EFFICACY OF INSECTICIDES FOR THE CONTROL OF SOME HARMFUL ORGANISMS IN SUNFLOWER VIA SEED TREATMENT

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SUMMARY

During 1998 and 1999 we studied insecticide efficacy by treating sunflower seeds against soil pests (larvae of the family *Elateridae*) and the leaf curl plum aphid (*Brachycaudus helichrysi)*.

Used in the trial were the following insecticides: carbofuran (Furadan 480 FS; 2.50 l; Furadan 35 ST; 2.0 l), furathiocarb (Promet 400 CS; 3.0 l), thiodicarb (Semevin 375 FS; 2.40 l), tefluthrin (Force 20 CS; 0.45 l), imidacloprid (Gaucho 70 WS; 0.85; Gaucho 600 FS; 1.75 and 1.166 l; Gaucho 350 FS; 2,0 l), fipronil (Cosmos 500 FS; 0.50 l) and thiamethoxam (Cruiser 350 FS; 0.60 and 1.00 l per 100 kg of seed).

The best stand density was attained using thiamethoxam, imidacloprid, carbofuran, thiodicarb, and tefluthrin. The highest efficacy in reducing plum aphid populations was exhibited by imidacloprid, thiamethoxam, and tefluthrin, while the lowest levels of attack caused by *S.sclerotiorum* were recorded on plants grown from seeds treated with thiamethoxam-, imidacloprid-, and tefluthrin-based preparations.

The highest yield increase was achieved using thiamethoxam-, imidacloprid-, and fipronil-based insecticides. The increases in grain yield relative to the control ranged from 2.16 to 12.69%, or 321 to 406 kg/ha. The largest oil yield was produced when thiamethoxam-, imidacloprid-, and tefluthrin-based insecticides were applied, and the increases ranged between 148 and 216 kg/ha in relation to the control.

In 1999 when wireworms were dominant the increase in grain yield relative to the control ranged from 14.89 to 38.29%. The largest grain yield was produced when imidacloprid and thiamethoxam based insecticides were applied and the increases range between 210 to 540 kg/ha in relation to the control.

To summarize, the two insecticides that stand out in terms of efficacy are thiamethoxam and imidacloprid, while all the others belong in another, less effective, group.

KEY WORDS: treatment of sunflower seed using insecticides, wireworms (*Elateridae*), leaf curl plum aphid (*Brachycaudus helichrysi* Kalt.), white stem rot - leaf - stem form (*Sclerotinia sclerotiorum* Lik. De Bary.).

Introduction

In southeastern Europe, Yugoslavia included, a number of phytophagous insect species can be found in the initial stages of sunflower growth and development (from germination till emergence), until the plants develop several permanent leaves. Among them, the majority are polyphagous pests, which are threat not only to sunflower but to other row crops as well. Among the pests that attack the underground parts of the plant, the most economically important ones are the larvae of the click beetle and the cockchafer (families Elateridae and Scarabaeidae).

In some years, in the second half of May and most of June, young sunflower plants suffer from mass infestations by various species of the leaf aphid and other members of the Homoptera order, especially the leaf curl plum aphid (*Brachycaudus helichrysi* Kalt.). According to French data, these insects can reduce seed yields by about 16% (Čamprag, 1988). In addition to the damage they cause directly, aphids increase the severity of a number of diseases, especially those caused by the parasites of the genera *Sclerotinia* and *Botrytis*.

In this paper, we will present the results of a study on the efficacy of insecticides against wireworms (larvae of the family Elateridae) as the most important soil pests as well as our findings on the effects of insecticides on the reduction of plum aphid (*B.helichrysi*) populations and severity of attack by the leaf-stem form of white stem rot (*Sclerotinia sclerotiorum* Lik.de Bary).

Materials and Methods

Our study on insecticide efficacy using seed treatment was carried out during 1998 and 1999 and involved formulations based on carbofuran, furathiocarb, tiodicarba, tefluthrin, imidacloprid, fipronil and thiamethoxam.

