilseed rape (*Brassica napus* L.)

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One of the most dangerous pests of rape is a complex of the undulating flea beetles that can do harm to the plants from the phase of sprouting and until the harvest ripening. According to our research, all six species of the undulating flea beetles are spread in the Eastern Forest–Steppe of Ukraine. The most numerous species are *Phyllotreta atra* F. (about 71%) and *Phyllotreta nigripes* F., the latter is less numerous (about 16%). The rest 4 species make up from 0.4 to 8.8% in the population structure. The damage of spring rape sprouts caused by the leaf beetles both against the background with the fertilizers (N30P30K30) and against the background without the fertilizers significantly affects a weight of 1000 seeds. Against the background without the fertilizers it is a little less and R^2=0.875 while against the background with the fertilizers R^2=0.9986. The yield capacity of spring rape both against the background with the fertilizers (N30P30K30) and against the background without the fertilizers depends on the degree of the sprouts damaged by the leaf–eating pests largely. It is a little higher against the background without the fertilizers and R^2=0.9995 while against the background with the fertilizers R^2=0.9911. The presowing toxicity of spring rapeseeds with the subsequent spraying of the crops in the phase of sprouting, namely the toxicity of two pairs of true leaves, provides a reduction in the density of the undulating flea beetles population 7.5–10.0 times below the level of the economic threshold of harmfulness. The best field germination of rape seeds both against the background without the fertilizers and against the background with the fertilizers is noted. The applied insecticide and fungicide seed treatment agents have a negative affect on the laboratory germination of spring rape seed material. The worst indices of germination were noted in the variants when applying Royal FLO, 48% of water and suspension concentrate in the dose 5.0 L/t and Royal FLO, 48% of water and suspension concentrate+Taboo, 50% of suspension concentrate in the dose of 5.0+6.0 L/t and on the 9th day these indices were 77.0% and 76.5% respectively.

Key words: Spring rape; Pests; Harmfulness; Undulating flea beetles; Protection

Introduction

One of the most dangerous pests of winter rape is a complex of the undulating flea beetles that can do harm to the plants from the phase of sprouting and until the harvest ripening. Undulating flea beetles are a complex of species, namely *Phyllotreta atra* F., *Phyllotreta nigripes* F, *Phyllotreta nemorum* L., *Phyllotreta undulata* Kutsch., *Phyllotreta vitata* Redt., and *Phyllotrta armoracie* Koch which belong to the genus of *Phyllotreta*. The species are very widely spread. The most harmful pests have been found in the North Caucasus, the Lower Volga region and other places characterised by early, friendly and warm spring. They cause a great harm in Eastern and Western Siberia and in the Upper Volga region. In Ukraine they can be found everywhere; but the most numerous number of these pests is found in the south of the Forest–Steppe zone and in the Steppe region (Palyi, 1962).

At the beginning of the XXI century plant protection becomes more ecologically oriented. The advantage is given to less toxic preparations with low rates of applying. The presowing protection becomes especially relevant; and if the economic threshold of harmfulness in the phase of sprouting is exceeded then it will be recommended to spray the crops with the insecticides authorised to use (Fedorenko, Luhovskyi, 2011; Stankevych, Yevtushenko, Krasylovets, 2014; Stankevych, 2015; Stankevych, Kava, 2015).

Methods

The research was carried out in 2010–2012. The soil was typical chernozem with a content of humus in the arable layer of about 5.3%. After the preceding crop of winter wheat spring rape of Ataman variety was sown at a rate of 2.5 million of germinating seeds per 1 hectare in two blocks: without the fertilizers and with the applying of a complex of the mineral fertilizers (N30P30K30). The agrarian equipment was common for the cultivation zone. The seeds of spring rape were sprayed with the preparations of insect fungicide and fungicide actions on the day before sowing according to the List of the pesticides and agrochemicals authorized for use in Ukraine. During the phase of sprouting (not later than 4 true leaves appeared) the crops of spring rape were sprayed with Karate Zeon insecticide, 5% of microcapsule water suspension with a rate of consumption of 0.15 L/ha.

The scheme of the research in 2010:

1. Royal FLO, 48% of water and suspension concentrate (5.0 L/t) + Karate Zeon, 5% of microcapsule water suspension (0.15 L/ha in the phase of sprouting);
2. Maxim XL 035 FS, 35% of liquid suspension concentrate (5.0 L/t)+Karate Zeon, 5% of microcapsule water suspension (0.15 L/ha in the phase of sprouting);
3. Royal FLO, 48% of water and suspension concentrate +Taboo, 50% of suspension concentrate (5.0+6.0 L/t)+Karate Zeon, 5% of microcapsule water suspension (0.15 L/ha in the phase of sprouting);
4. Maxim XL 035 FS, 35% of liquid suspension concentrate +Cruiser, 35% of liquid suspension concentrate (5.0 +4.0 L/t) + Karate Zeon, 5% of microcapsule water suspension (0.,15 L./ha in the phase of sprouting).

The scheme of the research in 2011–2012:

1. Control, water (H_2O) (10.,0 L/t) + Karate Zeon, 5% of microcapsule water suspension (0.15 L/ha in the phase of sprouting);
2. Royal FLO, 48% of water and suspension concentrate (5.0 L/t)+Karate Zeon, 5% of microcapsule water suspension (0.15 L/ha in the phase of sprouting);
3. Maxim XL 035 FS, 35% of liquid suspension concentrate (5.0 L/t)+Karate Zeon, 5% of microcapsule water suspension (0.15 L/ha in the phase of sprouting);
4. Royal FLO, 48% of water and suspension concentrate +Taboo, 50% of suspension concentrate (5,0+6,0 L./t)+Karate Zeon, 5% of microcapsule water suspension (0,15 L./ha in the phase of sprouting);
5. Maxim XL 035 FS, 35% of liquid suspension concentrate +Cruiser, 35% of liquid suspension concentrate (5.0+4.0 L/t)+Karate Zeon, 5% of microcapsule water suspension (0.15 L./ha in the phase of sprouting).

