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TOXICITY OF NEEM AND PYRETHRUM PRODUCTS APPLIED ALONE AND IN COMBINATION WITH DIFFERENT ORGANIC PRODUCTS TO SOME PREDATORS AND THEIR POPULATION DENSITY

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ABSTRACT

The trial was conducted with spring forage pea (*Pisum sativum* L.) during the period 2011-2013 in the experimental field of the Institute of Forage Crops, Bulgaria. We studied the effect of three insecticides - NeemAzal T/S®, Pyrethrum FS EC (biological insecticides) and Nurele D Chlorcyrine 550 EC (synthetic pyrethroid) applied alone and in combination with growth regulators - Polyversum (biological growth regulator and fungicide) and Flordimex 420 (synthetic growth regulator) and an organic foliar fertilizer, known as Biofa, on predators population density and their toxicity on *Aeolothrips intermedius* Bagnall (*Thysanoptera: Aeolothripidae*) and *Coccinella septempunctata* L. (Coleoptera: *Coccinellidae*). The treatment of plants with biological insecticide NeemAzal-T/S® (azadirachtin) was associated with a lower numbers of *A. intermedius* with 17.2% under alone use and from 27.5 to 33.9% in combination with organic products respectively Polyverzum (growth regulator) and Biofa (foliar fertilizer). Using of Pyrethrum FS EC was associated with a reduction in the numbers of *A. intermedius* by 26.8%, while combining it with Polyverzum and Biofa - from 33.2 to 37.1%. Individual application of biological insecticides had no significant harmful effect on natural populations of beneficial thrips. The use of NeemAzal-T/S® reduced to a less degree the numbers of predatory ladybird *C. septempunctata* from 11.2 (used alone) to 20.5% (in combination with Biofa) compared to Pyrethrum FS EC for which the reduction varied from 16.4 to 26.3%. The biological insecticides had a less pronounced influence on the density of species with insignificant differences of the absolute values to the control. NeemAzal-T/S® applied alone and in combination with Polyversum in regard to *A. intermedius* was manifested primarily like harmless, and in combination with Biofa mainly as slightly harmful. Pyrethrum FS EC used alone and in combination with Polyversum was manifested mainly as slightly harmful and combining it with the organic foliar fertilizer Biofa - as moderately harmful, slightly harmful and harmless depending on the reported days. Biological insecticides manifested themselves as harmless regarding of *C. septempunctata* and their toxic action did not exceed 25%. NeemAzal-T/S® and Pyrethrum FS EC, used alone and in combination with organic products Biofa and Polyversum in general had not significant harmful effects on predatory species and are suitable for application in conditions of an organic farming.

Key words: Biological insecticides, organic farming, neem, pyrethrum, toxicity, *Aeolothrips intermedius, Coccinella septempunctata*.

INTRODUCTION

Continuous use of broad-spectrum insecticides has resulted in the development of resistant pests, resurgence of target insect populations, and secondary pest outbreaks. All of these consequences can be at least partially related to the disruption of natural enemy populations (Hsieh & Allen, 1986). Therefore for effective, bio-degradable pest control is necessary to use materials with greater selectivity (Saxena, 1987). Some studies reported for growth-regulating compounds which kill phytophagous pests sparing at the same time adult beneficials (Schmutterer, 1987). Different biopesticides, such as botanical pesticides, fungi, nematodes can contribute to insect control. Biopesticides used to control pests include extracts from animals, plants, bacteria, and minerals. For each pest and its biological control agent, research is required to evaluate the biopesticide as part of an Integrated Pest Management (IPM) strategy (Bonsignore and Vacante, 2012).

In general, neem products are thought to possess medium to broad-spectrum activity toward phytophagous insects, while being

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relatively benign to beneficial insects, such as pollinators, predators, and parasitoids (Saxena 1987; Schmutterer, 1988; National Research Counci1, 1992). The selectivity of neem products is believed to result primarily from a general lack of contact toxicity and the need for ingestion (Saxena, 1989; Schmutterer, 1990).

Among the sources of botanical pesticides, pyrethrins from pyrethrum plants (*Chrysanthemum cinerariefolium*) represent one of the economically most important class of compounds with broad usage in organic agriculture (Casida, 1973). Bioinsecticides such as pyrethrum which rapidly lose their effectiveness are not so detrimental to the beneficial forms. They may kill the larval or adult predators and adult parasites which are present upon the foliage during the period immediately following the application, but those parasites emerging thereafter, and those predators which soon invade the controlled area, are not affected. As a result often there is a marked increase of parasites and predators in relation to that of the host (Weems, 1954).

