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RESEARCH ARTICLE

# The effectiveness of protection measures for maize hybrids of different FAO groups against damage caused by *Ostrinia nubilalis* Hübner under continuous maize cultivation conditions with irrigation

**Andrii Donets[1], Tetiana Marchenko[2*], Olena Piliarska[1], Serhii Mishchenko[3], Yuri Lavrynenko[1]**
[1]Institute of Climate-Smart Agriculture of the NAAS, Khlibodarske, Ukraine
[2]Odesa State Agrarian University, Odesa, Ukraine
[3]Oleksandr Dovzhenko Hlukhiv National Pedagogical University, Hlukhiv, Sumy region, Ukraine

***Corresponding author:** Tetiana Marchenko, Odesa State Agrarian University, Odesa, Ukraine
E-mail: tmarchenko74@ukr.net

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## Abstract

The aim of the study was to determine the effectiveness of chemical and biological control agents applied to maize hybrids of different FAO maturity groups against *Ostrinia nubilalis* Hübner under drip irrigation in continuous maize cropping during 2020-2024. Field experiments were conducted at the Institute of Climate-Smart Agriculture of the NAAS in the agro ecological zone of the Southern Steppe of Ukraine. The use of a biological control agent demonstrated the effectiveness of the product 'Trichopsyn BT' (a biological preparation with insecticidal, fungicidal, and growth-stimulating properties) in combating *Ostrinia nubilalis* Hübner. The application of the chemical insecticide 'BI 58' proved to be more effective than the biological control agent over two- and five-year periods of continuous maize cropping. Integrated pest management of maize hybrids slightly outperformed chemical control, but the advantage was minimal. The use of biological preparations for maize protection is feasible in organic farming for producing food and feed maize grain without the application of chemical agents.

**Keywords:** Maize, Pests, Biological preparations, Plant protection, Genotypes

## Introduction

In the context of intensified agricultural production, producers of crop products are increasingly focusing on cultivating profitable crops. Currently, maize, sunflower, soybean, and hemp are among the most profitable crops, prompting an increase in their share in crop rotations. The use of these crops in repeated and continuous cropping is becoming more widespread (Vashchenko, 2017; Tkachuk & Bondarenko, 2023).

The saturation of maize in crop rotations can be highly profitable; however, such production systems face the challenge of pest control, as pests accumulate in crop residues after grain harvesting. In maize pest control systems, key factors may

include the genotypic resistance of hybrids, chemical control, and biological control (Hadzalo et al., 2023; Vozhehova et al., 2021).

Under irrigation, maize hybrids of various FAO maturity groups can annually yield over 10 t/ha-16 t/ha in continuous cropping systems. However, pest infestation levels increase with each subsequent year. One of the most harmful insect pests is the European corn borer (*Ostrinia nubilalis* Hübner), which damages maize stems and ears, leading to significant yield and quality losses. Moreover, plants often break at the site of damage below the ear, causing the ear to fall to the ground, making it impossible to harvest mechanically using a combine harvester. Ineffective or untimely pest control can result in yield losses of up to 40% (Melnychuk et al., 2017).

The European corn borer (*Ostrinia nubilalis* Hübner) is one of the most dangerous maize pests, causing grain yield losses of 14%-16%, and during years of mass outbreaks, up to 25% or more. The feeding activity of its larvae facilitates the penetration of pathogens that cause common smut, fusarium, and ear mold. Broken stems and ears (a result of larvae feeding) complicate mechanized harvesting and lead to additional yield losses (Fedorenko & Hulyak, 2013).

Irrigation in the arid regions of Ukraine is a crucial factor for ensuring high maize yields, as it not only affects plant growth conditions but also impacts the development of all living organisms inhabiting the soil, plants, and plant canopy. Irrigation significantly alters the microclimate of the soil and near-ground atmospheric layer. For most hygrophilous and mesophilous pest species, which are not soil-dependent in any developmental phase and inhabit the plant canopy zone, irrigation creates more favorable conditions. Among pests whose populations increase under irrigation is the European corn borer (*Ostrinia nubilalis* Hübner), which is widely distributed throughout Ukraine (Dudka, 2013).

