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ECOLOGICAL METHOD FOR PEST MANAGEMENT AT EARLY STAGES OF FORAGE PEA AND VETCH DEVELOPMENT

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Abstract

Development of contemporary agriculture is related with obtaining of profitable yields of good quality by application of ecologically friendly plant protection. The pre-sowing seed treatment with insecticides is considered an efficient and ecological method for plant protection against insect pests, as well as for conservation of beneficial insects. In the IFC, Pleven, a field trial was carried out with insecticidal products by pre-sowing treatment of seeds of forage pea and vetch for insect pest control at the stage of emergence and stem formation. Furadan 35 ST (carbofuran) at the dose of 2.5 l and Gaucho FS 600 (imidacloprid) – 1 l, tested alone and in combination with the growth stimulant Atonic at the dose of 0.1%, were used for treatment of 100 kg seeds. The insecticides had a good protective effect against adult weevils of *Sitona* genus. The insecticides provided a high protective effect against *Sitona* species as their combination with Atonic increased their efficiency. In addition, the products influenced positively the nodulation and nodule protection, which resulted in better conditions for growth, development and high productivity.

Kew words: Gaucho FS 600, Furadan 35 ST, *Sitona* sp., nodulation, productivity

Introduction

Development of contemporary agriculture is related with obtaining of profitable yields of good quality by application of ecologically friendly plant protection. The pre-sowing seed treatment with insecticides is considered an efficacy and ecological method to plant strengthen and protection against insect pests during early stages of their development, as well as for conservation of beneficial insects (Albajes et al., 2003; Brian et al., 2004; William et al., 2007). This method is used with success in a number of countries in the control against the larvae of the May beetle, larvae of genus *Sitona*, *Agriotes* sp., and against *Sitona* weevils, beet weevils, thrips, *Opatrum sabulosum* L., etc. (Cluzeau, 1994). Romanian researchers (Barbulescu, 1994) found that formulations Carbodan 35 CT and Talstar 20 CT had high efficacy against insect pests during plant germination, and also in some cases had a positive influence, and led to an increase in the pod number, the root and stem length of alfalfa. The use of insecticides for pre-sowing seed treatment resulted in a significant increase of aboveground biomass, root mass and yield even in the absence of insect attack (Krohn and Hellpointner, 2002; Dewar et al., 2003).

During the earlying period of plant development, they are attacked by different species of pest insects as *Sitona crinitus* Herbst, *Opatrum sabulosum* L., *Otiorhynchus ligustici* L., *Tanymecus dilaticollis* Boh. etc. (Čamprag, 1996). These species gnaw cotyledons, vegetative apex and leaves. In years with a dry and warm spring they cause defoliation and killing of young plants. The larvae of *Sitona* genus destroy the bacterial nodules on root system which disturbs the normal process of symbiotic nitrogen fixation of plants (Hungria and Vargas, 2002). The larvae of wireworms attack the sown seeds and the underground organs of plants. That decreases the stand evenness and the grain yield.

It was found that the pre-sowing treatment of seeds of spring forage pea Pisum sativum L. (Dochkova et al., 2000),

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broad beans Vicia faba L. (Epperlein, 1992), soybean Glycine max L (Cluzeau, 1994), lucerne *Medicago sativa* L.(Dochkova et. al., 2003) with systemic formulations contributes to a decrease of population density of pest insects, as well as of the damages caused by them in seedlings and young plants.

In Bulgaria were tested and recommended for use in practice a different set of insecticides by pre-sowing treatments against pests of spring vetch, alfalfa, soybeans and others. (Nikolova, 2005; Nikolova et al., 2004; Nikolova and Vassileva, 2007).

The aim of the study was to make a comparative assessment of economically important pests in field pea and vetch in the early stages of plant development, insecticide efficiency of products by pre-sowing seed treatment as an environmentally friendly method to control pests and of the consequence on the nodulation and productivity.

Materials and Methods

In the IFC, Pleven, a field trial was carried out with insecticidal products by pre-sowing treatment of seeds of forage pea (variety Pleven 4) and vetch (variety Obrazets 666) for insect pest control at the stage of emergence and stem formation during the 2007-2008. Furadan 35 ST (carbofuran) at the dose of 2.5 l and Gaucho FS 600 (imidacloprid) – 1 l, applied alone and in combination with the growth stimulant Atonic at the dose of 0.1%, were used for treatment of 100 kg seeds. According to data of the Japanese Company Azahi Chemical, the phenolic compounds – active ingredients in the growth stimulant, are natural substances contained naturally in plant cells. The preparation Atonic is suitable for pre-sowing treatment of seeds of different crops, because it stimulates the germination. It is also recommended to mix it with different kinds of pesticides, for which positive synergism is observed.

