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INSECTICIDAL ACTIVITY OF THE BACILLUS THURINGIENSIS-BASED BIOPREPARATION BIOTURIN AGAINST THE PEST OULEMA MELANOPUS

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Abstract
This article presents the results of evaluating the biological efficacy of the Bacillus thuringiensis-based biopreparation Bioturin as a safe alternative to broad-spectrum chemical insecticides in controlling the economically significant pest Oulema melanopus (cereal leaf beetle) in wheat crops under the conditions of Tashkent, Syrdarya, and Surkhandarya regions. The preparation was applied at a rate of 2.0–3.0 liters per hectare. At the application rate of 3.0 liters per hectare, Bioturin reduced the Oulema melanopus population by an average of 75.9% on the 14th day after treatment. The results confirmed the potential of Bioturin as an effective biological alternative to chemical insecticides. Other significant research findings are also discussed.

Keywords: wheat, microorganism, pest, biological control, biological efficacy.

Introduction

Triticum aestivum is considered one of the primary food crops and holds a leading position among grain products [2]. To achieve high yields from cereal crops, including wheat, it is crucial to follow advanced agrotechnical practices and thoroughly study the damage potential of various pests that harm the plants and their yields from the seedling stage to maturity, ensuring timely and effective control measures are implemented [3;9].

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One of the most economically significant pests of cereal crops in Europe is the Oulema melanopus [20]. This pest primarily infests wheat, barley, and oats, but can also damage other cereal crops. It leads to yield reductions of 5-20% [11], while in Serbia, losses ranging from 2-30% have been reported [13]. In years of severe infestations, this pest has been known to reduce yields by up to 80% [22].

The use of entomopathogenic microorganisms as biological control agents is becoming one of the most effective alternatives to chemical pest control. Among these, the Gram-positive bacterium Bacillus thuringiensis (Bt) remains one of the most important entomopathogenic bacteria used in crop protection. This bacterium is widely distributed in water, soil, and within insect bodies [18].

Products based on Bt isolates represent the most successful microbial insecticides, with their global market value estimated at 8 billion USD annually [16]. The success of these insecticidal proteins drives the search for new Bt isolates capable of producing insecticidal agents with diverse specificities [8].

A distinguishing feature of B. thuringiensis compared to other Bacillus species is its ability to form parasporal crystal inclusions. These crystals consist of proteins (Cry and Cyt) with insecticidal properties against insect species from the orders Lepidoptera, Diptera, Coleoptera, Hymenoptera, and Hemiptera [19]. These toxins are specific, safe, and fully biodegradable, having been used as alternatives to chemical insecticides for more than 60 years [10;14].

It has been shown that enzymes encoded by the gut microbiota genes of insects play a role in their adaptation to insecticides [5]. Moreover, insecticides used against pests can significantly alter the structure and function of the bacterial communities residing in the insect gut [7;21].

Studies analyzing the sensitivity of Oulema melanopus to B. thuringiensis-expressed Cry3Bb1 and Cry1Ab toxins have confirmed their insecticidal activity against this pest [6;12]. However, the virulence and efficacy of Bt strains against many insect species of the order Coleoptera, including O. melanopus, remain insufficiently studied. Therefore, the insecticidal activity of a newly isolated Bt strain-based preparation-Bioturin-was tested against this pest.

Research Methods

Field trials against Oulema melanopus infesting wheat were conducted in the following locations:

A 10-hectare experimental plot at the “Scientific Research Institute of Grain and Leguminous Crops” in Tashkent region.

A 13.4-hectare field of the “Elyor O‘g‘li Asilbek” farm in Khovos district, Syrdarya region.

A 12.3-hectare experimental wheat field at the “Research Institute of Fine-fiber Cotton” in Termiz district, Syrdarya region.

The timing of pest emergence and population density assessments were carried out according to the generally accepted methods of Osmolovskiy G.E. and Bondarenko N.V. (1978) [1;15].

For comparative analysis, the biological product Bioturin, containing Bacillus thuringiensis as its active ingredient, was applied at rates of 2.0-3.0 L/ha, and Killer Neo 10% EC was used at a rate of 0.1 L/ha as a reference standard.

The experiment included treatment, reference, and control variants, each replicated three times. Pest population counts were conducted before treatment and at 3, 7, 14, and 21 days post-treatment. The effectiveness of the products was evaluated in comparison to the control variant. Field trials were conducted following the methodological guidelines of Khojaev Sh.T. (2004) [4], and biological

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efficacy was calculated using the established method by Pontener (1981) [17].