The review of the current literature reveals that a few data are available regarding the impact of neem (Hoelmer et al., 1990) and pyrethrum on beneficial insects, other than direct contact toxicity studies under field conditions. Because aphids and phytophagous thrips serve as a food source for a large number of predatory and parasitic insects, the effect of neem and pyrethrum on non-target organisms is particularly important for the management of pest populations.

A predominant opinion is that azadirachtin should be combined with plant oils in order to be more effective against some pest (Höhn et al., 1996; Schulz et al., 1997; Bessin, 2008; UC, 2008**)**. But there is a great lack of toxicity comparisons between pyrethrum and neem products to some beneficial insects, which are applied alone and in combination with different organic products.

Therefore the purpose of the study was to compare the toxicity of NeemAzal-T/S with that of Pyrethrum, when they are applied alone and in combination with different organic products to *Aeolothrips intermedius and Coccinellidae* species and the impact of these products on population density of above mentioned ones in spring forage pea (*Pisum sativum* L.).

MATERIAL AND METHODS

The trial was conducted with spring forage pea (*Pisum sativum* L.) variety „Pleven 4" during the period 2011-2013 in the experimental field of the Institute of Forage Crops, Bulgaria. The experiment was designed by the split plot method with sowing rate of 120 seeds m^{-2} in 4 replications and plot size of 6.5 m^2. It was studied the effect of three insecticides - NeemAzal, Pyrethrum (biological insecticides) and Nurele D Chlorcyrine550 EC (synthetic pyrethroid) applied alone and in combination with growth regulators - Polyversum (biological growth regulator and fungicide) and Flordimex (synthetic growth regulator) and an organic foliar fertilizer, known as Biofa on *Aeolothrips intermedius* Bagnall and *Coccinellidae* species population density. The treatment was conducted twice at budding and flowering. Variants of the trial: 1. control (treated with distilled water); 2. Biofa-500 ml/ha (dose); 3. Polyversum-100 g/ha; 4. Flordimex-50 ml/ha; 5. NeemAzal-500 ml/ha; 6. Pyrethrum-50 ml/ha; 7. Nurele D Chlorcyrine-400 ml/ha; 8. NeemAzal-0.5% + Biofa-0.5%; 9. Pyrethrum-0.05% + Biofa-0.5%; 10. NeemAzal-500 ml/ha+ Polyversum-100 g/ha; 11. Pyrethrum-50 ml/ha + Polyversum-100 g/ha; 12. Nurele D Chlorcyrine-400 ml/ha + Flordimex-50 ml/ha.

During the vegetation period the population density of predators was recorded once a week. The method of sweeping with entomological net was used. According to the principles of International Organization of Biological Control (IOBC), four evaluation categories (% mortality or reduction in beneficial capacity) were used: 1 = harmless (<25%); 2 = slightly harmful (25 to 50%); 3 = moderately harmful (51 to 75%); and 4 = harmful (>75%) (Hassan et al., 1994). The toxicity of the insecticides was calculated according to the formula of Abbott (1925) on the first, third, fifth and

seventh day after second treatment. The statistical processing of experimental data was conducted using the Statgraphics Plus software program and ANOVA for statistical analysis.

NeemAzal-T/S® is product from Indian Neem tree *Azadirachta indica* A. Juss: *Meliaceae*. Active substances**:** 1 % azadirachtin A + 0.5 % azadirachtin B, W, G, D and 2.5 % neem substance. Producer: Trifolio–M, Germany.

Pyrethrum FS EC is natural extract of *Chrysanthemum cinerariefolium*. Components: 32 % extract from pyrethrum (25 % pyrethrin) + 32 % sesame oil + 36 % adhesives (soft potassium soap). Producer: Andermatt Biocontrol, Switzerland.

Nurele D Chlorcyrine D 550 EC (50 g a.i. l^{-1} cypermethrin + 500 g a.i. l^{-1} chlorpyrifos-ethyl) - pyrethroid insecticide. Producer: Dow AgroSciences-Indiana, USA.

Biofa (brown algae extract) is a natural product obtained through cold extraction and is extremely rich in macro and microelements. It contains organic matters (9%), alginic acid (4%), natural plant hormones, total nitrogen (0.20%), total phosphorus (P_2O_5) - 8%, soluble potassium (K_2O) - 14%.

