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RESEARCH ARTICLE

The effectiveness of biological preparations for the protection of different FAO groups maize hybrids in the Northern Steppe of Ukraine

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Abstract

The use of biological preparations to reduce the harmfulness of pathogenic fungi and insects on agricultural crops is a promising direction in the global dimension of scientific research. Maize is the main grain crop of Ukraine, and one of the main factors of grain yield reduction is damage by fungi *Ustilago zeae* Beckm. (bubble slag), *Fusarium moniliforme* Scheld. (fusarium) and corn moth (*Ostrinia nubilalis* Hübner). In connection with the destruction of the main massifs of irrigated land (more than 800 thousand ha) as a result of russian aggression, the main areas of maize are concentrated on non-irrigated lands, where damage by harmful organisms increases in an arid climate. Determining the effectiveness of the use of biological protection against the main harmful organisms on crops of maize hybrids of different FAO groups in the agro-ecological conditions of the Northern Steppe of Ukraine was the goal of our research. Based on the results of the research, it was established that the specific genotypic features of maize hybrids and the FAO group did not significantly affect the damage caused by the fungi *Ustilago zeae* Beckm., *Fusarium moniliforme* Scheldt. and insect damage by *Ostrinia nubilalis* Hübner. The use of biological means of protection showed the effectiveness of Biplan M and Biospectr BT (microbiological preparations with insecticidal and growth-stimulating action). The level of damage by harmful organisms, the technical efficiency of the drugs depended significantly on the active basis of the biological preparation. Maize grain yield mainly depended on the FAO group and genotypic characteristics. The 'Oleshkivsky' hybrid had the maximum yield increase when using Biospectr BT biological preparation –0.79 t/ha (10.2%). The obtained results can be used by farms engaged in the cultivation of grain corn under organic farming

Keywords: Agricultural technology, Corn, Means of protection, Productivity, Pests, Diseases

Introduction

Previous studies on the effects of biopreparations under irrigation conditions have demonstrated high efficiency at optimal moisture levels (Vozhehova et al., 2022). Considering that significant areas of irrigated land in Ukraine were destroyed due to the criminal destruction of the Kakhovka Reservoir, the main maize planting areas are currently concentrated on non-irrigated lands with more challenging agroecological conditions.

Anjorin et al. (2022) found that the destructive actions of invasive pathogens and pests on maize increase when plants experience prolonged soil moisture deficits and air drought. These phenomena are currently observed in the Northern Steppe region of Ukraine on non-irrigated lands, emphasizing the need for improved plant protection technologies under these agroecological conditions.

Gadzalo and Luzan (2023) argue that the scientific justification for the biologization of agricultural production in Ukraine will facilitate synchronization of research with leading innovative structures in the EU and globally in the direction of rational natural resource management.

The problem of maintaining environmental homeostasis poses a challenge for science to find safe means of controlling pests and pathogens of crops. The biological method is a key strategic environmentally safe measure for controlling harmful organisms in crop fields under organic farming conditions (Tkalenko et al., 2020).

The aim of the research was to determine the effectiveness of using biological protection agents on maize of different FAO groups in the agroecological conditions of the Northern Steppe of Ukraine.

Materials and Methods

Field experiments were conducted from 2021 to 2023 on the territory of "Svitlana" farm, Yelanets district, Mykolaiv region. The experimental field is located in the Northern Steppe agroecological zone (HTC V-IX = 0.69-0.89). The study used hybrids of Ukrainian selection, listed in the State Register of Plant Varieties Suitable for Distribution in Ukraine: 'Stepovyi', 'Oleshkivskyi', 'Tronka', 'Hileia' (Originator: Institute of Climate-Oriented Agriculture NAAS).

Experimental data were processed using the methods of mathematical statistics (Ushkarenko et al., 2013). The study employed microbiological preparations of Ukrainian production (https://biotekhnika.od.ua/uk, https://centrbio.com/), specifically: Biospectrum BT and Biplan M – biological preparations with insecto-fungicidal action and containing biologically active growth-regulating substances. Plants were treated with biopreparations during vegetation according to the recommendations of the Engineering and Technological Institute "Biotekhnika" NAAS (Odessa).

Meteorological observations were conducted using the autonomous professional weather station DLS-009 (AW009). The weather conditions during the study were typical for this agroecological zone. The driest year was 2022, while 2021 and 2023 were favorable in terms of precipitation for certain FAO maize groups.

