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CHANGES IN CHEMICAL COMPOSITION OF SOYBEAN [*GLYCINE MAX* (L.) MERRILL] PLANT AFTER PRESOWING TREATMENT OF SEEDS WITH INSECTICIDES

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Abstract

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Changes in some charatcteristics of chemical composition of aboveground and root mass of soybean after presowing treatment of seeds with insecticides were studied in a pot trial carried out at the Institute of Forage Crops, Pleven, Bulgaria (2003-2004). Soybean cultivar Pavlikeny 121 was used and the next insecticide preparations were tested: Gaucho 600 FS (600 $g.L^{-1}$ imidacloprid) (1, 2 and 3 $L.100\ kg^{-1}$ seeds), Carbodan 35 ST (350 $g.L^{-1}$ carbofuran) (1, 2 and 3 $L.100\ kg^{-1}$ seeds), and Promet 400 CS (400 $g.L^{-1}$ furathiocarb) (3 $L.100\ kg^{-1}$ seeds) (standard). It was found that Gaucho 600 FS at the dose of 1 $L.100\ kg^{-1}$ seeds increased crude protein content in aboveground mass by 14.0 $g.kg^{-1}$ dry matter (DM) and in root mass by 22.6 $g.kg^{-1}$ DM as compared to untreated control. Crude fiber content in aboveground mass increased by 28.0 $g.kg^{-1}$ DM when Carbodan 35 ST at the dose of 3 $L.100\ kg^{-1}$ seeds was applied and decreased in root mass by 74.5 $g.kg^{-1}$ DM for the same insecticide at the dose of 2 $L.100\ kg^{-1}$ seeds. Calcium content in aboveground mass was by 1.9 $g.kg^{-1}$ DM higher as compared to untreated control for Gaucho 600 FS at the dose of 1 $L.100\ kg^{-1}$ seeds. When Carbodan 35 ST at the dose of 1 $L.100\ kg^{-1}$ seeds was applied, phosphorus content in aboveground mass increased by 0.20 $g.kg^{-1}$ DM and in root mass by 0.28 $g.kg^{-1}$ DM for Gaucho 600 FS at the dose of 1 $L.100\ kg^{-1}$. Chemical composition of plant biomass did not include the amount of possible residues after the using of insecticides.

Key words: soybean, chemical composition, aboveground mass, root mass, presowing treatment

Introduction

The chemical composition of plants is related to the food quality. Presowing treatment of seeds with insecticide preparations is a common practice (Dochkova et al., 2000; Vasileva et al., 2003; Wahid and Farooq, 2012) but it is important to know how it affects the chemical composition, particularly crude protein in legumes as a main source of proteins (Frame et al., 1998).

Soybean [*Glycine max* (L.) Merrill] is a nitrogen-fixing crop, valuable precursor as well as protein source for livestock (Lindemann and Glover, 1999; Marinov - Serafimov et al., 2007). Changes in soil micro flora after use of insecticides (with an active ingredient carbofuran) in soybean were studied and it was found nitrogen-fixing bacteria remained unaffected (Sarnaik et al., 2006). Vasileva et al. (2003) and Ilieva et al. (2004) reported increased protein nitrogen content in spring pea and vetch after presowing treatment of seeds. There are data for positive effect of this measure on germination energy and germination of lucerne seeds (Rotrekl and Cejtchaml, 2008), root mass, nodulation, dry matter yield in spring forage pea (Vasileva, 2006; Georgieva and Nikolova, 2009); yield components in maize and winter oilseed rape (Anjum Suhail et al., 2000; Kazda et al., 2005), etc. We did not found any data for effect of presowing treatment of seeds with insecticides on chemical composition of soybean plants.

This work aimed to study the changes in crude protein, crude fiber, calcium and phosphorus content in aboveground and root mass of soybean after presowing treatment of seeds with insecticide preparations.

Materials and Methods

A pot trial with soybean variety Pavlikeny 121 was carried out in the greenhouse of Institute of Forage Crops, Pleven,

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Bulgaria (2003-2004). Pots of 10 L and leached chernozem soil were used for this experiment. The insecticide preparations Gaucho 600 FS (600 g.L^{-1} imidacloprid) and Carbodan 35 ST (350 g.L^{-1} carbofuran) at the doses of 1, 2 and 3 L.100 kg^{-1} seeds, and Promet 400 CS (400 g.L^{-1} furathiocarb) (standard) at the dose of 3 L.100 kg^{-1} seeds (standard) were used for presowing treatment. The seed treatment was made a day before sowing and Absorbent TZ 21 was used as a drying agent. The seeds were inoculated on the sowing day with a Nitragine preparation containing *Bradyrhizobium japonicum* strain. Seeds were sown at the depth of 2-3 cm and 4 well-developed plants were left in each pot.