Polyversum (spores of fungus *Pythium oligandrum*) - natural product with a double effect: a fungicide and growth regulator.

Flordimex 420 (420 g/l ethephon) is synthetic growth regulator which stimulates the formation of generative organs. Producer: Bayer CropSciences.

RESULTS AND DISCUSSION

Useful entomofauna on spring forage pea was represented by species belonging to the order *Thysanoptera*, *Coleoptera*, *Hemiptera* and *Hymenoptera*. With relatively high numbers and presence in stands are distinguished the predators *Aeolothrips intermedius* Bagnall (*Thysanoptera*: *Aeolothripidae*) and *Coccinella septempunctata* L. (*Coleoptera*: *Coccinellidae*), which allowed to follow their response to an investigational biological products under field conditions. Five predators, which belong to five genuses from family *Coccinellidae* were identified as a result of the investigation, namely *Propylaea quatuordecimpunctata* L., *Coccinula quatuordecimpustulata* L., *Adonia variegata* Goeze, *Scymnus (Neopulus) quadrimaculatus* Herb. and *Coccinella septempunctata* L. Other predators (excluding *C. septempunctata*) of the family *Coccinellidae* had insignificantly participation.

Weather conditions over the years influenced the development and multiplication of pests and in certain degree of their bioagents. The total amount of rainfall during the growing season of spring forage pea of 141.6 mm (April, May and June) and the daily average temperature of 16.5°C in 2011 inhibited the development and reproduction of phytophagous thrips and aphids and determined a lower number of predatores *A. intermedius* and *C. septempunctata* (Table 1). Higher temperature in 2012 and 2013 with average of 2.2 and 1.8°C, combined with greater rainfall with 30.2 and 84.4 mm and their relatively uniform distribution had favorable impact for the development and reproduction of pests and their bioagents. Their average density in the vegetation period was significantly higher in 2012 and 2013.

It should be noted that the biological insecticides are unstable in light, yielding to low temperatures and rainfall and have rapid photo degradation by UV radiation (Schmutterer, 1990; Pavela, 2009) as opposed to synthetic pesticides and therefore NeemAzal and Pyrethrum exhibited significantly lower efficacy against polyphagous thrips and aphids in 2012 (Nikolova and Georgieva, 2014a; 2014b). That was the result of lower average daily temperatures, combined with significant rainfall in May and especially in the second and third ten days of the month in 2012 (79.2 mm compared to 61.5 mm in 2011, and 59.95 mm in 2013) when was performed treatment over the years. That had a significant impact on the exhibited toxic action of organic products on beneficial thrips and ladybugs, respectively on their numbers. Less pronounced reduction and impact on the density of predators was

observed in 2012. Depending on the mode of treatment, the average number of predatory thrips *A. intermedius* during the vegetation period took different values (Table 1).

Table 1. Mean number of *Aeolothrips intermedius* and *Coccinella septempunctata* for vegetation period per 100 sweepings

Variants	2011	2012	2013	Mean	To C,%	2011	2012	2013	Mean	To C,%
	Aeolothrips intermedius					*Coccinella septempunctata*				
Control (C)	26.2	33.0	33.6	30.9 c[a]		1.9	30.0	12.0	14.6bc	
Biofa	28.3	36.0	30.8	31.7 c	2.6	2.3	29.3	11.6	14.4bc	-1.4
Polyversum	25.6	33.4	36.1	31.7 c	2.6	2.0	32.5	13.4	16.0 c	9.4
Flordimex	27.8	29.3	34.8	30.6 c	-0.9	2.4	33.3	11.7	15.8 c	8.2
NeemAzal	19.8	28.4	28.6	25.6 bc	-17.2	1.6	26.4	10.9	13.0bc	-11.2
Pyrethrum	17.0	26.0	24.9	22.6 bc	-26.8	1.4	25.2	10.0	12.2bc	-16.4
Nurele D Chlorsyrin	5.9	10.9	9.4	8.7 a	-71.7	0.6	7.5	4.2	4.1 a	-71.9
NeemAzal + Biofa	15.4	24.0	21.9	20.4 b	-33.9	1.4	23.6	9.8	11.6bc	-20.5
Pyrethrum + Biofa	13.6	22.1	22.6	19.4 b	-37.1	1.3	22.0	9.0	10.8bc	-26.3
NeemAzal + Polyversum	16.7	26.1	24.4	22.4 b	-27.5	1.5	24.3	9.8	11.9bc	-18.7
Pyrethrum + Polyversum	14.9	23.5	23.5	20.6 b	-33.2	1.4	23.7	9.3	11.5bc	-21.5
Nurele D + Flordimex	4.8	8.3	7.6	6.9 a	-77.7	0.4	6.5	3.0	3.3 a	-77.4
LSD $_{0.05\%}$				7.403					4.909	

[a]Means in each column followed by the same letters are not significantly different (P>0.05).