The experiments were conducted under field conditions at the Rimski Šančevi Experiment Field of the Institute of Field and Vegetable Crops in Novi Sad and at the "Savo Kovačević" state farm at Vrbas. The seed of the hybrid NS-H-111 was machine-sown at a spacing of 70 x 27 cm. Before 5he sowing, the seed treated first with a fungicide (metalaksil + benomil) and then with insecticides. The treating was carried out on a Hege 11 in a laboratory at the processing center of the Institute of Field and Vegetable Crops. Before the start of the trials, population density of the click beetle larvae was determined by the soil samples method (50 x 50 x 50 cm). Wireworm abundance at the trial sites ranged between 3 and 24 per meter square. The threshold for control of wireworms in a sunflower crop is two larvae per meter square, meaning that the prerequisite for conducting this type of trial had been met. The extremely phytophagous genus *Agriotes* was dominant, and the dominant species was *A. ustulatus.*

The stand density, seed (grain) yield at 11% moisture, and oil yield per hectare were used as the parameters for assessing the efficacy of the insecticides. The severity of infestation by the leaf aphids and infection by the leaf-stem form of white rot was estimated based on the percentage of infested and infected plants in absolute terms. The oil was analyzed using NMR. Depending on the data obtained, most of the results were subjected to variation and statistical processing and expressed in terms of deviation in relation to the control plots.

Results and Discussion

The results for insecticide efficacy obtained based on the stand density are shown in Table 1. The assessment was made on two occasions — at the cotyledon and first leaf pair stage and at the stage of two to three pairs of leaves. On both assessment dates, the insecticides proved to have had a positive effect on the number of emerged plants. Averaging both assessments, the best efficacy in 1998 was achieved using the following insecticides thiamethoxam (Cruiser 350 FS; 0.6 and 1.0 l), imidacloprid (Gaucho 70 WS; 0.85 l and Gaucho 600 FS; 1.75 and 1.166 l), carbofuran (Furadan 480 FS; 2.5 l), thiodicarb (Semevin 375 FS;2.4 l) and tefluthrin (Force 20 CS; 0.45 l/100 kg seed). The increases of stand density relative to the control varied from 10.24 and 17.08%. At the Vrbas site in 1999, as a result of the presence of large wireworm populations, even greater differences among the treatments were recorded. The increases of stand density in relation to the control ranged between 88.42 and 127.91% and were the largest when thiametoxam-based preparations were used (Cruiser 350 FS; 1.0 kg/100 kg seed). It is also worth noting that the stand was retained, whereas in the rest of the plot, where no seed treatment was carried out, the crop had to be resown. Overall, only two insecticides — thiametoxam and imidacloprid — exhibited high efficacy on both assessment dates. When the results were processed using two-factorial trial analysis, chemicals based on these two active ingridients came out on top again. The good biological properties of imidacloprid when it comes to the control of soil pests have been known in our country for a number of years (Sekulić et al., 1991, 1993, 1998), while studies involving thiamethoxam have begun only recently. According to Senn et al., (1998), the active ingredient of thiamethoxam is also intended for the control of soil pests and is very effective when used for that purpose.