Research Results

In the experimental field of 10 hectares at the Scientific Research Institute of Grain and Leguminous Crops located in Tashkent region, the biological efficacy of the Bioturin biopreparation against *Oulema melanopus* was studied. Prior to application at a rate of 2.0 liters per hectare, an average of 19.3 live pests per 50 wheat stems was recorded. After treatment, the number of live pests was reduced to 15.8; 13.7; 9.2; and 13.4 individuals on the 3rd, 7th, 14th, and 21st days, respectively. The highest biological efficacy was observed on the 14th day, reaching 65.1%.

When applied at a rate of 3.0 liters per hectare, the initial pest population was 18.6 individuals per 50 wheat stems. Post-treatment counts showed 13.8; 11.4; 7.2; and 11.1 live pests on the 3rd, 7th, 14th, and 21st days, respectively. The maximum biological efficacy in this variant was recorded on the 14th day at 71.6%.

For comparison, the chemical insecticide Killer Neo 10% EC was applied at a rate of 0.1 liters per hectare. The initial pest population was 18.9 individuals, which decreased to 4.5; 3.3; 5.2; and 9.6 individuals on the 3rd, 7th, 14th, and 21st days after treatment, respectively. The highest efficacy for this variant was observed on the 7th day, reaching 85.0% (Figure 1).

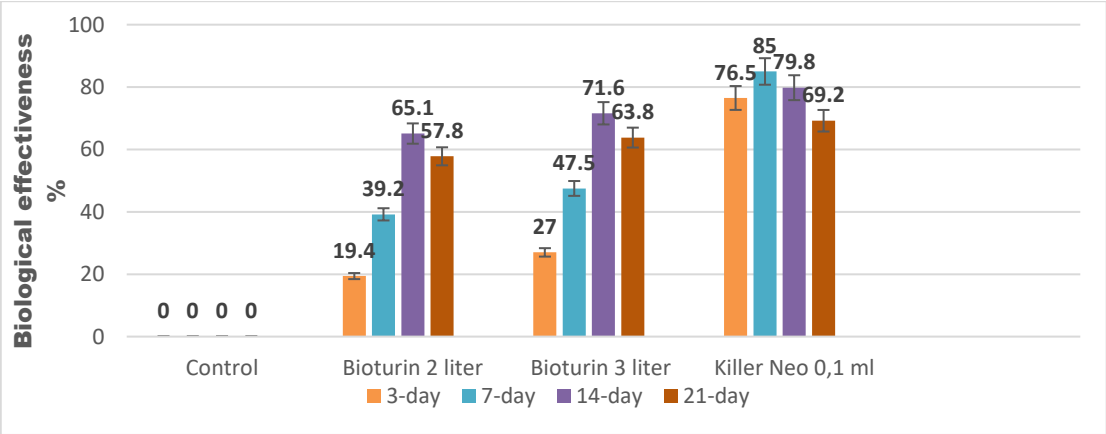

Figure 1. Biological efficacy of the Bioturin biopreparation against the pest *Oulema melanopus*

In the fields of the "Elyor O'g'li Asilbek" farm located in Khovos district of Syrdarya region, the biological efficacy of the Bioturin biopreparation against Oulema melanopus was tested on a 13.4-hectare wheat field. At an application rate of 2.0 liters per hectare, prior to treatment, an average of 14.6 live larvae per 50 wheat stems was recorded. After treatment, the number of live pests was monitored on days 3, 7, 14, and 21, resulting in counts of 11.2, 9.3, 5.8, and 10.2 individuals, respectively. The highest biological efficacy was observed on day 14, reaching 72.2%.

When applied at a rate of 3.0 liters per hectare, the initial pest density was 15.0 live larvae per 50 wheat stems. Post-treatment counts on days 3, 7, 14, and 21 were recorded as 10.6, 8.4, 4.4, and 9.0 individuals, respectively. The maximum biological efficacy at this dosage was also noted on day 14, achieving 79.5%.

For comparison, the chemical insecticide Killer Neo 10% EC, applied at a rate of 0.1 liters per hectare, demonstrated a higher biological efficacy of 87.3% on day 7 (Figure 2).