When spraying the crops the technical efficiency of the preparations against the main rape pests was determined by the formula:

$$T = \frac{a-b}{a} \times 100, \quad (1)$$

where T— technical efficiency, %; a — density of the pests population before spraying, b — density of the pests population in 3, 7 or 14 days after spraying (Recommendations, 1975; Methods of calculation, 1976; Triebel and others, 2001).

The economic efficiency or increase in the yield was determined according to the following formula:

$$I = \frac{a-b}{a} \times 100, \quad (2)$$

where *I* — increase in the yield, %; a — average yield from a calculated unit on a cultivated plot, t.; b — average yield from a calculated unit on a plot under control, t. (Recommendations, 1975; Methods of calculation, 1976; Triebel and others, 2001).

The degree of spring rape sprouts damaged by the undulating flea beetles was determined on a scale of 0 to 5: mark 0 — no damage; mark 1 — damage up to 25%; mark 2 — 26–50% of damage; mark 3 — 51–75% of damage; mark 4 — more than 75% of the leaf surface of the plant are damaged.

The average degree of the damaged spring rape sprouts was determined by the formula:

$$D = \frac{\Sigma n - b}{\Sigma n}, \quad (3)$$

where *D* — average degree of damage; *∑(n × b)* — sum of damaged plants of the corresponding damage degree; *n* — total number of plants in the test.

The coefficient of the damaged spring rape sprouts was determined by the formula:

$$C = \frac{a-b}{100}, \quad (4)$$

where C—coefficient of damage; *a*—proportion of damaged plants, %; *b*—average degree of damage.

The influence of the seed treatment agents on the sowing quality of seeds was determined in accordance with the State Standard of Ukraine 4138–2002 in the laboratory of the Phytopathology Department of Kharkiv National Agrarian University named after V.V. Dokuchaiev and at the Educational and Scientific Centre of the Soil Science and Agro–Chemistry Institute named after O.N. Sokolovskyi of the National Academy of Agrarian Sciences of Ukraine. In order to determine the influence of the seed treatment agents on the seed germination under the laboratory conditions the seed material was placed into Petri dishes (100 seeds of each variant) which were then placed into a thermostat at a temperature of 20°C; further the seed material was moistened every day to maintain a constant level of 60% moisture. The seed germination rates were fixed on the 3rd, 5th, 7th and 9th days.

Results and Discussion

The necessity to conduct the presowing treatment and spraying of the plants in the phase of sprouting is explained by the fact that for the years of the researches the density of the undulating flea beetles population on the spring rape sprouts reached 81.4 specimens per m² that exceeded the economic threshold of harmfulness (3 specimens per m²) 27.1 times. Such a number of pests can lead to the loss of crops within a few hours. When treating the seeds with the tank mix of the fungicide treatment agent Royal FLO, 48% of water and suspension concentrate together with the insecticide treatment agent Taboo, 50% of suspension concentrate the density of the fleas population on the sprouts was 8.9 specimens per m² and exceeded the economic threshold of harmfulness almost 3 times. When treating the seeds with the tank mix of the fungicide treatment agent Maxim XL 035 FS together with Cruiser, 35% of liquid suspension concentrate the density of the fleas population on the sprouts was 8,2 specimens per m² and exceeded the economic threshold of harmfulness 2.7 times. Thus the presowing toxicity of spring rape seeds does not provide a reduction in the density of the undulating flea beetles population during their mass reproduction to the level of the economic threshold of harmfulness (Table 1).

Table 1. Efficiency of spring rape sprouts protection from undulating flea beetles by the method of presowing seeds treatment with insecticide seed treatment agent*.

Variants of research	Litres per ton of seeds, L.	Density of fleas population, specimens per m²	Technical efficiency, %
Control (H_2O)	0	81.4	—
Royal FLO, 48% of water and suspension concentrate+Taboo, 50% of suspension concentrate	6.0+5.0	8.9	89.1
Maxim XL 035 FS, 35% of liquid suspension concentrate+Cruiser, 35% of liquid suspension concentrate	4.0+5.0	8.2	89.9
HIP05		4.8	

Here and in Tables 2-5 the data from State Enterprise "Research Farm "Elitne", the Institute of Plant Growing named after V.Ya. Yuriev of the National Academy of Agrarian Sciences of Ukraine, 2011-2012; in Table 6 data for 2010-2012.

The efficiency of protection from the undulating flea beetles on the spring rape crops by the method of the ground spraying with the insecticide Karate Zeon, 5% of microcapsule water suspension was determined in the phenophase of 2 true leaves (the beginning of the first decade of May). The population density of the undulating flea beetles before spraying amounted to 81.4 specimens per m² and exceeded the economic threshold of harmfulness (3 specimens per m²) 27.1 times. In 3 days after spraying their population density under control was 102.3 specimens per m² and exceeded the economic threshold of harmfulness 34.1 times. In the variant with the crops spraying with the insecticide Karate Zeon, 5% of microcapsule and water suspension the density of the fleas population in 3 days after spraying was 5.7 specimens per m² and exceeded the economic threshold of harmfulness 1.9 times. So the spraying of rape crops in the phase of sprouts (2 true leaves) does not provide a reduction in the density of the undulating flea beetles population during their mass reproduction to the level of the economic threshold of harmfulness (Table 2).

Table 2. Efficiency of spring rape sprouts protection from undulating flea beetles in phenophase of 2 true leaves by ground spraying.