In 1998, primarily because of a mass occurrence of the plum aphid (*B.helichrysi*), we estimated in natural conditions the efficacy, or the systemic effects, of the studied insecticides in reducing the abundance of this species. The plum aphid can reduce the yield by about 16% (Badenhauser et al., 1985, cit. Čamprag, 1988). In Vojvodina, severe aphid attacks reduced the seed yield by 11% (Čamprag, 1988). The assessment of insecticide efficacy against the leaf aphids was conducted at the beginning of the second ten-day period of May, that is, when a mass infestation of the plants started. The results (Table 2) showed that the lowest percentage of infested plants was achieved using insecticides based on imidacloprid (Gaucho 600 FS; 1.75 l), tefluthrina (Force 20 CS; 0.45 l), imidacloprid again (Gaucho 70 WS; 0.5 l), and thiamethoxam (Cruiser 350 FS; 0.6 l/100 kg seed). In treatments with these insecticides, the infestation levels ranged from 20 to 60%. The high efficacy of teflutrin despite its lack of systemic properties can probably be explained by the high initial toxicity and the possession of gas phase. A noticeable decrease in attack severity, i.e. aphid abundance, in relation to the control plants was also observed in treatments with these insecticides. The reduction ranged between - 75,5 do - 92,8A particularly positive correlation is known to exist between the severity of attack by aphids and the level of infection by the parasites of the genus *Sclerotinia*. In sunflower populations severely infested by the plum aphid, the number of plants attacked by the *Sclerotinia* parasites is 57% higher than in those that are not (Čamprag, 1988). In parallel with monitoring plant development during the growing season, in late May and early June, we assessed the level of attack by the stem-leaf form of white head rot (*S.sclerotiorum*) in order to determine the indirect effect of the insecticides on this disease. The results (Table 2) showed that all the insecticides decreased the plant infection percentage. The average proportion of attacked plants was 4.2% in the control but only 0.2-3.2% in the other treatments. The largest decreases were obtained using preparations based on imidacloprid,

tefluthrin, and thiamethoxam. With these insecticides, the reduction of the plant infection levels ranged from - 33,3 to -95,2%.

Tab.1. Insecticide efficacy against soil pests (*Elateridae*) in sunflower crops, expressed through grain and oil yields (kg |ha)

Chemical	Rate (l,kg/100 kg seed)	stand density per 10 m row (mean)		seed yield, kg/ha (mean)		oil yield kg/ha (mean)
		1998	1999	1998	1999	1998
Cruiser 350 FS	0,60	29,67	26,63	3.358	1.860	1.537
Cruiser 350 FS	1,00	28,47	33,66	3.521	1.620	1.631
Gaucho 70 WS	0,85	29,95	-	3.403	-	1.516
Gaucho 600 FS	1,75	28,91	-	3.606	-	1.691
Gaucho 600 FS	1,166	27,78	-	3.413	-	1.593
Gaucho 350 FS	2,00	-	31,16	-	1.950	-
Furadan 480 FS	2,50	28,22	-	3.136	-	1.399
Furadan 35 ST	2,00	27,25	-	3.269	-	1.478
Promet 400 CS	3,00	26,37	-	3.378	-	1.489
Force 20 CS	0,45	28,62	-	3.487	-	1.623
Semevin 375 FS	2,40	27,38	-	3.459	-	1.582
Cosmos 500 FS	0,50	26,22	-	3.530	-	1.610
check	-	25,72	15,33	3.200	1.410	1.475
LSD0,05 =		**2,43**	**4,10**	**301**	**427**	**166**

Tab.2. Efficacy of insecticides used for the control of soil pests (*Elateridae*) against the leaf plum aphids (*Brachycaudus helichrysi*) and white rot (*Sclerotinia sclerotiorum*) in sunflower crops

Chemical	rate (l,kg/100 kg seed)	(*B. helichrysi*)		S. sclerotiorum	
		total aphids (mean)	decresing check = 100%	attacked plants % (mean)	decresing chek = 100%
Cruiser 350 FS	0,60	34	- 75,5	0,2	- 95,2
Cruiser 350 FS	1,00	43	- 69,1	0,5	- 88,1
Gaucho 70 WS	0,85	31	- 77,7	0,8	- 81,0
Gaucho 60 FS	1,75	29	- 79,1	0,5	- 88,1
Gaucho 600 FS	1,166	19	- 86,3	1,5	- 64,3
Furadan 480 FS	2,50	118	- 15,1	1,0	- 76,2
Furadan 35 ST	2,00	96	- 30,9	3,2	- 23,8
Promet 400 CS	3,00	113	- 18,7	1,2	- 71,4
Force 20 CS	0,45	10	- 92,8	2,8	- 33,3
Semevin 375 FS	2,40	97	- 30,2	2,2	- 47,6
Cosmos 500 FS	0,50	72	- 48,2	2,5	- 40,5
Check	-	139	0,0	4,2	0,0