Biological products Biofa and Polyversum did not significantly affect population density and the values during the years slightly exceeded those of the control. Average for the period was found an insignificant increase of 2.6%. The treatment of the plants with biological insecticide NeemAzal was associated with a lower number of species with an average 17.2% under used alone and from 27.5 to 33.9%, respectively, in combination with plant growth regulators and foliar fertilizer on biological basis. Despite the different population density of *A. intermedius* in different years depending on weather conditions and the number of phytophagous thrips and especially the dominant species *Thrips tabaci* L. (Nikolova and Georgieva, 2014), the relative values expressed as a percentage reduction to the control between variants with NeemAzal were similar. They varied in a narrow ranges and reliable differences in values between them were not established The decrease in the absolute number of entomophagous to the control was not statistically significant over the years and the period of study, which showed that NeemAzal (used alone and in combination with organic products) had no significant adverse impact on natural populations of beneficial thrips under field conditions. Lowery (1992) reported analogously results for slight impact of the products based on azadirachtin. According to author the product may lead to some mortality of preimaginal stages of predators, but the overall effect on the populations of predators is minimal.

Similar trend about impact on NeemAzal was observed by using of Pyrethrum alone where the decrease in the number of *A. intermedius* was average 26.8%, while combining it with Polyversum and Biofa - from 33.2 to 37.1% respectively compared to the control. It was found that the influence of Pyrethrum in combination with natural foliar fertilizer (Biofa) slightly exceeded the reduction in the number of bioagent compared with growth regulator (Polyversum) but regardless of that the differences between these variants were insignificant. In addition, no significant differences were observed between treatment with NeemAzal and Pyrethrum, regardless of how they were applied (alone and in combination with the biological products).

Unlike biological insecticides, synthetic insecticide Nurele Chlorcyrine D, in combination with Flordimex (synthetic plant

growth regulator), substantially reduced the number of *A. intermedius* with average 77.7% to the control.

With regard to the predatory ladybirds was observed different trend as the impact of bioinsecticides on their density was relatively less pronounced with insignificant differences in the absolute values to the control. Use of NeemAzal in appended variants reduced to a less extent the predator ladybirds numbers from 11.2 (used alone) to 20.5% (in combination with Biofa) compared to Pyrethrum where the reduction varied from 16.4 to 26.3%. However no significant differences were found between the two biological insecticides, regardless of the mode of application.