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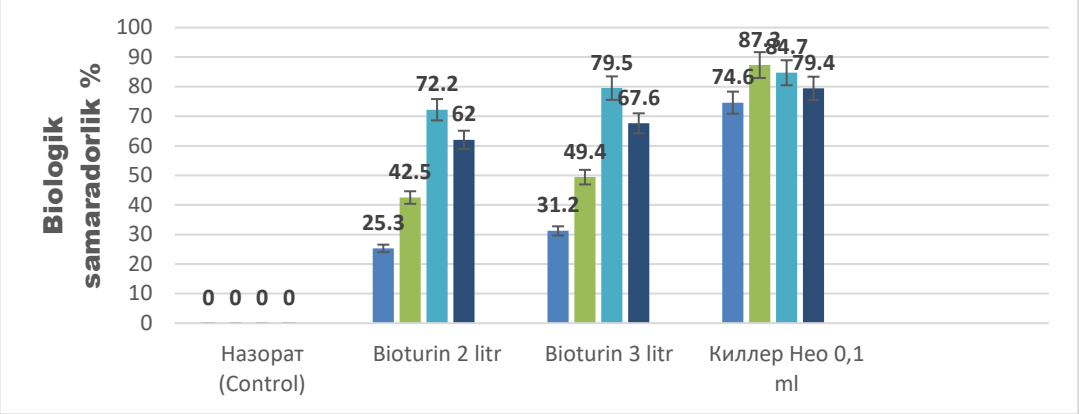

Figure 2. Biological efficacy of the Bioturin biopreparation against the pest *Oulema melanopus*

In the experimental field of 12.3 hectares at the Scientific Research Institute of Fine-Fibered Cotton in Termez District, Surkhandarya Region, trials were conducted using the Bioturin biopreparation. When applied at a rate of 2.0 L/ha, the initial count of Oulema melanopus on 50 wheat stems was 17.2 specimens. After treatment, the number of live pests decreased, reaching 7.2 specimens on the 14th day, demonstrating a biological efficacy of 70.4%. At a higher application rate of 3.0 L/ha, the initial count was 16.5 specimens, which declined to 5.4 specimens by the 14th day, resulting in a biological efficacy of 76.8%.

For comparison, the chemical insecticide Killer Neo 10% EC applied at a rate of 0.1 L/ha showed an initial pest count of 16.8 specimens, which reduced to 2.5 specimens by the 7th day after treatment, corresponding to a biological efficacy of 87.4% (Figure 3).

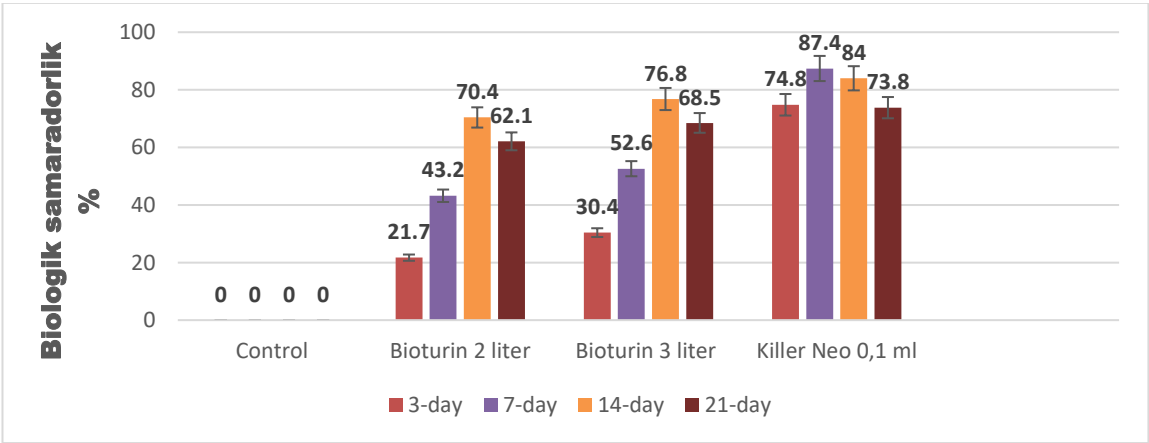

Figure 3. Biological efficacy of the Bioturin biopreparation against the pest *Oulema melanopus*

Conclusion and Recommendations

Based on the research results, the application of the *Bioturin* biopreparation, based on *Bacillus* thuringiensis, at a rate of 3.0 L/ha against *Oulema melanopus* in wheat crops demonstrated an average insecticidal activity of 75.9%. Application of this biopreparation during the early developmental stages of the pest can effectively mitigate potential damage. This method is considered ecologically safe, economically viable, and beneficial in reducing the problem of pesticide resistance.

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Utilizing local biological agents against pests under the conditions of our Republic is one of the key factors for the successful implementation of Integrated Pest Management (IPM).

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