The following treatments were studied: 1. Control– dry; 2. Gaucho 600 FS – 1 L.100 kg^{-1} seeds; 3. Gaucho 600 FS – 2 L.100 kg^{-1} seeds; 4. Gaucho 600 FS – 3 L.100 kg^{-1} seeds; 5. Carbodan 35 ST – 1 L.100 kg^{-1} seeds; 6. Carbodan 35 ST – 2 L.100 kg^{-1} seeds; 7. Carbodan 35 ST – 3 L.100 kg^{-1} seeds; 8. Promet 400 CS – 3 L.100 kg^{-1} seeds (standard).

After harvesting of soybean aboveground and root mass (after washing) were dried at 60^{o}C. Crude protein content (CP) was determined by Kjeldahl method (CP = N X 6.25), crude fibre (CF) by Weende method, calcium (Ca) – complexometrically, and phosphorus (P) by hydroquinone (AOAC, 1990). The data from two experimental years were statistically processed using SPSS® software version 10.0 (SPSS Inc., Chicago, IL, USA).

Results and Discussion

The data in Table 1 show that crude protein (CP) content in aboveground mass increased from 10.3 to 14.0 g.kg^{-1} dry matter (DM) as compared to untreated control when the insecticide preparation Gaucho 600 FS was used. Comparing to the standard Promet 400 CS, when Gaucho 600 FS was applied at the dose of 1 L.100 kg^{-1} seeds, CP in aboveground mass was by 9.1 g.kg^{-1} DM higher.

CP content in aboveground mass increased when Carbodan 35 ST was used, but twofold less than that for Gaucho 600 FS. When Carbodan 35 ST was applied at the doses of 2 and 3 L.100 kg^{-1} seeds, CP in aboveground mass increased by 4.0 - 4.4 g.kg^{-1} DM (P>0.05).

Crude protein values in aboveground mass for three doses tested of Carbodan 35 ST were similar to these showed the plants for the standard Promet 400 CS. Crude fiber content in aboveground mass was higher as compared to untreated control and varied in narrow limits for two insecticide prepa-

Table 1
Chemical composition of aboveground and root mass of soybean after presowing treatment of seeds with insecticides (g.kg^{-1} DM)

Treatments	CP	CF	Ca	P
		Aboveground mass		
Control (C) - dry	158.1	219.1	12.0	1.26
Gaucho 600 FS - 1 L.100 kg^{-1} seeds	172.1	229.5	13.9	1.37
Gaucho 600 FS - 2 L.100 kg^{-1} seeds	168.4	234.6	13.5	1.32
Gaucho 600 FS - 3 L.100 kg^{-1} seeds	170.4	232.8	13.1	1.31
Carbodan 35 ST - 1 L.100 kg^{-1} seeds	164.5	242.5	12.4	1.46
Carbodan 35 ST - 2 L.100 kg^{-1} seeds	162.5	244.1	12.7	1.42
Carbodan 35 ST - 3 L.100 kg^{-1} seeds	162.1	247.1	12.8	1.44
Promet 400 CS - 3 L.100 kg^{-1} seeds	163.0	233.9	13.8	1.36
SE (P=0.05)	1.67	3.19	0.23	0.02
		Root mass		
Control (C) - dry	79.9	300.2	4.0	0.87
Gaucho 600 FS - 1 L.100 kg^{-1} seeds	102.5	265.4	5.2	1.15
Gaucho 600 FS - 2 L.100 kg^{-1} seeds	99.8	286.6	4.9	1.03
Gaucho 600 FS - 3 L.100 kg^{-1} seeds	99.9	292.3	4.8	1.04
Carbodan 35 ST - 1 L.100 kg^{-1} seeds	86.0	228.1	5.0	0.95
Carbodan 35 ST - 2 L.100 kg^{-1} seeds	85.4	225.7	4.7	0.92
Carbodan 35 ST - 3 L.100 kg^{-1} seeds	82.3	227.1	4.7	0.94
Promet 400 CS - 3 L.100 kg^{-1} seeds	90.4	258.8	4.5	0.88
SE (P=0.05)	3.11	10.91	0.12	0.03

rations. For Gaucho 600 FS – from 229.5 to 234.6 g.kg^{-1} DM and the lowest were values for the dose of 1 L.kg^{-1} seeds. For Carbodan 35 ST the variation was from 233.9 to 247.1 g.kg^{-1} DM and there were no statistically differences between the experimented doses. Ahmed et al. (2003) reported the similar tendency for increased CF content in maize after applying of insecticide with active substance carbofuran. Crude fiber values were lower for Gaucho 600 FS as compared to these of Promet 400 CS.