Recently, there has been growing interest among producers in the use of biological plant protection agents. The scientific justification for the biologization of agricultural production in Ukraine will facilitate the synchronization of research with leading innovative organizations in the EU and worldwide in the areas of sustainable natural resource management, resource conservation, and adaptation to climate change processes in Ukraine (Hadzalo & Luzan, 2023).

The objective of the research was to assess the effectiveness of chemical and biological plant protection agents applied to maize hybrids of various FAO maturity groups against *Ostrinia nubilalis* Hübner under drip irrigation in continuous maize cropping during 2020-2024.

## Materials and Methods

Field experiments were conducted at the Institute of Climate-Smart Agriculture of the National Academy of Agrarian Sciences (NAAS) in the agroecological zone of the Southern Steppe of Ukraine. The study involved Ukrainian-bred maize hybrids listed in the State Register of Plant Varieties of Ukraine. A commonly recognized research methodology was applied (Vozhehova P. et al., 2014; Trybel et al., 2001).

The microbiological preparation *Trichopsin* BT', a Ukrainian-produced insecto-fungicide containing biologically active growth-regulating substances, was used in the study (https://biotekhnika.od.ua/uk, https://centrbio.com/). The plants were treated during the vegetation period according to the recommendations of the Engineering and Technological Institute "Biotechnics" of NAAS (Odesa). Additionally, the chemical insecticide Bi-58 (active ingredient: dimethoate, manufacturer: BASF) was applied.

## Results and Discussion

The research findings revealed that in continuous maize cropping, plant damage significantly increased during the fourth and fifth years compared to the initial years (2020-2021). Hybrids with FAO above 300 were more affected due to the longer vegetation period of these genotypes, which extended the duration of invasive pressure on the plants (Tab. 1).

The application of biological plant protection significantly reduced plant damage, with damage rates ranging from 2.3% to 4.2% during the first 2 years of continuous cropping. Over a 5-year period, the use of *'Trichopsin BT'* further reduced plant damage by 9%-47.7% lower than the control.

Integrated plant protection (chemical insecticide+biological preparation) reduced maize hybrid damage by an additional 0.3%-1.7%, indicating a weak synergistic effect of the two preparations.

The study also identified genotype-specific responses of maize hybrids to damage by *Ostrinia nubilalis* Hübner. Without plant protection measures, hybrids with FAO 290-430 were the most affected. This may be associated with an extended vegetation period of these hybrids by 10 days-20 days, making them more susceptible to damage by the second generation of *Ostrinia nubilalis* Hübner.

**Table 1. Effect of plant protection measures on the intensity of corn borer (*Ostrinia nubilalis* Hübner) damage to corn hybrids under continuous corn cultivation, % (2020-2024).**

| Hybrid, FAO (Factor A) | Years of Continuous Cultivation (Factor B) | Plant Protection (Factor C) | | | |
|---|---|---|---|---|---|
| | | Control | Biological Protection (*Trichopsin* BT) | Chemical protection (Bi 58) | Integrated protection (*Trichopsin* BT + Bi 58) |
| **Stepovyi, FAO 190** | 2020...2021 | 18.6 | 14.8 | 7.9 | 7.2 |
| | 2023...2024 | 48.7 | 39.2 | 1.8 | 11.5 |
| **Khotyn,** | 2020...2021 | 19.3 | 16.0 | 8.5 | 8.2 |
| **FAO 250** | 2023...2024 | 45.7 | 40.3 | 11.4 | 9.7 |
| **Skadovskyi, FAO 290** | 2020...2021 | 19.9 | 17.6 | 9.4 | 9.0 |
| | 2023...2024 | 51.8 | 44.9 | 10.6 | 8.8 |
| **Askaniya, FAO 320** | 2020...2021 | 20.2 | 16.5 | 7.3 | 6.8 |
| | 2023...2024 | 54.0 | 42.2 | 9.7 | 9.3 |
| **Tronka,** | 2020...2021 | 22.5 | 19.3 | 8.2 | 7.9 |
| **FAO 380** | 2023...2024 | 56.4 | 45.6 | 8.5 | 8.0 |
| **Arabat,** | 2020...2021 | 23.6 | 19.4 | 6.4 | 6.1 |
| **FAO 430** | 2023...2024 | 54.7 | 46.0 | 7.0 | 6.8 |
| **Vira,** | 2020...2021 | 22.5 | 18.3 | 8.4 | 7.6 |
| **FAO 430** | 2023...2024 | 53.1 | 44.1 | 9.1 | 8.2 |