Variants of research	Litres 1 ha of crops	Density of fleas population, specimens per m² before spraying	Density of fleas population, specimens per m² in 3 gays after spraying	Technical efficiency,%
Control (H_2O)	0	81.4	102.3	–
Karate Zeon, 5% of microcapsule water suspension	0.15	81.4	5.7	92.0
HIP05			2.8	

The efficiency of controlling the undulating flea beetles on the spring rape crops by the method of the presowing seeds treatment with the insecticide seed treatment agents Taboo, 50% of suspension concentrate and Cruiser, 35% of liquid suspension concentrate and spraying the crops in the phase of sprouting with the insecticide Karate Zeon, 5% of microcapsule water suspension was noted in the phase of sprouting, namely in the phase of 2 true leaves of spring rape (the beginning of the first decade of May).

Below we presented the data on efficiency of spring rape crops protection from undulating flea beetles by presowing toxicity and ground spraying in phenophase of sprouting.

Table 3. Efficiency of spring rape crops protection from undulating flea beetles by presowing toxicity and ground spraying in phenophase of sprouting.

Variants of research	Litres per ton of seeds or per ha of crops	Density of fleas population, specimens per m²		Technical efficiency, %
		before spraying	in 3 gays after spraying	
Control (H_2O)	10.0 L/t	81.4	102.3	–
Royal FLO, 48% of water and suspension concentrate+Taboo, 50% of suspension concentrate+Karate Zeon, 5% of microcapsule water suspension (in phase of sprouting)	6.00+5.00+0.15	8.9	0.4	95.5
Maxim XL 035 FS, 35% of liquid suspension concentrate+Karate Zeon, 5% of microcapsule water suspension (in phase of	4.00+5.00+0.15	8.2	0.3	96.3

sprouting)		
HIP05	0.04	0.01

That is the presowing toxicity of spring rape seeds with the subsequent ground spraying of crops in the phase of sprouts (2 pairs of true leaves) provides a decrease in the density of the undulating fleas population 7,5–10 times below the level of the economic threshold of harmfulness. The field germination of the seeds was determined and the inspection as for the damage of the sprouts by the leaf pests was carried out when the spring rape sprouts appeared. Before harvesting the test sheaves were selected and the average height of the plants, the number of productive branches, the number of productive and unproductive pods, the number of pods damaged by the sucking pests, the average number of seeds in each pod and the number of frail seeds were determined.
The yield purification, the moisture content determination, the weight of 1000 seeds, the actual yield capacity and the determination of other indices were carried out after harvesting the crops. The data concerning the influence of seed treatment agents on germination and damage of sprouts caused by leaf pests, quantitative and qualitative indices of rape crop yield capacity against the background without and with fertilizers are given in Tables 4 and 5.

Table 4. Influence of seed treatment agents on germination and damage of sprouts caused by leaf pests, quantitative and qualitative indices of rape crop yield capacity against the background without the fertilizers.

Years	**Variants of research**	**Plants in a test, Specimens per m_2**	**Damaged plants , %**	**Average degree of damage**	**Damage coefficient**	**Yield capacity ,t\ha**	**Weight of 1000 seeds, gm**	**Plants height, m**	**Number of productive branches, pieces**	**Total number of pods on a plant, pieces**	**Number of undeveloped pods, pieces**	**Number of pods damaged by sucking pests, pieces**	**Length of pods, cm**	**Number in pods , pieces**	**Number of trall seeds, pieces**
Average in 2010-2012	Control, water ;H_2O] (10.0 L/t)	120	96	3.19	3.06	0.044	2.45	0.72	3.1	44.5	9.4	22.3	5	11.5	3.7
	Royal FLO, 48% of water and suspension concentrate (5.0 L/t)	151	86	2.75	2.43	0.17	2.7	0.8	3.4	55.2	9.6	21.2	5.4	13.4	4.4
	Maxim XL 035 FS, 35% of liquid suspension concentrate (5.0 L/t)	167	88	2.74	2.42	0.175	2.89	0.8	3.4	58	9.3	21	5.2	13.3	4.2
	Royal FLO, 48% of water and suspension concentrate+Taboo, 50% of suspension concentrate [5.0+ 6.0 L/t)	185	40	1.34	0.44	0.261	2.97	0.85	3.7	64.8	8.2	19.9	5.3	15.5	3.3
	Maxim XL 035 FS, 35% of liquid suspension concentrate+Cruiser, 35% of liquid suspension concentrate 15.0 + 4.0 L/t)	221	42	1.39	0.47	0.271	2.89	0.85	3.7	62.4	8.4	20.5	5.3	14.7	3.6

Table 5. Influence of seed treatment agents on germination and damage of sprouts caused by leaf pests, quantitative and qualitative indices of rape crop yield capacity against the background with fertilizers.

Years	Variants of research	Plants in a test, Specimens per m_2	Damaged plants , %	Average degree of damage	Damage coefficient	Yield capacity ,t\ha	Weight of 1000 seeds, gm	Plants height, m	Number of productive branches, pieces	Total number of pods on a plant, pieces	Number of undeveloped pods, pieces	Number of pods damaged by sucking	Length of pods, cm	Number in pods , pieces	Number of trall seeds,
Average in 2010-2012	Control, water ;H_2O] (10.0 L/t)	129	94	3.2	3.01	0.071	2.79	0.74	3.2	44.5	9.0	22.0	5.3	11.9	3.4
	Royal FLO, 48% of water and suspension concentrate (5.0 L/t)	170	85	2.7	2.30	0.205	2.97	0.81	3.9	66.6	8.4	19.9	5.4	15.6	3.2
	Maxim XL 035 FS, 35% of liquid suspension concentrate (5.0 L/t)	164	85	2.71	2.35	0.229	2.97	0.83	4.2	69.9	8.5	20.3	5.4	16.1	3.2
	Royal FLO, 48% of water and suspension concentrate+Taboo, 50% of suspension concentrate [5.0+6.0 L/t)	209	37	1.29	0.48	0.307	3.20	0.92	4.7	76.8	7.0	18.5	5.6	16.8	2.9
	Maxim XL 035 FS, 35% of liquid suspension concentrate+Cruiser, 35% of liquid suspension concentrate 15.0+4.0 L/t)	213	37	1.4	0.50	0.322	3.18	0.98	4.6	73.8	6.4	18.8	5.7	16.7	3.0

