

Using bioproducts for soybean protection against the soybean pod borer (*Leguminivora glycinivorella* Mats.) under the conditions of the steppe zone of Primorsky kray

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Abstract. This paper presents the results of a study on bioproducts BioKill, EC, and Proclaim, WG, against the soybean pod borer (*Leguminivora glycinivorella* Mats.), which damages soybean pods in the agroecosystems of Primorsky kray. This species is one of the main soybean pests in the Russian Far Eastern federal district. The research was conducted on late soybean variety Briz in the conditions of the steppe zone of Primorsky kray – in the soybeans fields of FSBSI "FSC of Agricultural Biotechnology of the Far East named after A.K. Chaiki". The plan of the experiment included the use of bioinsecticides BioKill, EC, and Proclaim, WG, for treating plants either during the growing period (two times) or in combination with seed-applied insecticide Imidor Pro, SC. Our research goal was to evaluate the biological and economic efficacy of the bioproducts against *Leguminivora glycinivorella* Mats. It was established that applying the bioinsecticides decreased the degree of the damage caused by the soybean pod borer (larvae) to soybean pods and seeds and positively affected the productivity of soybean plants. Bioproduct BioKill, EC, had the highest biological efficacy. The protective properties of bioinsecticide Proclaim, WG, were observed to be weaker. The research results demonstrated that bioproducts BioKill, EC, and Proclaim, WG, were effective against the soybean pod borer *Leguminivora glycinivorella* Mats. and could be used as soybean protection products in the agroecosystems of the Russian Far East.

1 Introduction

Ever-increasing interest in soybean production has been observed in Russia in recent years. Pest control is one of the main problems for soybean growing. More than 120 species of phytophagous insects are registered as the pests of soybean in the conditions of the Russian Far East. The harmfulness of pest species depends on the climatic zone. However, twenty species are considered to be the most dangerous pests [1], for example, *Paraluperodes*

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suturalis nigrobilineatus Motsch., *Loxostege sticticalis* L., *Aphis glycines* Mats., *Leguminivora glycinivorella* Mats., *Chortophila florilega* Zett., etc. [1-2].

Annually soybean seeds in Primorsky kray are damaged by the soybean pod borer *Leguminivora glycinivorella* Mats. (Lepidoptera, Tortricidae) – a common soybean pest in the Russian Far East – [3-4] (Figure 1). The soybean pod borer is widely spread in Khabarovskiy and Primorsky kray, Amur oblast, the Northeast China, Korea, and Japan [5, 6]. The soybean seeds damaged by this pest might lose up to 30% of their weight and have a significantly reduced content of oil. According to T.K. Kovalenko and A.V. Lukashenko, the average degree of the damage caused by the soybean pod borer is 8.3 % at the stage of maturity [7]. Larvae of *Leguminivora glycinivorella* Mats. might damage from 70 to 100 % of soybean fields at the stage of seed maturing under the conditions of Khabarovskiy kray in particular years [8].



Fig. 1. Soybean pods damaged by *Leguminivora glycinivorella* Mats. (photo by the author).

Agrochemicals are widely used by farmers to protect soybean against the soybean pod borer during the growing season. However, the frequent use of chemical products against the pest, which has a high growth rate, leads to the development of resistance to pesticides in *Leguminivora glycinivorella* Mats. Today the biological methods of plant protection (bioproducts) against soybean pests have been gaining in importance all around the world. This happens for two reasons – the ever-increasing demand for soybean seeds and the impossibility to employ chemical plant protection methods against phytophagous insects due to sanitary norms.

The research goal was to evaluate the biological and economic efficacy of bioproducts against *Leguminivora glycinivorella* Mats.

2 Materials and methods

The field experiment was conducted under the conditions of the steppe zone of Primorsky kray in the fields of FSBSI “FSC of Agricultural Biotechnology of the Far East named after A.K. Chaiki”.

The efficacy of the following bioproducts was studied in 2023: Proclaim, WG (50 g/kg of emamectin benzoate as the active ingredient) and BioKill, EC (10 g/l of abamectin as the active ingredient).

The plan of the experiment included:

- Control – growing plants were treated with distilled water.
- Imidor Pro, SC – 2.5 l/t (the pre-sowing treatment of seeds).

- Proclaim, WG – 0.4 kg/ha (the spraying of plants).
- Imidor Pro, SC (the pre-sowing treatment of seeds) – 2.5 l/t + Proclaim, WG (the spraying of plants) – 0.4 kg/ha.
- BioKill, EC (the spraying of plants) – 0.4 l/ha.
- Imidor Pro, SC (the pre-sowing treatment of seeds) – 2.5 l/t + BioKill, EC (the spraying of plants) – 0.4 l/ha.

Soybean seeds were treated with Imidor Pro, SC, two days before sowing. Soybean plants were treated with the studied bioproducts two times during the growing period. The first treatment was conducted at the emergence stage, the second one – at the stage of pod formation.

The phenological data were collected according to generally accepted methodology [9-10]. The mathematical processing of the obtained research data was performed according to B.A. Dospekhov [11].