The trial was laid out by the block method with 6 variants and four replications, under no irrigated conditions and at the sowing rate of 120 g.s m^{-2} for forage pea and 250 g.s m^{-2} for vetch.

The efficacy of the insecticides was determined at natural population density of nodule weevils by the formula of Henderson and Tillton (1955).

The following characteristics were recorded at the early flowering stage: nodulation and weight of root and aboveground biomass $plant^{-1}$. Stand density (plant number m^{-2}) and forage productivity (kg ha^{-1}) were determined at the stage of flowering-pod formation.

Statistical processing of the experimental data was performed by using the programmed product MS/DOS – STDTA.

Results and Discussion

In the early development stages of the forage pea and vetch (germination and stem development) the plants are fragile and susceptible to pest attacks, mainly from species of the order *Coleoptera*. A considerably lower population density of beetles was founded in 2008 compared to the previous 2007 year, which was associated with the more humid and rainy period in March and April (with 66.5 mm more rainfall).

The species composition in both cultural species was very similar as in the vetch were determined 15 species, while in the forage peas - 14 species (except *Psalidium maxillosum*) - Table 1. Unlike the composition, the abundance and proportion of pest insects varied greatly. The population density of the species in the forage pea was 36.2% lower compared to vetch plants. The lack of wax coating, presence of more tender leaf (plant) structure and higher protein and lower fiber content of above-ground mass (Georgieva et al., 2010; Georgieva et al., 2011) probably determined the considerable preference of pests to vetch plants. Constantly appearing and with dominant numbers with high density over the years were beetles *Opatrum sabulosum* (1852 number of specimens), weevils from the genus *Sitona* (1719 number of specimens) and *Tanymecus dilaticollis* (1555 number of specimens), while *Otiorhynchus ligustici* (552 number of specimens) was the sub-dominant species. Other species from the order of *Coleoptera* took low percentage of the infesting species (below 3%) and did not represent a real threat to the vetch plants.

During the period of germination and stem development, forage pea was attacked primarily by weevils from the genus *Sitona* (1569 specimens) and *O. sabulosum* (1516 number specimens), while *T. dilaticollis* (441 specimen number) and larvae of wire worms (*Agriotes lineatus* and *A. ustulatus* – a total number of 154 specimens) had a lower presence and were sub-dominant species. The other coleopteran species occupied 7.6% of the total population density.

In a comparative assessment of the forage peas and vetch was found that species of the genus *Sitona* and *O. sabulosum* were in a higher density in the vetch, and *T. dilaticollis* also belonged to the dominant species with high participation, in contrast by the pea plants. *Otiorhynchus ligustici* manifested as sub-dominant species, while in the pea, its number was negligible (total 17 of specimens).

The tested insecticides had a rapid initiation action and immediately after plant germination, they had complete control of the species of *Sitona* genus, and their efficiency was close to 100.0%. The products had a longer after-effect, which provided a better protection of plants one month after germination (Table 2). Approximately 20 days after germi-

nation of the plants, the efficiency was higher and varied in the range 74.6 - 100.0%, depending on weather conditions during the year and the crop. It was noteworthy that neonicotinoid insecticide Gaucho showed a higher toxic effect, and its efficacy was high on the 30th day-after treatment. It was also important that the combined use of Gaucho and Furadan with the growth stimulator Atonic increased the toxicity of products in comparison to their alone use and during the two years of study. That positive interaction was more pronounced at Gaucho as efficiency increases from 3.0 to 6.2%,

Table 1
Quantitative and qualitative composition of insect pest in forage pea and vetch in the early stages of plant development

Spesies	Forage pea				Vetch			
	2007	2008	Total	%	2007	2008	Total	%
Agriotes lineatus L.	200	21	221	5.5	82	41	123	1.9
Agriotes ustulatus Schaller	141	46	188	4.7	21	10	31	0.5
Chromoderus fasciatus Müll.	2	1	3	0.1	25	12	37	0.6
Dermestes lardarius L.	8	1	8	0.2	21	15	36	0.6
Harpalus sp.	3	4	7	0.2	30	17	47	0.7
Opatrum sabulosum L.	1200	316	1516	37.6	1501	351	1852	29.3
Otiorrhynchus ligustici L.	6	11	17	0.4	402	150	552	8.7
Phytodecta fornicate Brugg	10	0	10	0.3	19	12	31	0.5
Phyllotreta atra F.	0	2	2	0.1	3	4	7	0.1
Psalidium maxillosum L.	1	0	1	0.0	16	8	24	0.4
Rhagonycha fulva	20	0	20	0.5	64	32	96	1.5
Sitona sp.	1111	458	1569	39.0	1001	718	1719	27.2
Tanymecus dilaticollis Gyll.	273	169	441	11.0	960	595	1555	24.6
Tanymecus paliatus F.	3	0	3	0.1	124	1	125	2.0
Tychius quinquepunctatus L.	0	7	7	0.2	10	12	22	0.4
Other spesies	11	3	14	0.3	49	5	54	0.9
Total Coleoptera	2988	1040	4028	100.0	4328	1983	6311	100.0