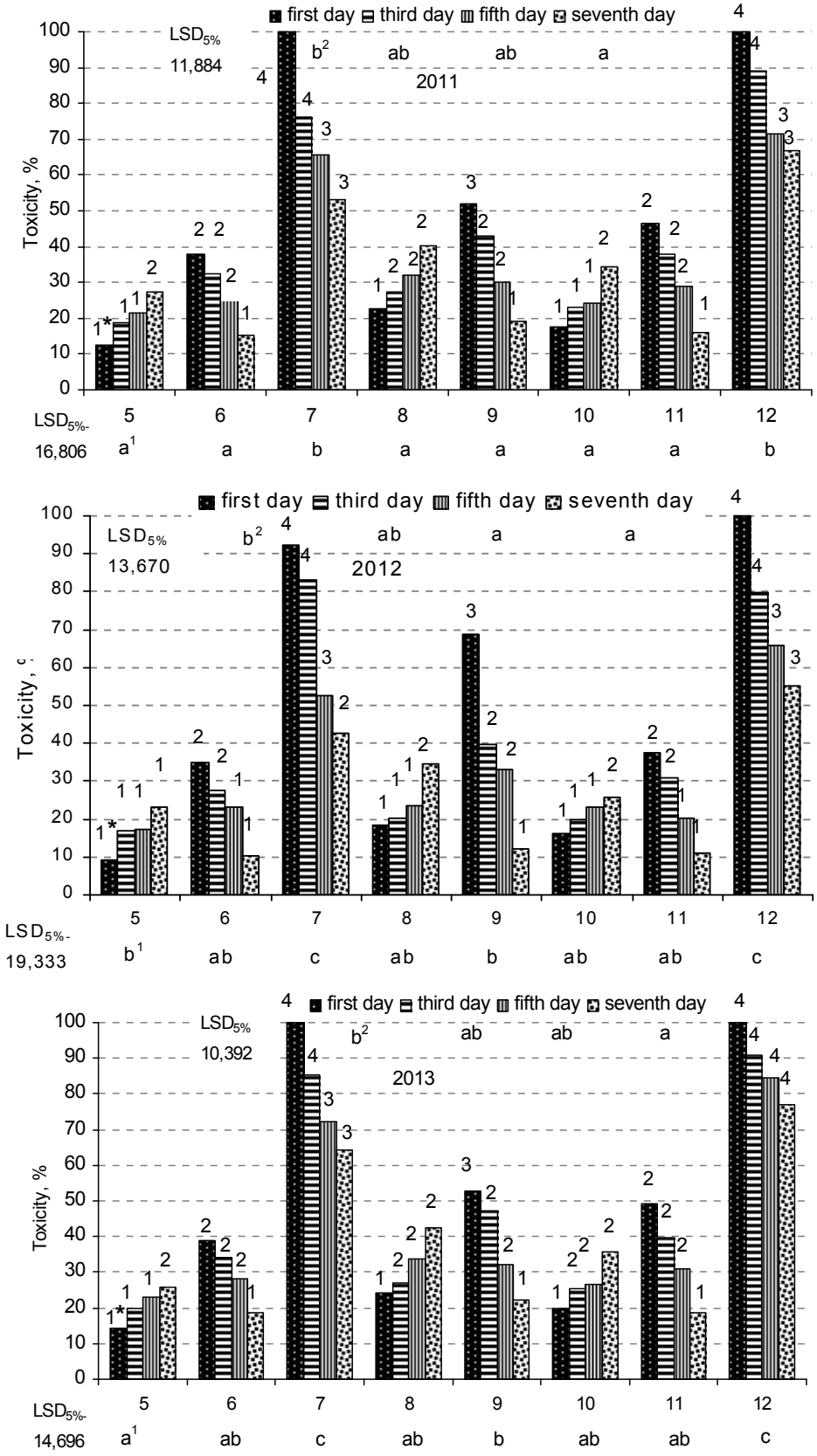
The application of synthetic chemicals had a strong negative impact on the *C. septempunctata* numbers, as combination significant decreased the density by 71.9 to 77.4%. Pyrethroid Nurele Chlorcyrine D used alone and in combination had highly toxic impact on predators *A. intermedius* and *C. septempunctata* and lead to distortion of the balance and relationship between pest-bioagent.

According to some authors the numbers of predators and parasitoids depends on population density of their hosts in result of that the increase or decrease of phytophagous population is related to increase or decrease of the numbers of their natural enemies (Wright and Laing, 1980; Frazer, 1988; Nijveldt, 1988). The amount of predators in variants involving treatment with biological insecticides was less likely as a result of lower population density of their host, and may have overestimated the damaging effect of the products on the basis of azadirachtin. However, the relationship between the predators and their preys is often variable and it is difficult to be determined (Stary, 1970; Coderre, 1988). Therefore, an accurate measure about the impact of insecticides on natural enemies is the toxicity.

The results for the direct influence of the biological and synthetic insecticides on numbers of *A. intermedius* over the years showed that the highest established toxic effect had synthetic products Nurele Chlorcyrine D, used alone or in combination with plant growth regulator Flordimex. In the conditions of these variants, mortality was with highest values from 92.1 to 100.0% on the first day after treatment and was kept relatively high to the seventh day from 42.6 to 76.8%, regardless of a gradual reduction of toxicity over time (Figure 1).

Organic product NeemAzal showed significantly the least impact on predatory thrips as toxicity for the period 2011 to 2013 depending on the year ranged from 9.3 to 14.1% on the first day after treatment. Gradually over the next reporting days the toxicity relatively increased and reached maximum values on the seventh day, ranging in limits 23.3-27.2%. It should be noted that the biological product is distinguished with significant the least impact and toxicity on *A. intermedius* except the latest report (seventh day) in 2011. The higher values of analyzed parameter was observed when NeemAzal is combined with Biofa and Polyversum, as the differences compared to alone use of NeemAzal were usually statistically proven over the years. Especially indicative were the values of the seventh day after treatment, as the combination between NeemAzal and Biofa had significant stronger toxic effect than NeemAzal + Polyversum as well as application of insecticide alone.