LSD 05 Significant Difference, % A=1.2; B=2.5; C=1.8

The calculations of the technical efficiency of plant protection products for protecting corn hybrids from *Ostrinia nubilalis* Hübner demonstrated the highest efficiency with integrated plant protection (Tab. 2). Chemical plant protection showed slightly lower technical efficiency, especially during the first two years of continuous maize cultivation. With the increasing invasion pressure over the 5 year period, the maximum increase in technical efficiency reached 1.7 for the hybrid 'Khotyn', indicating a weak synergistic effect of these products. The chemical product for controlling *Ostrinia nubilalis* Hübner proved to be the most effective during the 2 year and 5 year periods of continuous corn cultivation.

**Table 2. Technical efficiency of plant protection measures for maize hybrids against maize borer (*Ostrinia nubilalis* Hübner) under continuous maize cultivation (2020 .... 2024).**

| Hybrid, FAO (Factor A) | Years of Continuous Cultivation (Factor B) | Plant Protection (Factor C) | | |
|---|---|---|---|---|
| | | Biological Protection (*Trichopsin* BT) | Chemical protection (Bi 58) | Integrated protection (*Trichopsin* BT + Bi 58) |
| Stepovyi, FAO 190 | 2020...2021 | 20.4 | 57.5 | 61.3 |
| | 2023...2024 | 19.5 | 73.7 | 76.4 |
| Khotyn, FAO 250 | 2020...2021 | 17.1 | 56 | 57.5 |
| | 2023...2024 | 11.8 | 75.1 | 78.8 |
| Skadovskyi, FAO 290 | 2020...2021 | 11.6 | 52.8 | 54.8 |
| | 2023...2024 | 13.3 | 79.5 | 83 |
| Askaniya, FAO 320 | 2020...2021 | 18.3 | 63.9 | 66.3 |
| | 2023...2024 | 21.9 | 82 | 82.8 |
| Tronka, FAO 380 | 2020...2021 | 14.2 | 63.6 | 64.9 |
| | 2023...2024 | 19.1 | 84.9 | 85.8 |
| Arabat, FAO 430 | 2020...2021 | 17.8 | 72.9 | 74.2 |
| | 2023...2024 | 15.9 | 87.2 | 87.6 |
| Vira, FAO 430 | 2020...2021 | 18.7 | 62.7 | 66.2 |
| | 2023...2024 | 16.9 | 82.9 | 84.6 |

## Conclusions

The use of the biological plant protection product *'Trichopsin BT'* (a biological insect-fungicide and growth stimulant) demonstrated its efficacy in controlling *Ostrinia nubilalis* Hübner. The application of the chemical insecticide 'BI 58' was more effective compared to biological protection over the two-year and five-year periods of continuous corn cultivation. Integrated protection of corn hybrids slightly surpassed chemical protection; however, the advantage was minimal. Maize hybrids with shorter growing seasons (FAO 190–290) exhibited lower damage levels due to reduced exposure to invasion pressure. The use of biological plant protection products is feasible in organic farming and continuous corn cultivation to produce food and feed corn without the application of chemical products.

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