Since the thinning of the stand (or reduction of the stand density) resulting from the attack by soil pests as well as the presence of aphids during the growing season can significantly reduce seed yields and, hence, oil yields as well, these two parameters were assessed at technological maturity. The results (Table 1) indicated that all the insecticides except the carbofuran-based ones (Furadan 480 FS; 2.5 l/100 kg seed) had a positive effect on the parameters in question. When the leaf aphids were the dominant pests (1998), seed yield increases in relation to the control ranged between 2.16 and 12.69%. The largest increase of seed yield relative to the control treatment was achieved using insecticides based on imidacloprid (Gaucho 600 FS; 1.75 l), thiamethoxam (Cruiser 350 FS; 1.0 l), and fipronil (Cosmos 500 FS; 0.5 l/100 kg seed). When the wireworms (larvae of the family Elateridae) were dominant (1999), the seed yield increases compared with the control ranged from 14.89 to 38.29%. The highest increase of seed yield was achieved using imidacloprida and thiamethoxam. The increases ranged between 210 and 540 kg/ha. These preparations achieved significant results in relation to the control at the 0.05% significance level.

Similar tendencies were observed in the case of oil yield per hectare as well. In addition to the aforementioned insecticides, very good results were achieved using tefluthrin (Force 20 CS; 0.45 l/100 kg seed). The increases of oil yield (those of more than 10% relative to the control) varied from 10.03 to 14.64%. Only imidacloprid (Gaucho 600 FS) at 1.75 l produced significant differences at the 0.05% significance level. During 1999, depending on the insecticide, the increases of oil yield ranged between 80 and 270 kg/ha, or 12.69 and 42.85%.

Summing up the findings for all the parameters used for assessing insecticide efficacy (stand density, aphid abundance and white rot severity reduction, seed yield, and oil yield), it can be concluded that the two insecticides that stood out in terms of efficacy were imidacloprid (Gaucho 600 FS; 1.75 and 1.166 l; Gaucho 70 WS; 0.85 l and Gaucho 350 FS; 1.0l) and thiamethoxam (Cruiser 350 FS; 0.6 and 1.0 l / 100 kg seed), while all the others belonged in another, less effective, group. No phytotoxic effects were observed on the plants during the study in any of the treatments.

In light of the results of numerous studies carried out worldwide (Barbulescu et al., 1993, 1994., Drinkwater et al., 1990, etc) as well as our own long-term studies in this field, this method of insecticide application should be introduced into agricultural practice less conservatively, as that would be fully justified both economically and environmentally.

Conclusion

During 1998 and 1999, we studied, using sunflower seed treatment, the efficacy of insecticides in controlling soil pests (larvae of the family Elateridae) and reducing plum aphid (*Brachycaudus helichrysi*) abundance and the level of attack by the leaf-stem form of white head rot.

The following insecticides were used in the study: carbofuran, furatiocarb, thiodicarb, tefluthrin, imidacloprid, fipronil and thiamethoxam.

The best stand density was achieved using thiametoxam, imidacloprid, carbofuran, thiodicarb and tefluthrin. The highest efficacy in reducing plum aphid populations was

exhibited by imidacloprid, thiamethoxam and tefluthrin. The lowest number of *S.sclerotiorum* parasites was recorded on plants developed from the seed treated with preparations based on imidacloprid, thiamehoxam and tefluthrin.

When the leaf aphids were the dominant pests in sunflower crops (1998), seed yield increases relative to the control ranged from 2.16 to 12.69%. The highest increase of yield was achieved using insecticides based on imidacloprid, thiamethoxam and fipronil. In absolute terms, the increases varied from 321 to 406 kg/ha. The highest oil yields were obtained using insecticides based on imidacloprid, thiametoxam and tefluthrin. Relative to the control, the increases ranged between 148 and 216 kg/ha.

When wireworms (larvae of the family Elateridae) were dominant (1999), the seed yield increases in relation to the control ranged from 14.89 and 38.29%. The highest yield increase was recorded in the treatments with imidacloprid i thiamethoxam. The increases were 210-540 kg/ha. Oil yield increased from 80 to 270 kg/ha compared with the control treatment.

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