The treatment with Pyrethrum alone had stronger toxic effect compared to NeemAzal (applied alone or in combination), but the differences between them were not significant for the three years period (Figure 1). The trend remained for combination Pyrethrum + Polyversum, as differences were not significant compared to the other variants with biological products, regardless of the higher values of analyzed parameter to NeemAzal and Pyrethrum used alone. Exception was found in regard to Pyrethrum + Biofa in 2012 and 2013, when a significant difference was established compared to treatment with NeemAzal alone. Synthetic products showed the most toxic effect and significant differences compared to the other variants.



Legend: 5. NeemAzal; 6. Pyrethrum; 7. Nurele D Hlorsirin 550 EC; 8. NeemAzal+Biofa, 9. Pyrethrum+Biofa; 10. NeemAzal+Poliverzum; 11. Pyrethrum+Poliverzum; 12. Nurele D Hlorsirin 550 EC+Flordimex.
[1]Means in each row followed by the same letters are not significantly different (P>0.05) about products;
[2]Means in each row followed by the same letters are not significantly different (P>0.05) about reported days.
*evaluation categories (% mortality or reduction in beneficial capacity) were used: 1 = harmless (<25%); 2 = slightly harmful (25 to 50%); 3 = moderately harmful (51 to 75%); and 4 = harmful (>75%).

Figure 1. Toxicity of NeemAzal and Pirethrum on *Aeolothrips intermedius*

With regard to reported days, significant differences in mortality of predatory thrips were observed between the first and seventh days after treatment in 2011 and 2013, between the first and fifth, and the first and seventh days after treatment in 2012. It should be noted that the biological insecticide Pyrethrum according to its mechanism of action is characterized by a "knock-down" effect and its toxic effect against *Thrips tabaci* and *Acyrthosiphon pisi* decreased over time (Nikolova and Georgieva, 2014; 2014b). Same effect was observed about *A. intermedius*. The synthetic pyrethroid Nurele D Chlorcyrine showed similar effects on predators, as toxicity was highest on the first day after the treatment, as under alone application so as in combination with plant growth regulator Flordimex. Unlike these products, NeemAzal causes a decrease in food consumption, reduced mobility of pests and ultimately death within a few days as for the harmful species so as the beneficial species. This explained the increasing toxicity of NeemAzal, applied alone and in combination against A. intermedius.