Analysing the data from Figures 1 and 2 we suggested that the yield capacity of spring rape both against the background with the fertilizers (N30P30K30) and against the background without applying the fertilizers significantly depends on the degree of the sprouts damaged by the leaf pests. It is slightly higher against the background without applying the fertilizers, R^2=0.9995 vs. R^2=0.9911 against the background with the fertilizers. From the data given in the diagrams it is seen that the critical point after which there is a rapid decrease in the yield capacity is the plants damage from two degrees and more.

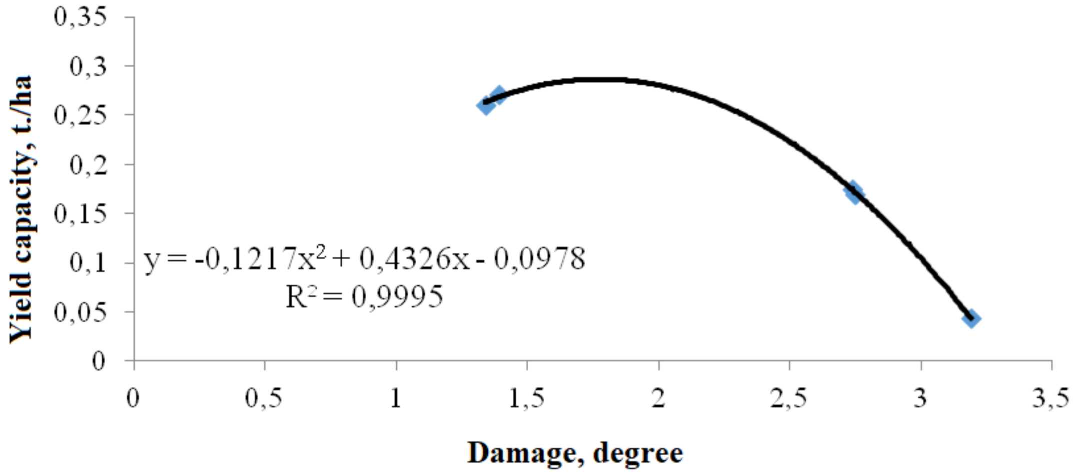

Figure 1. Dependence of spring rape yield capacity in the phase of sprouting on the level of damage caused by undulating flea beetles (background without fertilizers). Here and in Figures 2-4 the data are from State Enterprise "Research Farm "Elitne", the Institute of Plant Growing named after V.Ya. Yuriev of the National Academy of Agrarian Sciences of Ukraine (2010–2012).

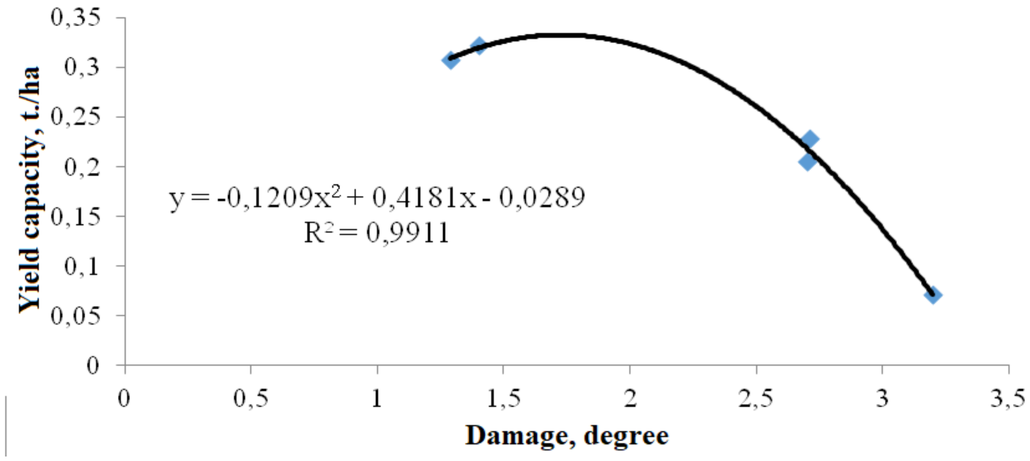

Figure 2. Dependence of yield capacity of spring rape crops in the phase of sprouting on the level of damage caused by undulating flea beetles (background N30P30K30).

Analysing Figures 3 and 4 we concluded that the damage of the spring rape sprouts by leaf pests both against the background with the fertilizers (N30P30K30) and against the background without applying the fertilizers significantly influences the weight of 1000 seeds. It is slightly lower against the background without applying the fertilizers, R^2=0.875 vs. R^2=0.9986 against the background with the fertilizers. From the data given in the diagrams it is seen that the critical point after which there is a rapid decrease in the weight of 1000 seeds against the background with the fertilizers is the plants damage from 1.5 degrees and more; and against the background without the fertilizers the weight of 1000 seeds is decreasing beginning from two degrees and more.