Table 2
Efficacy of insecticide products by presowing treatment of the seeds of spring pea and vetch against species of the *Sitona* genus

Insecticides	Efficacy, % - 2007			Efficacy, % - 2008		
	Days after treatment					
	20	25	30	20	25	30
	Forage pea					
Furadan 35 ST	80.1	70.4	66.9	74.6	70.7	63.4
Gaucho FS 600	89.0	82.5	81.7	82.1	74.5	71.2
Furadan 35 ST + Atonic	83.7	78.7	66.4	78.9	73.1	62.3
Gaucho FS 600 + Atonic	91.2	86.8	81.3	85.5	79.6	74.5
	Vetch					
Furadan 35 ST	88.6	80.3	75.2	85.0	80.9	77.1
Gaucho FS 600	97.4	92.6	89.8	92.6	88.3	84.0
Furadan 35 ST + Atonic	94.0	87.3	76.5	89.2	83.5	76.4
Gaucho FS 600 + Atonic	100.0	98.4	92.8	98.5	92.6	89.2

while at Furadan - from 2.4 to 5.5%. The growth stimulant will not protect plants from *Sitona* attacks, but enhanced the effect of the insecticide action and led to increased efficiency.

According to Epperlein and Schmidt (2001), the active ingredient (imidacloprid) contained in plant tissues and cells, acted as a repellent nutrient and prevented the insect pests from inhabiting when in contact with the treated plants, without killing them necessarily. In field conditions, Krohn and Hellpointner (2002) found comparative immobility of the Gaucho active ingredient that combined with soil particles and remained in surface soil layer. In contrast to it, Furadan showed mobility in the soil medium (particularly under heavier rainfall), which resulted in metabolite leaching in the lower layers and decreased of its efficacy (Deleva, 1995). Probably, the comparative immobility of Gaucho, as well as its repellent effect determined the good protection of forage pea and vetch against *Sitona* species in the early stages of plant development.

Furadan and Gaucho showed a greater toxic effect in the spring vetch, probably due to the higher sowing rate and the creation of a wider safety zone around the sown seeds.

Data on the total nodule number plant^{-1} showed an increase in all studied variants relative to the control as the increase was most pronounced for Gaucho and Gaucho + Atonic for both pea and vetch plants (Figure 1). The combined use of insecticides with Atonic in comparison with their alone application increased nodulation activity from 3.3 to 12.8 nodule number plant^{-1} in vetch and 5.4 to 0.9 nodule number plant^{-1} - in forage pea. The growth stimulant Atonic did not protect the bacterial nodules from the attack of species of *Sitona* genus, but helped the plants to restore from the caused injuries, by stimulating the activity of soil microorganisms and contributing to formation of a greater nodule number.

It should be noted that the vetch plants were distinguished by a higher nodulation activity exceeding that of the forage pea averagely by 41.5%.

The protective effect of insecticides on the *Sitona* species affected the population density of larvae, respectively, the degree of bacterial destroyed nodules by them. The weevil larvae of the genus *Sitona*, eating nodules and roots of young plants, hindered the nitrogen-fixing process and can reduce the length of roots to 30% and the amount of dry root mass over 60% (Byers and Kendall, 1982; Hardwick, 1998). The percentages of damaged nodules in the control and Atonic, depending on the culture, exceeded a double or triple the degree of damage compared to insecticide treatment variants averagely of 2007-2008. Their percentage of damaged nodules was low and did not exceed 16.0%. The combined application of insecticide products with Atonic, compared to their alone use, further increased the protective effect, and the degree of damaged nodules does not exceed 6.5% in vetch and 12.5% in forage pea. That was related to the increased efficiency of the insecticides under the action of the growth stimulator, and the creation of better conditions for nodulation activity. The lowest damage was characterized combination of Gaucho and Atonic. In addition, the protection of the root nodules was more highly expressed in vetch plants compared to the pea.

The use of imidacloprid and carbofuran alone provided good protection of the plants from soil insect pests, including *Sitona* species, but the addition of the growth stimulant favoured nodulation and created better condition for plant growth and development.