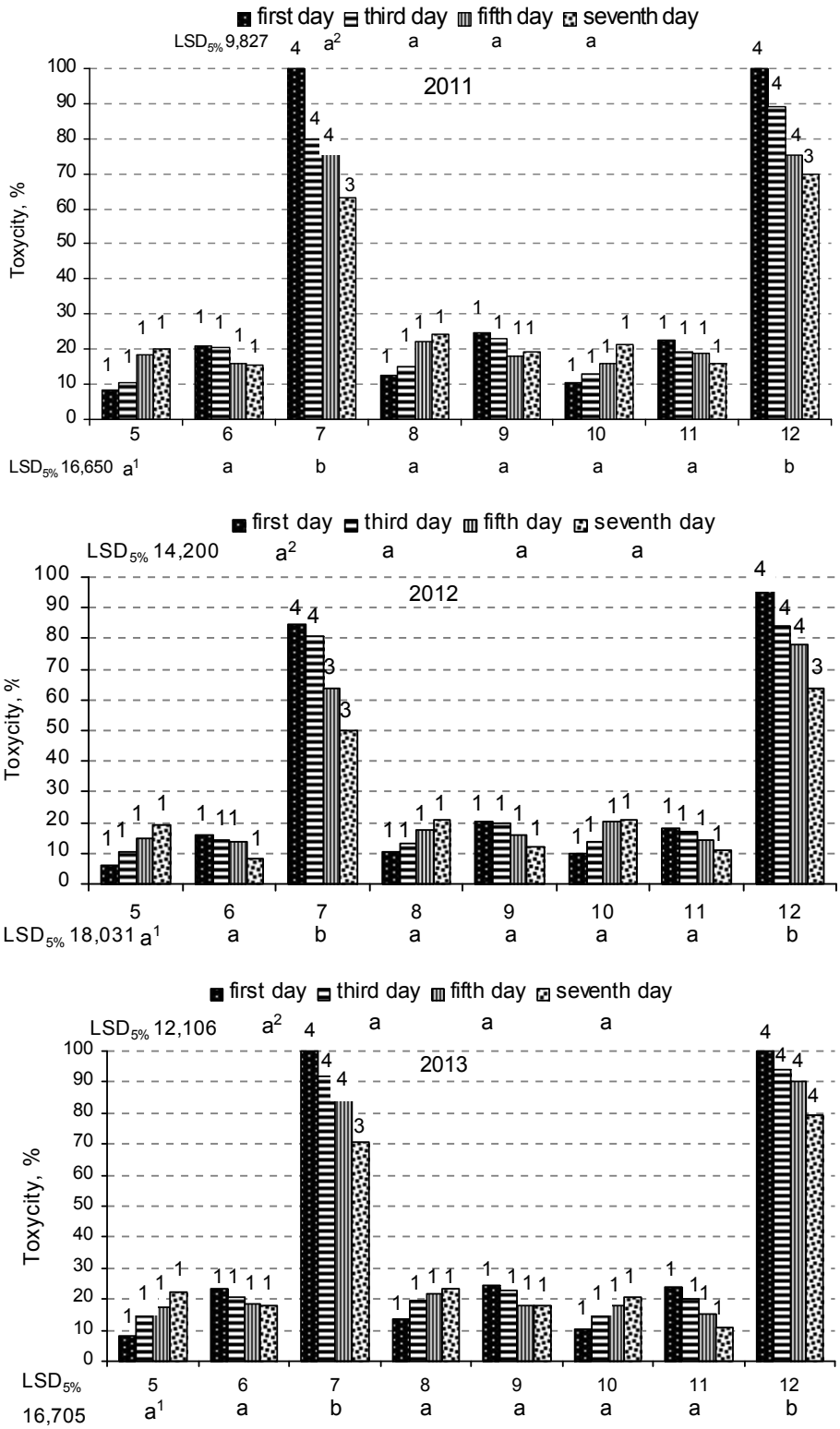
According to the principles of International Organization of Biological Control (IOBC), NeemAzal, used alone is manifested primarily as harmless (non toxic) with score 1 and only on the seventh day (2011 and 2013) - as slightly harmful (score 2) in regard to *A. intermedius* due to its mechanism of action. Identical manifestation of insecticide was found in combination with Polyversum in 2011 and 2012 while in 2013 in this combination NeemAzal was determined mainly as slightly harmful. Applying of NeemAzal with Biofa occupied generally score 2 (slightly harmful) with the exception of 2011 when the combination was determined mainly as harmless to beneficial species.

It is necessary to note that the biological insecticides were classified as harmless as regards predatory ladybird *C. septempunctata* and their toxic action was not more than 25% (Figure 2).

A number of authors reported that Neem products do not show harmful effects on frequent predators such as mites, syrphid flies and ladybirds (Wu, 1986; Fernandez et al., 1992; Parmar, 1993; Markandeya and Diwakar, 1999). Others found the existence of negative effects on the development of beneficial insects after application of biological products containing azadirachtin (Srinivasan and Sundara Babu, 2000; Ranga Rao et al., 2008). Results similar to the present study were reported by Hoelmer et al. (1990), in laboratory tests, according to which the product of the base azadirachtin was not toxic to adult predators of the family *Coccinellidae*. The product was also non-toxic to the larvae of *C. septempunctata*, directly treated in the laboratory (Banken and Stark, 1997).

A different trend was observed in Pyrethrum which used alone or in combination with Polyversum manifested itself primarily as slightly harmful (score 2) over the years. Pyrethrum in combination with organic foliar fertilizer (Biofa) manifested itself as moderately harmful during the first day after treatment, while in the third and fifth day - as slightly harmful, and in the seventh day - as harmless.

Studies on the toxicity of Pyrethrum to certain beneficial species are contradictory. Price and Schuster (1991) found that azadirachtin and pyrethrum were toxic to beneficial parasites of *Bemisia tabaci*: *Encarsia* sp. and *Aleurodiphilus* sp. (*Hymenoptera*: *Aphelinidae*), while Bonsignore and Vacante (2012) concluded that azadirachtin showed some toxicity against beneficial bugs of the genus *Orius*, but there was no significant effect on mortality or their fecundity. Meanwhile authors found no harmful effects of Pyrethrum on beneficial bugs. Yankova et al. (2011) observed low toxicity of NeemAzal (0.3% concentration) against the parasite *Encarsia formosa* and toxicity of Pyrethrum (0.05% concentration) to the beneficial species in laboratory conditions.