Results and Discussion

The damage to maize hybrids by the European corn borer (Ostrinia nubilalis Hübner) was similar among the hybrids 'Stepovyi', 'Oleshkivskyi', and 'Tronka', ranging from 14.2% to 14.7%. The hybrid 'Hileia' showed slightly lower damage at 15.4%. The hybrid factor had minimal impact on the damage level and was mostly insignificant among the hybrids, indicating the difficulty of developing genotypes resistant to the corn borer through traditional breeding methods (Tab. 1).

Table 1. Effect of Biopreparations on the intensity of infestation or damage to Maize Hybrids by Harmful Organisms, % (average for 2021–2023)

		Intensity of Damage or Infection, %		
Hybrid (Factor A)	**Biopreparation (Factor B)**	**Stem (Corn) Borer (*Ostrinia nubilalis* Hübner)**	**Fusarium Ear Rot (*Fusarium moniliforme* Scheld.)**	**Common Smut кукурудзи (*Ustilago zeae* Beckm.)**
Stepovyi (FAO 190)	Control (water treatment)	14.6	11.2	8.2
	Biplan M	11.2	8.6	4.4
	Biospectrum BT	11.1	7,4	4,3
Oleshkivs`kyi (FAO 280)	Control (water treatment)	14.5	9.7	9.5
	Biplan M	11.8	5.9	6.6
	Biospectrum BT	11.5	4.8	4.7
Tronka (FAO 380)	Control (water treatment)	14.7	10.7	9.4
	Biplan M	11.9	6.9	4.5
	Biospectrum BT	11.5	6.8	4.4
Hileia (FAO 420)	Control (water treatment)	15.4	10.2	8.7
	Biplan M	11.8	6.8	3.4
	Biospectrum BT	11.9	6.5	3,2
LSD_{05}	Factor A	0.34	0.22	0.51
	Factor B	0.26	0.37	0.39

The application of Biplan M and Biospectrum BT reduced damage by the European corn borer from 14.6% to 11.1%–11.2% in the 'Stepovyi' hybrid. In the 'Oleshkivskyi' hybrid, damage was reduced from 14.5% to 11.5%–11.8% with these treatments. For the 'Tronka' hybrid, damage decreased from 14.7% to 11.5%–11.9%. The 'Hileia' hybrid experienced significantly higher damage in the control group at 15.4%, which is attributed to its longer growing season and extended pest activity period. There was no significant difference between Biplan M and Biospectrum BT in reducing pest damage.

The biopreparations also positively influenced resistance to fungal diseases. In the early-maturing 'Stepovyi' hybrid (FAO 190), the biopreparations suppressed the development of common smut (*Ustilago zeae Beckm*)—Biplan M by 3.8% and Biospectrum BT by 3.9%. They also reduced the incidence of fusarium ear rot (Fusarium moniliforme Scheld)—Biplan M by 2.6% and Biospectrum BT by 3.8%.

In the mid-early hybrid 'Oleshkivskyi' (FAO 280), Biplan M reduced common smut by 2.9%, and Biospectrum BT by 4.8%. The incidence of fusarium ear rot was reduced by 3.8% with Biplan M and by 4.9% with Biospectrum BT.

For the 'Tronka' hybrid (FAO 380), disease incidence was reduced by 4.9% with Biplan M and by 5.0% with Biospectrum BT. Fusarium ear rot incidence decreased by 3.8% with Biplan M and by 3.9% with Biospectrum BT.

In the 'Hileia' hybrid (FAO 420), these biopreparations also reduced common smut incidence. Biplan M decreased incidence by 5.3%, and Biospectrum BT by 5.5%. Fusarium ear rot incidence was reduced by 3.4% with Biplan M and by 3.7% with Biospectrum BT.

Yield assessments showed that under the influence of the biopreparations, the grain yield of the studied maize hybrids ranged from 6.15 t/ha to 8.51 t/ha over the research years (Fig. 1)