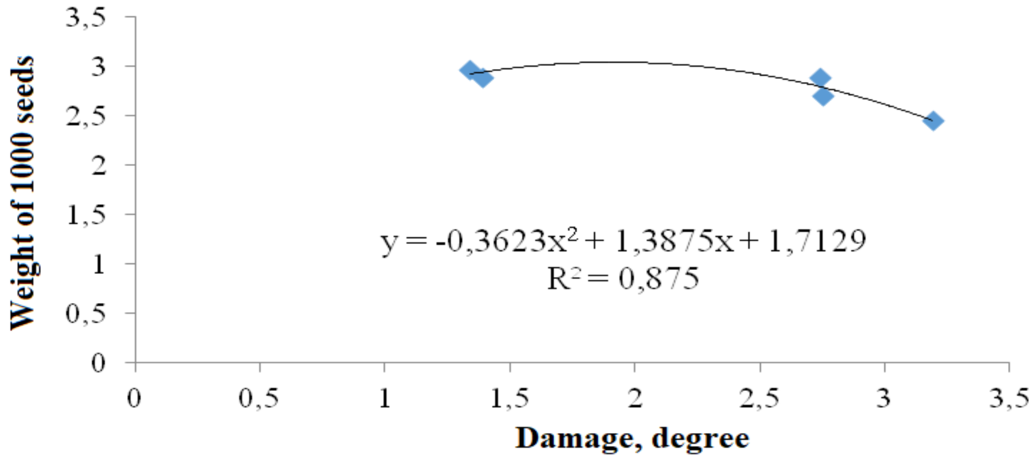

Figure 3. Dependence of weight of 1000 spring rape seeds on the level of damage caused by undulating flea beetles in the phase of sprouting (background without fertilizers).

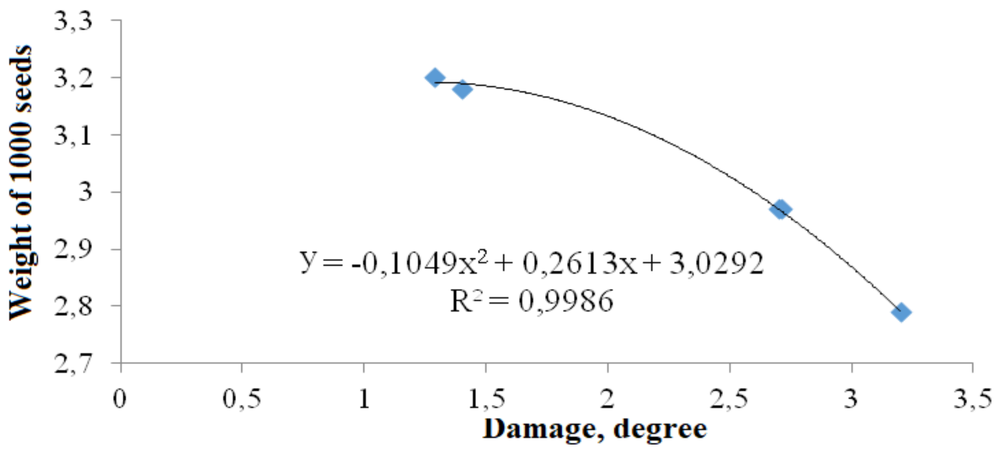

Figure 4. Dependence of weight of 1000 spring rape seeds on the level of damage caused by undulating flea beetles in the phase of sprouting (background N30P30K30).

The most damaged crops of spring rape were in the variant under control; the damage was 94 %. In the variants with the fungicide seed treatment agents Royal FLO, 48% of water and suspension concentrate (5,0 L./t.)+Karate Zeon, 5% of microcapsule water suspension (0.15 L./ha in the phase of sprouting) and Maxim XL 035 FS, 35% of liquid suspension concentrate (5.0 L/t)+Karate Zeon, 5% of microcapsule water suspension (0.15 L/ha in the phase of sprouting) the damage of plants was slightly less than in the variant under control and amounted to 85 %; this fact can be explained by a more friendly and better plants germination since the given preparations do not exhibit the insecticide action. The highest yield against the background with the fertilizers (N30P30K30) was in the variants of Royal FLO, 48% of water and suspension concentrate+Taboo, 50% of suspension concentrate (5.0+6.0 L/t)+ Karate Zeon, 5% of microcapsule water suspension (0.15 L/ha in the phase of sprouting) and Maxim XL 035 FS, 35% of liquid suspension concentrate + Cruiser, 35% of liquid suspension concentrate (5.0+4.0 L/t)+Karate Zeon, 5% of microcapsule water suspension (0.15 L/ha in the phase of sprouting) and it amounted to 0.307 and 0.322 t/ha (Table 6).

Table 6. Economic efficiency of treating spring rape seed material in the phase of sprouting with insecto–fungicides and spraying them with insecticides.

Background	**Variants of research**	**Yield capacity, t/ha**	**Yield saved**	
			t/ha	**%**
Without fertilizers	Control. water (H_2O) (10.0 L./t.) +Karate Zeon. 5% of microcapsule water suspension (0.15 L/ha in the phase of sprouting)	0.044	—	—
	Royal FLO. 48% of water and suspension concentrate (5.0 L/t) +Karate Zeon. 5% of microcapsule water suspension (0.15 L/ha in the phase of sprouting)	0.099	0,055	125
	Maxim XL 035 FS. 35% of liquid suspension concentrate (5.0 L/t) +Karate Zeon. 5% of microcapsule water suspension (0.15 L/ha in the phase of sprouting)	0.109	0,065	148
	Royal FLO. 48% of water and suspension concentrate + Taboo. 50% of suspension concentrate (5.0+6.0 L/t)+Karate Zeon. 5% of microcapsule water suspension (0.15 L/ha in the phase of sprouting)	0.201	0,157	357
	Maxim XL 035 FS. 35% of liquid suspension concentrate+Cruiser. 35% of liquid suspension concentrate (5.0+4.0 L/t)+Karate Zeon. 5% of microcapsule water suspension (0.15 L./ha in the phase of sprouting)	0.222	0,178	404
Average in a block without fertilizers		**0.135**	—	
N30P30K30	Control. water (H_2O) (10.0 L/t)+Karate Zeon. 5% of microcapsule water suspension (0.15 L/ha in the phase of sprouting)	0.071	—	—
	Royal FLO. 48% of water and suspension concentrate (5.0 L/t)+Karate Zeon. 5% of microcapsule water suspension (0.15 L/ha in the phase of sprouting)	0.137	0,066	93
	Maxim XL 035 FS. 35% of liquid suspension concentrate (5.0 L/t) +Karate Zeon. 5% of microcapsule water suspension (0.15 L/ha in the phase of sprouting)	0.143	0,072	101
	Royal FLO. 48% of water and suspension concentrate+Taboo. 50% of suspension concentrate (5.0+6.0 L/t)+Karate Zeon. 5% of	0.261	0,190	268