Legend: 5. NeemAzal; 6. Pyrethrum; 7. Nurele D Hlorsirin 550 EC; 8. NeemAzal+Biofa, 9. Pyrethrum+Biofach; 10. NeemAzal+Poliverzum; 11. Pyrethrum+Poliverzum; 12. Nurele D Hlorsirin 550 EC+Flordimex.
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*evaluation categories (% mortality or reduction in beneficial capacity) were used: 1 = harmless (<25%); 2 = slightly harmful (25 to 50%); 3 = moderately harmful (51 to 75%); and 4 = harmful (>75%).

Figure 2. Toxicity of NeemAzal and Pirethrum on *Coccinella septempunctata*

As it is found from the studies about the toxic effects of biological products on beneficial species, the results of laboratory and field trials are not always similar. Usually products exhibited higher toxicity in laboratory testing. This requires their exploration under

field conditions. Not so many sources are available on the comparative toxycity of Pyrethrum and NeemAzal, applied alone and in combination with different organic products against *A. intermedius* and *C. septempunctata*, and therefore the results presented here could be interesting for the science.

On the other part Nurele D Chlorcyrine (used alone and in combination with Flordimex) was harmful and moderately harmful.

Based on the results presented in this study, one can conclude that the application of NeemAzal and Pyrethrum, alone and in combination with organic products Biofa and Polyverzum, overall had not significant harmful effects on predatory species, although Pyrethrum in regard to *A. intermedius* manifested mainly as slightly harmful. The analyzed results have scientific and applied value.

Analysis of variance regarding to the population density of predators *A. intermedius* and *C. septempunctata* demonstrated that the factors Year and Products had different effects on individual species (Table 2). In terms of predatory thrips, products had the strongest effect on the average number - 76.7% of the total variance of the variants. This is explained by the higher sensitivity of *A. intermedius* to products, probably due to lack of elytra, that *C. septempunctata* has. The influence of years was 13.0%, also statistically significant. There was significant interaction between the products and the conditions of years – A x B - 2.4%.

Table 2. Analysis of variance on the numbers of beneficial species

Source of variation	Df	SS	Influence of factor, %	MS
Aeolothrips intermedius				
Total	107	8978.2	-	-
Variants	35	8268.1	92.1 *	236.2
Factor A - year	2	1164.9	13.0 *	582.5
Factor B - product	11	6886.9	76.7 *	626.1
AxB	22	216.3	2.4 *	9.8
Pooled error	94	710.0	7.9	7.6
Coccinella septempunctata				
Total	107	12329.5	-	-
Variants	35	11832.7	96.0 *	338.1
Factor A - year	2	9076.2	73.6 *	4538.1
Factor B - product	11	1638.0	13.3 *	148.9
AxB	22	1118.5	9.1 *	50.8
Pooled error	94	501.2	4.1	5.3

With regard to C. septempunctata an opposite trend was established - with the greatest impact on the numbers of species by factor B - year (73.6%). Weaker, but significant impact had factor A - product (13.3%) and the interaction between A x B (9.1%).

CONCLUSIONS

The treatment of plants with biological insecticide NeemAzal-T/S® (azadirachtin) was associated with a 17.2% lower number of *Aeolothrips intermedius* when used alone and from 27.5 to 33.9%, in combination with organic products Polyversum (growth regulator) and Biofa (foliar fertilizer), respectively. Using of Pyrethrum FS EC was associated with a reduction in the numbers of *A. intermedius* by 26.8%, while its combining with Polyversum and Biofa - from 33.2 to 37.1%. Individual application of biological insecticides had no significant harmful effect on natural populations of beneficial thrips.

The use of NeemAzal-T/S® reduced less the numbers of predatory ladybird *Coccinella septempunctata* from 11.2 (used alone) to 20.5% (in combination with Biofa), as compared to Pyrethrum FS EC, where the

reduction varied from 16.4 to 26.3%. Biological insecticides had a less pronounced influence on the density of species, with insignificant differences to the control absolute values.

NeemAzal-T/S® applied alone and in combination with Polyversum was primarily harmless to *Aeolothrips intermedius*, and in combination with Biofa was mainly slightly harmful. Pyrethrum FS EC used alone and in combination with Polyversum was mainly slightly harmful, while its combining with the organic foliar fertilizer Biofa - was moderately harmful, slightly harmful and harmless depending on the reported days.

Biological insecticides manifested themselves as harmless to *Coccinella septempunctata,* as their toxic action did not exceed 25%.

NeemAzal-T/S® and Pyrethrum FS EC, used alone and in combination with organic products Biofa and Polyversum in general had not significant harmful effects on predatory species and are suitable for use in an organic farming.

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