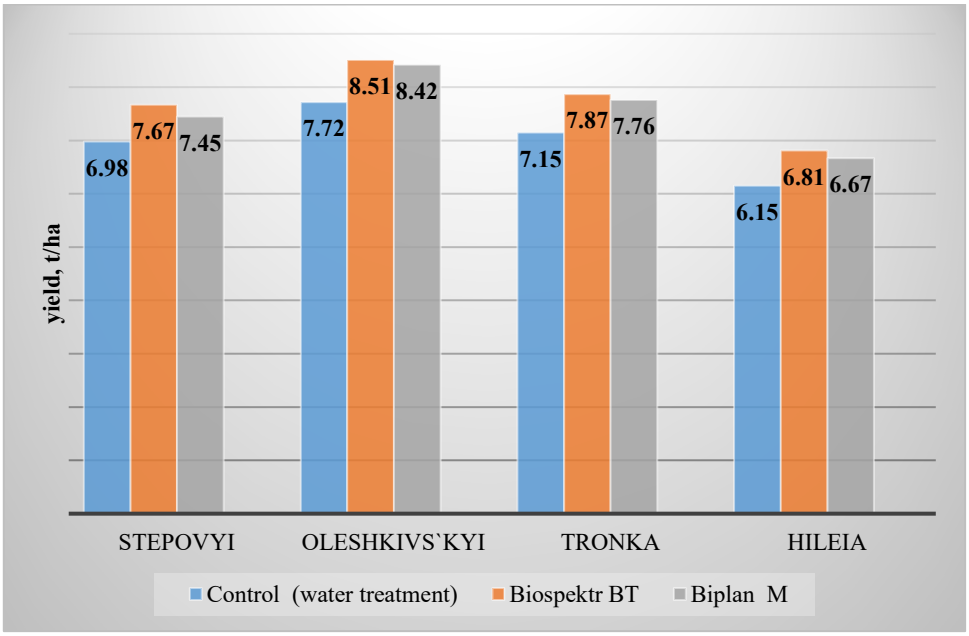

Figure 1. Grain yield of maize hybrids depending on biopreparation treatment, t/ha

It was found that the application of Biospectrum BT resulted in the highest average grain yield of maize, averaging 7.72 t/ha across the hybrids. Treatment with Biplan M resulted in a slightly lower yield, averaging 7.58 t/ha. Compared to the control, the yield increase from using Biospectrum BT was 0.72 t/ha, or 10.2%. The yield increase from using Biplan M was 0.58 t/ha, or 8.2%.

The 'Stepovyi' hybrid (FAO 190) showed an average grain yield of 6.98 t/ha without biopreparation treatment. With biopreparations, its yield increased to between 7.34 t/ha and 7.67 t/ha. The highest yield for 'Stepovyi' was achieved with Biospectrum BT at 7.67 t/ha, which is 9.9% higher than the control.

The 'Oleshkivskyi' hybrid (FAO 280) was the most productive on average over the study years, with a grain yield of 7.72 t/ha without biopreparations. The highest yield for 'Oleshkivskyi' was achieved with Biospectrum BT at 8.51 t/ha, a 10.2% increase. The effect of Biplan M was less pronounced, with a yield of 8.42 t/ha and a yield increase of 9.1%.

The 'Tronka' hybrid (FAO 380) showed an average grain yield of 7.57 t/ha over the study period, slightly lower than the previous hybrid. The highest yield for 'Tronka' was achieved with Biospectrum BT at 7.87 t/ha, a 10.1% increase. Biplan M had a smaller impact on yield, with an increase of 0.61 t/ha.

The 'Hileia' hybrid (FAO 420) showed the lowest average yield during the study period at 6.53 t/ha. The reduced yield was due to the hybrid's longer growing season and higher moisture requirements, which were not met by the natural precipitation levels in the Northern Steppe's agroecological conditions. The highest yield for 'Hileia' was achieved with

Biospectrum BT at 6.81 t/ha, with an increase of 0.66 t/ha, or 10.7%. The yield increase from using Biplan M was 0.52 t/ha, or 8.5%.

Conclusions

The use of biological protection agents demonstrated the effectiveness of Biplan M and Biospectrum BT, which are biological preparations with insecticidal, fungicidal, and growth-stimulating properties.

It was found that treatment with Biospectrum BT resulted in the highest average maize grain yield across hybrids, averaging 7.72 t/ha. Treatment with Biplan M resulted in a slightly lower yield, averaging 7.58 t/ha.

Compared to the control, the yield increase from using Biospectrum BT was 0.72 t/ha, or 10.2%. The yield increase across all FAO groups from using Biplan M was 0.58 t/ha, or 8.2%.

Maize hybrids with shorter growing periods (FAO 190–290) exhibited higher grain yields under the non-irrigated conditions of the Northern Steppe of Ukraine.

The use of biological protection agents for maize is feasible in organic farming to produce food and feed grain without chemical preparations.

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