microcapsule water suspension (0.15 L/ha in the phase of sprouting)			
Maxim XL 035 FS. 35% of liquid suspension concentrate+Cruiser. 35% of liquid suspension concentrate (5.0+4.0 L/t)+Karate Zeon. 5% of microcapsule water suspension (0.15 L/ha in the phase of sprouting)	0.294	0,223	314
Average in a block with fertilizers	**0.181**	—	
HIP05 according to research variants (factor A) — 90.26			
HIP_{05} according to background (factor B) — 8.58			

In the variants with the fungicide seed treatment agents Royal FLO, 48% of water and suspension concentrate (5.0 L./t.)+Karate Zeon, 5% of microcapsule water suspension (0.15 L./ha in the phase of sprouting) and Maxim XL 035 FS, 35% of liquid suspension concentrate (5.0 L./t.)+Karate Zeon, 5% of microcapsule water suspension (0.15 L./ha in the phase of sprouting) the yield was at the level of 0.205 and 0.229 t./ha. In the variant under control the yield was the lowest one and amounted only to 0.071 t./ha.
When treating the seeds the insecticides not only protect the sprouts of the agricultural crops from the pests, but being the biologically active substances, they certainly influence the initial growth and development of plants. With the introduction of organic insecticides this problem has acquired a great practical and theoretical importance in the chemical protection of plants. The scientific literature data indicate the negative influence of the insecticides on the processes of vital functions of the plants treated with the preparations during the vegetative period. However there is almost no information about the influence of such insecticides on the seeds treated with them, although they are decisive when applying the preparations according to this technology. The reaction of cereals and other crops to the biologically active insecticides has been experimentally proven in the case of organic and chlorine and organic and phosphorus compounds. The data of the authors show that the nature of the plants reaction to the insecticides depends on the class of the toxicant chemical compounds, the norms of expenditure and the conditions of the crop cultivation. As a result of the researches concerning the influence of the seed treatment agents on the rape seeds germination under the laboratory conditions we obtained the data given in Table 7.

Table 7. Influence of insecto–fungicide seed treatment agents on laboratory germination of spring rape seed material of Ataman variety.

Variants of research	Rate of expenditure, L/t	Years of researches	Seed germination, %			
			3rd day	5th day	7th day	9th day
Control, water (H_2O)	10.0	2011	0	81	88	91
		2012	0	78	86	93
		average	0	79.5	87	92
Royal FLO, 48% of water and suspension concentrate	5.0	2011	0	48	70	78
		2012	0	52	71	76
		average	0	50	70,5	77
Maxim XL 035 FS, 35% of liquid suspension concentrate	5.0	2011	0	82	86	87
		2012	0	73	80	84
		average	0	77.5	83	85.5
Royal FLO, 48% of water and suspension concentrate+Taboo, 50% of suspension concentrate	5.0 + 6.0	2011	0	50	68	79
		2012	0	53	57	74
		average	0	51.5	62.5	76.5
Maxim XL 035 FS, 35% of liquid suspension concentrate+Cruiser, 35% of liquid suspension concentrate	5.0 + 4.0	2011	0	67	76	84
		2012	0	63	78	86
		average	0	65	77	85
HIP_{05} according to research variants (factor A) — 96.49						
HIP_{05} according to the years of researches (factor B) — 1.32						

Conclusion

A complex of undulating flea beetles which consists of six species was found on the crops of oil producing cabbage crops. The dominant species are *Phyllotreta atra* F. (about 72 %) and *Phyllotreta nigripes* F. which is less numerous (about 16 %). In the spring the first undulating flea beetles appear on the early cabbage weeds (first of all on colza), when the average daily temperature is at the level of 7–11°C; it is the beginning of the first and third decades of April. The mass appearance of the undulating flea beetles occurs when the average daily temperatures exceed 11°C and the sum of the effective temperatures above 5°C is 101°C–130°C, and it is the middle of the second and the third decades of April. The damage of spring rape sprouts caused by the leaf beetles both against the background with the fertilizers (N30P30K30) and against the background without the fertilizers significantly influences the weight of 1000 seeds. Against the background without the fertilizers it is a little less and R^2=0.875 while against the background with the fertilizers R^2 = 0.9986. The critical point after which there is a rapid decrease in the weight of 1000 seeds against the background with the fertilizers is the plants damage from 1.5 degrees and more; against the background without applying the fertilizers the weight of 1000 seeds is decreasing beginning from the damage of two degrees and more.

The yield capacity of spring rape both against the background with the fertilizers (N30P30K30) and against the background without applying the fertilizers significantly depends on the degree of the sprouts damaged by the leaf pests. It is slightly higher against the background without applying the fertilizers, R^2=0.9995 vs. R^2=0.9911 against the background with the fertilizers. The critical point after which there is a rapid decrease in the yield capacity is the plants damage from two degrees and more.