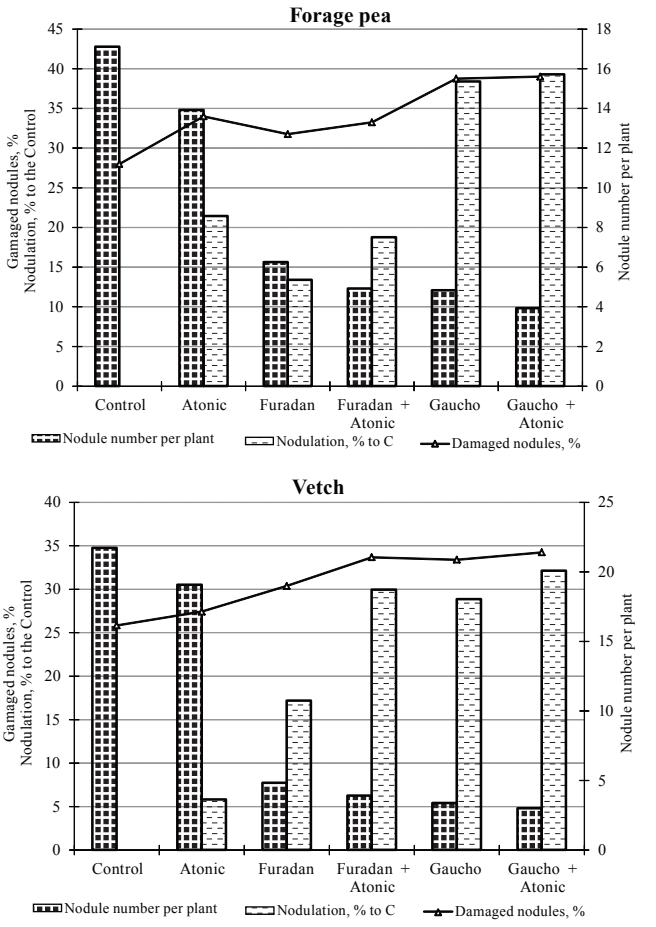

Fig. 1. Effect of insecticides with pre-sowing treatment of forage pea and vetch seeds on nodulation and degree of bacterial nodules damaged by species of *Sitona* genus, average

Table 3
Effect of insecticides by presowing treatment of forage pea and vetch seeds on green mass yield, kg ha^{-1}, averagely

Insecticides	Forage pea		% to C	Vetch		% to C
Control (C)	29000.0	a		12451.3	a	
Atonic	30603.3	ab	5.5	13450.0	b	8.0
Furadan 35 ST	30046.7	b	3.6	13801.0	bc	10.8
Gaucho FS 600	32923.3	c	13.5	14449.7	cd	16.0
Furadan 35 ST + Atonic	32846.7	c	13.3	14500.7	cd	16.5
Gaucho FS 600 + Atonic	35088.0	d	21.0	14802.5	d	18.9
$LSD_{0.05\%}$		1335.720		939.112		

The good protection from insect pests, as well as the stand evenness resulted in high productivity of plants in the insecticide-treated variants – Table 3. The green mass yield in seed treatment variants with Gaucho and Furadan exceeded the control from 3.6 to 21.0% in forage pea and from 10.8 to 18.9% - in vetch as the differences were statistically significant ($P<0.05$). Combinations of Furadan and Gaucho with Atonic compared to their use alone were associated with 6.6-9.3% higher green yield in pea plants and 2.4-5.1% higher yield in vetch as a result of the stimulating action of Atonic on the seed germination, and increasing effects on the insecticide efficacy, and provided high number plants.

Conclusions

During the period of germination and stem development, forage pea was attacked primarily by weevils from the genus *Sitona* (1569 specimens) and *O. sabulosum* (1516 specimens), while *T. dilaticollis* and larvae of wire worms (*Agriotes lineatus* and *A. ustulatus*) had a lower presence and were subdominant species. Constant and dominant beetles with high density in vetch plants were *Opatrum sabulosum* (1852 specimens), weevils from the genus *Sitona* (1719 specimens) and *Tanymecus dilaticollis* (1555 specimens), while *Otiorhynchus ligustici* was the sub-dominant species.

Insecticides Gaucho and Furadan had a rapid initiation and prolonged action-effect on weevils of *Sitona* genus, providing better protection of the plants one month after germination. The combinations with Atonici increased their efficiency, and it was more pronounced at Gaucho.

The products influenced positively the nodulation and nodule protection, which resulted in better conditions for growth, development and high productivity, exceeding the untreated control from 3.6 to 21.0% in forage pea and from 10.8 to 18.9% in vetch.

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