In 2023, the weather conditions of the growing period were characterized by significant differences in the monthly distribution of precipitation. The total amount of precipitation in June, July, and August exceeded the long-term average by 2.3-3.8 times. The growing degree-days (above 10°C) were 2863°C and the total precipitation was 833.5 mm over the growing period. In general, the growing conditions could be characterized as excessively wet (the hydrothermal coefficient of Selyaninov (HTC) was 2.9).

3 Results and Discussion

Our research showed that the use of the studied bioproducts decreased the degree of the damage caused by *Leguminivora glycinivorella* Mats. to soybean pods and seeds. According to our data, BioKill, EC, had the strongest insecticidal effect. Using the bioproducts was beneficial for plants in both experimental variants and decreased the degree of the damage caused by the soybean pod borer (3.4-3.8 % compared to 4.8 % in the control) (Figure 2). Damaged soybean seeds amounted to 2.7-3.4% (by two times lower than in the control) when BioKill, EC, was applied. Proclaim, WG, facilitated a decrease in the population size of the phytophagous insect as well. The percentage of damaged pods was 4.0-4.1%, which was by 0.7-0.8 % lower than the control (Figure 2). It was discovered that damaged seeds amounted to 3.1-4.3% when Proclaim, WG, was used compared to 7.0 % in the control (Figure 2).

In general, the biological efficacy of the used bioinsecticides reached 28.6-43.9% (Table 1). The variant with the use of BioKill, EC, and the pre-sowing treatment with Imidor Pro, SC, stood out among the other experimental variants.

Proclaim, WG, had a good result as well. Its biological efficacy was 39.3-40.3% (Table 1).

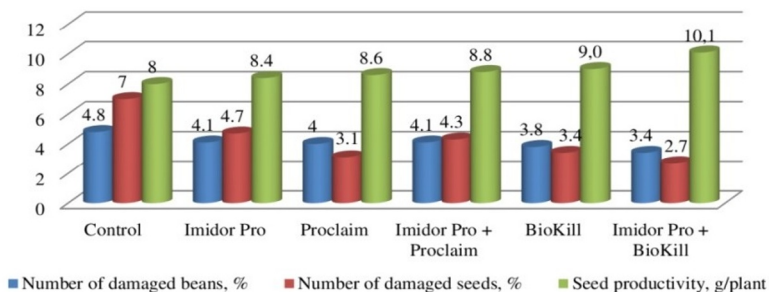


Fig. 2. Economic efficacy of the studied bioproducts against *Laspeyresia glycinivorella* Mats.

Table 1. Biological efficacy of the studied bioinsecticides against the soybean pod borer (*Laspeyresia glycinivorella* Mats.)

Variant	Decrease in the population size of the soybean pod borer relative to the control, %
Control – treatment of growing plants with distilled water	–
Imidor Pro, SEC	28.6
Proclaim, WG	39.3
Imidor Pro, SC + Proclaim, WG	40.3
BioKill, EC	42.6
Imidor Pro, SC + BioKill, EC	43.9
LSD ₀₅	1.7

We analyzed how the studied bioproducts influenced the economically important traits of the soybean plants collected at the maturing stage. It was discovered that the bioinsecticides had a positive effect on soybean productivity. For example, the number of pods per plant was 21.1-23.4, the number of seeds per plant was 42.4-48.1, and the TKW was 218.4-220.7 g after the treatment with BioKill, EC, which exceeded the control by 3.2-5.5 pods and 5.5-11.2 seeds per plant, and 23.3-25.6 g, respectively (Table 2). These characteristics were slightly lower after the application of Proclaim, WG: the number of pods per plant was 18.9-22.2, the number of seeds per plant was 42.3-44.3, and the TKW was 217.5-219.8 g.

Using BioKill, EC, and Proclaim, WG, had a positive effect on soybean yield, the yield gain was 0.5-1.2 t/ha relative to the control (Table 2).

Table 2. Effect of the studied bioproducts on the economically important traits and yield of soybean.

Variant	Number of pods per plant, pcs.	Number of seeds per plants, pcs.	TKW, g	Biological yield, t/ha
Control – treatment of growing plants with distilled water	17.9	36.9	195.1	4.1
Imidor Pro, EC	17.6	40.2	204.9	4.4
Proclaim, WG	18.9	42.3	217.5	4.6
Imidor Pro, SC + Proclaim, WG	22.2	44.3	219.8	4.7
BioKill, EC	23.4	48.1	220.7	5.3
Imidor Pro, SC + BioKill, EC	21.1	42.4	218.4	4.7

4 Conclusions

The research discovered that treating soybean plants with bioinsecticides BioKill, EC, and Proclaim, WG, facilitated a decrease in the degree of the damage caused by the soybean pod borer (*Laspeyresia glycinivorella* Mats.) to soybean seeds.

According to the obtained research data, BioKill, EC, had the highest insecticidal activity against the soybean pod borer. The percentage of damaged soybean pods and seeds was 3.4-3.8 % and 2.7-3.4%, respectively, being by 1.3-1.4 and 1.0-2.6 times lower than in the control.

Proclaim, WG, might be also recommended for the protection of soybean fields.

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