The presowing toxicity of spring rape seeds with the subsequent ground spraying of crops in the phase of sprouting (2 pairs of true leaves) provides a decrease in the density of the undulating fleas population 7.5–10 times less than the level of the economic threshold of harmfulness. The best field germination of spring rape seeds both against the background without the fertilizers and against the background with the fertilizers was in the variants when applying Royal FLO, 48% of water suspension concentrate+Taboo, 50% of suspension concentrate (5.0+6.0 L/t)+Karate Zeon, 5% of microcapsule water suspension (0.15 L/ha in the phase of sprouting) and Maxim XL 035 FS, 35% of liquid suspension concentrate+Cruiser, 35% of liquid suspension concentrate (5,0+4.0 L/t) + Karate Zeon, 5% of microcapsule water suspension (0.15 L/ha in the phase of sprouting) and amounted to 185 and 221 plants per m^2 respectively against the background without the fertilizers; against the background with the fertilizers the field germination was 209 and 213 plants per m^2 respectively. The least number of spring rape sprouts damaged by the leaf pests against both backgrounds was in the variants when applying the insecticide seed treatment agents Royal FLO, 48% of water and suspension concentrate+Taboo, 50% of suspension concentrate (5.0+6.0 L/t)+Karate Zeon, 5% of microcapsule water suspension (0.15 L/ha in the phase of sprouting) and Maxim XL 035 FS, 35% of liquid suspension concentrate+Cruiser, 35% of liquid suspension concentrate (5.0+4.0 L/t)+Karate Zeon, 5% of microcapsule water suspension (0.15 L/ha in the phase of sprouting) and ammounted to 40 and 42% respectively against the background without the fertilizers and to 37% in both variants against the background with the fertilizers. The highest yield capacity of spring rape was in the variants of Royal FLO, 48% of water and suspension concentrate + Taboo, 50% of suspension concentrate (5.0+6.0 L/t)+Karate Zeon, 5% of microcapsule water suspension (0,15 L./ha in the phase of sprouting) and Maxim XL 035 FS, 35% of liquid suspension concentrate+Cruiser, 35% of liquid suspension concentrate (5.0+4.0 L/t)+Karate Zeon, 5% of microcapsule water suspension (0.15 L/ha in the phase of sprouting) and ammounted to 0.307 and 0.322 t/ha respectively against the background with the fertilizers and to 0.261 and 0.271 t/ha against the background without the fertilizers.

The applied insect/fungicide seed agents have a negative influence on the laboratory germination of spring rapeseed material. The worst indices of germination were in the variants when applying Royal FLO, 48% of water and suspension concentrate (5.0 L/t) and Royal FLO, 48% of water and suspension concentrate+Taboo, 50% of suspension concentrate (5.0+6.0 L/t); on the 9th day these indices were 77.0% and 76.5% respectively.

References

Abramik M. I., Gajdash V. D., Gurinovich S. J. (2003). Ripak yarij. Ivano–Frankivsk (in Ukrainian).

Bardin Ya. P. (2000). Ripak: vid sivbi – do pererobki. Bila Cerkva, Svit (in Ukrainian).

Beleckij E. N., Stankevich S. V. & Nemerickaja L. V. (2017). Sovremennye predstavlenija o dinamike populjacij nasekomyh: proshloe, nastojashhee, budushhee. Sinergeticheskij podhod. Vesti HNAU im. V. V. Dokuchaeva. Series Fitopatologija i jentomologija, 1–2, 22–33. (in Russian).

Beleckij E. N. & Stankevich S. V. (2018). Policiklichnost', sinhronnost' i nelinejnost' populjacionnoj dinamiki nasekomyh i problemy prognozirovanija. Vienna, Premier Publishing s.r.o. Vienna (in Russian).

Chajka V. M. & Polishuk A. A. (2010). Na posivah ozimogo ripaku. Efektivnist riznih metodiv obliku chiselnosti dlya monitoringu entomofauni. Karantin i zahist roslin, 3, 5–7. (in Ukrainian).

Fasulati K. K. (1971). Polevoe izuchenie nazemnih bespozvonochnyh. Moscow (in Russian).

Fedorenko V. P. & Lugovskij K. P. (2011). Kontrol hrestocvitih blishok u posivah ozimogo ta yarogo ripaku. Karantin i zahist roslin, 10, 7–9. (in Ukrainian).

Fedorenko V. P., Sekun N. P., Markov I. L. (2008). Zashita rapsa. Zashita i karantin rastenij, 3, 69–93. (in Russian).

Gajdash V. D. (1998). Ripak. Ivano–Frankivsk, Siversiya LTD (in Ukrainian).

Gavrilyuk M. M., Chehov V. A. & Fedorchuk M. I. (2008). Olijni kulturi v Ukrayini. Kiyiv, Osnova. (in Ukrainian).

Golovan L. V., Klymenko I. V. & Stankevych S. V. (2019). The inheritance of economically valuable features in the intraspecific hybridization of bean (*Phaseolus* L). Ukrainian Journal of Ecology, 9 (2), 156–169.

Gusyev M. G., Kokovihin S. V. & Pelih I. Ya. (2011). Ripak – perspektivna kormova j olijna kultura na pivdni Ukrayini. Vinnicya, FOP Rogalska I. O. (in Ukrainian).

Kostromitin V. B. (1980). Krestocvetnye bloshki. Moscow, Kolos (in Russian).

Kuznecova R. Ya. (1975). Raps – vysokourozhajnaya kultura. Leningrad, Kolos (in Russian).

Megalov V. A. (1968). Vyyavlenie vredietlej polevyh kultur. Moscow, Kolos (in Russian).

Metodika uchyota i prognoza razvitiya vredietelej i boleznej polevyh kultur v Centralno–Chernozyomnoj polose. (1976). Voronezh, Centralno–chernozyomnoe knizhnoe izdatelstvo (in Russian).