Calcium content was higher than the untreated control when Gaucho 600 FS was used – for the dose of 1 L.100 kg^{-1} seeds by 1.9 g.kg^{-1} DM. Significant effect of Carbodan 35 ST on the Ca content was not observed. Calcium content in aboveground mass after treatment of seeds with insecticides tested did not exceeded that of the standard Promet 400 CS.

An increase in P content as compared to untreated control was recorded: for Gaucho 600 FS at the dose of 1 L.100 kg^{-1} seeds by 0.11 g.kg^{-1} DM, for Carbodan 35 ST at the dose of 1 L.100 kg^{-1} seeds by 0.20 g.kg^{-1} DM. Values of phosphorus in aboveground mass when Gaucho 600 FS was used did not exceeded these of the standard Promet 400 CS and for Carbodan 35 ST applied at the dose of 1 L.100 kg^{-1} seeds, an increase by 0.10 g.kg^{-1} DM was observed.

Presowing treatment of seeds effected the chemical composition of plant root mass. When Gaucho 600 FS was used CP content in root mass increased to 22.6 g.kg^{-1} DM – significantly more than that for aboveground mass. Almost no changes in CP content for Carbodan 35 ST applied at the dose of 3 L.100 kg^{-1} seeds were observed. For the rest doses of Carbodan 35 ST the exceeding were close (5.5 - 6.1 g.kg^{-1} DM). After the treatment with Gaucho 600 FS at the dose of 1 L.100 kg^{-1} seeds CP content exceeded the standard Promet 400 CS by 12.1 g.kg^{-1} DM.

Crude fiber content in root mass significantly decreased (to 74.5 g.kg^{-1} DM) as compared to untreated control for the three doses of the insecticide preparation Carbodan 35 ST. After applying of Gaucho 600 FS crude fiber content in root mass decreased most at the dose of 1 L.100 kg^{-1} seeds by 34.8 g.kg^{-1} DM. Crude fiber content in root mass when treated with Gaucho 600 FS at three experimental doses was higher than that of the standard, but when treated with Carbodan 35 ST was lower.

Calcium content in root mass increased after presowing treatment of seeds in narrow limits – from 0.7 to 1.2 g.kg^{-1} DM. For two insecticide preparations it was higher as compared to Promet 400 CS.

Phosphorus content increased by 0.28 g.kg^{-1} DM for Gaucho 600 FS applied at the dose of 1 L.100 kg^{-1} seeds and by 0.16 and 0.17 g.kg^{-1} DM for the doses of 2 and 3 L.100 kg^{-1} seeds. The differences for insecticide Carbodan 35 ST was insignificant.

Similar to the findings for Ca content as compared to the standard, P content in root mass was higher for the two insecticides.

Conclusions

When Gaucho 600 FS at the dose of 1 L.100 kg^{-1} seeds was applied for presowing treatment of seeds of soybean, crude protein content in aboveground mass increased by 14.0 g.kg^{-1} DM and in root mass by 22.6 g.kg^{-1} DM as compared to untreated control. Crude fiber content in aboveground mass increased to 28.0 g.kg^{-1} DM when Carbodan 35 ST at the dose of 3 L.100 kg^{-1} seeds was appleid and decreased in root mass to 74.5 g.kg^{-1} DM for the same insecticide at the dose of 2 L.100 kg^{-1} seeds. Calcium content in aboveground mass was higher by 1.9 g.kg^{-1} DM as compared to untreated control for Gaucho 600 FS at the dose of 1 L.100 kg^{-1} seeds. When Carbodan 35 ST at the dose of 1 L.100 kg^{-1} seeds was applied, phosphorus content in aboveground mass increased by 0.20 g.kg^{-1} DM and in root mass by 0.28 g.kg^{-1} DM for Gaucho 600 FS at the dose of 1 L.100 kg^{-1} seeds. However the chemical composition of the plant biomass did not include the amount of possible undegraded traces after using the insecticides tested.

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