Nacionalnij standart Ukrayini. Nasinnya silskogospodarskih kultur. Metodi viznachennya yakosti: DSTU 4138–2002. (2003). Kiyiv, Derzhspozhivstandart Ukrayini (in Ukrainian).

Nikiforov A. M. & Bezdenko T. G. (1951). Metodicheskie ukazaniya po vyyavleniyu vreditelej i boleznej selskohozyajstvennyh rastenij. Minsk, Belorussian Academy of Science Press (in Russian).

Omelyuta V. P. (1986). Oblik shkidnikiv i hvorob silskogospodarskih kultur. Kiyiv, Urozhaj (in Ukrainian).

Orobchenko V. P. (1959). Raps ozimyj. Moscow, Selhozgiz (in Russian).

Palij V. F.(1962). Rasprostranenie, ekologiya i biologiya zemlyanyh bloshek fauny SSSR. Frunze, Kirgizia Academy of Science Press (in Russian).

Palij V. F. & Avanesova G. A. (1975). Zemlyanye bloshki Coleoptera, Chrysomelidae, Halticinae: opredelitel rodov i vrednyh vidov. Tashkent, Fan (in Russian).

Pyatakova V. D. (1928). Ogorodnye bloshaki. Mleev (in Russian).

Rekomendacii po obsledovaniyu selskohozyajstvennyh ugodij na zaselyonnost vreditelyami i zaselyonnost boleznyami (1975). Kiev, Urozhaj (in Russian).
Saharov N. L. (1934). Vrediteli gorchicy i borba s nimi, Saratov, Saratovskoe kraevoe gosudarstvennoe izdatelstovo (in Russian).
Sekun M. P., Lapa O. M. & Markov L. I. (2008). Tehnologiya viroshuvannya i zahistu ripaku. Kiyiv, Globus–Print (in Ukrainian).
Shpaar D. (2007). Raps i surepica (Vyrashivanie, uborka, ispolzovanie). Moscow, DLV Agrodelo (in Russian).
Stankevich S., Yevtushenko M., Krasilovec Yu. (2014). Zahist shodiv ripaku yarogo vid hrestocvitih blishok. Visnik SNAU. Series Agronomiya i biologiya, 9(28), 161–165. (in Ukrainian).
Stankevich S.V. (2015). Zmina paradigmi u zahisti olijnih kapustyanih kultur vid hrestocvitih blishok za ostanni 130 rokiv. Visnik HNAU im. V. V. Dokuchayeva. Series Fitopatologiya ta entomologiya, 1–2, 156–180. (in Ukrainian).
Stankevich S. V. & Kava L. P. (2015). Zalezhnist urozhajnosti ripaka yarogo vid poshkodzhenosti shodiv zhukami hrestocvitih blishok. Naukovi dopovidi NUBiP Ukrayini, 8(57). Available from: http://nd.nubip.edu.ua/2015_8/20.pdf/ (in Ukrainian).
Stankevich S.V. & Zabrodina I.V. (2016). Ekonomichni porogi shkidlivosti osnovnih shkidnikiv silskogospodarskih kultur. Harkiv, HNAU (in Ukrainian).
Stankevich S.V. & Zabrodina I.V. (2016). Monitoring shkidnikiv silskogospodarskih kultur. Harkiv, FOP Brovin O.V. (in Ukrainian).
Stankevych S.V., Vasylieva Yu.V., Golovan L.V., Zabrodina I.V., Lutytska N.V., Nakonechna Yu.O., Molchanova O.A., Chupryna Yu.Yu., Zhukova L.V. (2019). Chronicle of insect pests massive reproduction. Ukrainian Journal of Ecology, 9 (1), 262–274.
Stankevych S. V., Yevtushenko M. D. & Zabrodina I. V. (2019). The significance of scientific school of V.V. Dokuchaev Kharkov National Agrarian University in development agricultural entomology in the XIX–XXI centuries. Ukrainian Journal of Ecology, 9 (2), 156–169.
Supihanov B. K. & Petrenko N. I. (2008). Olijni kulturi: istoriya, sorti, virobnictvo, torgivlya, Kiyiv, NNC IAE UAAN (in Ukrainian).
Tribel S. O. (2001). Metodiki viprobuvannya i zastosuvannya pesticidiv. Kiyiv, Svit (in Ukrainian).
Turenko V. P., Bilyk M. O. & Zhukova L. V. (2019). Pathogens of spring barley on abiotic factors in the eastern forest – steppe of Ukraine. Ukrainian Journal of Ecology, 9 (2), 179–188.
Vasilev V. P. (1989). Vrediteli selskohozyajstvennyh kultur i lesnyh nasazhdenij. Part 3. Metody i sredstva borby s vreditelyami, sistemy meropriyatij po zashite rastenij. Kiyiv, Urozhaj (in Russian).
Yakovenko T. M. (2005). Olijni kulturi Ukrayini. Kiyiv, Urozhaj (in Ukrainian).
Yeshenko V. O., Karichkovska G. I., Novak A. V. (2010). Tehnologiya viroshuvannya ripaka yarogo v Lisostepu Ukrayini. Uman, Vidavec Sochinskij (in Ukrainian).
Yevtushenko M. D., Stankevich S.V. & Vilna V.V. (2014). Hrestocviti blishki, ripakovij kvitkoyid na ripaku yaromu j girchici u Shidnomu Lisostepu Ukrayini. Harkiv, 170. (in Ukrainian).
Yevtushenko M. D., Vilna V. V. & Stankevich S. V. (2016). Hrestocviti klopi na ripaku yaromu j girchici u Shidnomu Lisostepu Ukrayini. Harkiv, FOP Brovin O.V. (in Ukrainian).
Zhukova L. V., Stankevych, S. V., Turenko, V. P. (2019). Root rots of spring barley, their harmfulness and the basic effective protection measures. Ukrainian Journal of Ecology, 9 (2), 232–238.

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