Article Type: Research Article

J Name: Modern Phytomorphology

Short name: MP

ISSN: ISSN 2226-3063/eISSN 2227-9555

Year: 2026

Volume: 20

Page numbers: 545-549

DOI: 10.5281/zenodo.19491915
(10.5281/zenodo.2025-20-545-549)

Short Title: Effect of protection systems on sunflower hybrid yield and resistance under irrigation in southern Ukraine

RESEARCH ARTICLE

Effect of protection systems on sunflower hybrid yield and resistance under irrigation in southern Ukraine

Tetiana Marchenko[1*], Yaroslav Likar[2], Igor Diedukh[1], Serhii Mishchenko[3], Oleksandr Haidash[4], Tetiana Khomenko[5], Ivanna Smulskaya[5]

[1]Institute of Climate-Smart Agriculture, National Academy of Agrarian Sciences of Ukraine, Odessa, Ukraine

[2]National University of Life and Environmental Sciences of Ukraine, Kyiv, Ukraine

[3]Oleksandr Dovzhenko Hlukhiv National Pedagogical University, Hlukhiv, Ukraine

[4]State Institution Institute of Grain Crops of the National Academy of Agrarian Sciences of Ukraine, 14 Vernadsky Volodymyr St. Dnipro, 49009, Ukraine

[5]Ukrainian Institute for Plant Variety Examination, 15 Horikhuvatskyi shliakh Str. Kyiv, 03041, Ukraine

*Corresponding author: Tetiana Marchenko, Institute of Climate-Smart Agriculture, National Academy of Agrarian Sciences of Ukraine, Odessa, Ukraine, Ukraine, Email: tmarchenko74@ukr.net

Received: 10.02.2026, Manuscript No. mp-26-184520 | **Editor Assigned:** 12.02.2026, Pre-QC No. mp-26-184520 (PQ) | **Reviewed:** 05.04.2026, QC No. mp-26-184520 (Q) | **Revised:** 06.04.2026, Manuscript No. mp-26-184520 (R) | **Accepted:** 07.04.2026 | **Published:** 11.04.2026

Abstract

Aim: To improve systems for protecting sunflower hybrids from harmful organisms under irrigated conditions.

Methods: A set of general scientific methods and approaches of empirical and theoretical knowledge was applied: Abstract-logical, statistical, modeling, generalization; two-factor field experiment.

Results: The effectiveness of plant protection against harmful organisms when using biological and chemical preparations with drip surface irrigation in the Steppe of Ukraine was established. The use of integrated protection contributes to the formation of the highest yield of sunflower hybrid seeds under irrigation conditions in the Southern Steppe of Ukraine. The use of a biological preparation with insecticidal and fungicidal protective action with a growth-stimulating effect provided an increase in seed yield by 0.72-0.86 t/ha.

Conclusion: Chemical protection against pests and diseases provided an increase in seed yield of sunflower hybrids by 0.93-1.06 t/ha. The mid-season sunlower hybrid Husliar achieved the highest seed yield (3.91 t/ha) with integrated protection.

Keywords: Sunflower, Hybrid, Resistance, Phytopathogens, Yield, Seeds, Pesticides, Irrigation

Introduction

Planning to increase the yield and quality of sunflower seeds in the conditions of intensification of production necessitates the search for innovative methods of phytosanitary control of crops with the use of environmentally safe agrochemicals and biological preparations. During the study conducted in the agroclimatic conditions of Ukraine, the complex effect of a combination of preparations-a chemical insecticide, a microfertilizer with a fungicidal effect and a biological growth regulator on the phytosanitary condition

of sunflower crops was assessed. The use of these agents contributed to a significant reduction in the level of damage by dominant phytopathogens, an increase in the level of yield and quality (Matusevich, et al. 2025).

Irrigation methods and irrigation water quality can be factors influencing the intensity of sunflower infestation by phytopathogens and insects (Amin, et al. 2025).

Despite the increase in sunflower areas, it is not always possible to fully reveal the high potential of modern hybrids. One of the reasons for this is significant crop losses from harmful organisms, mainly due to violations of scientifically based crop rotations and insufficient genetic potential for disease resistance (Sydiakina and Podriezov 2024, Markell, et al. 2015).

One of the most dangerous phytophagous pests of sunflower is the cotton bollworm *Helicoverpa armigera* Hb. This polyphagous pest can damage 120-250 plant species. In Ukraine, it can produce 2-3 generations (Klechkovsky, et al. 2017).

In Ukraine, common sunflower pathologies are white and gray rot (Kyryk and Pikovskyi, 2010, Kyryk, et al. 2013), at the same time, the development of white rot (sclerotiniosis), which is caused by a necrotrophic fungus, is extremely dangerous. S*clerotinia sclerotiorum* (Lib.) de Bary (Pikovsky and Kyryk, 2021).Thus, white rot caused by *S. sclerotiorum* is a significant biotic stress that affects crop productivity and leads to significant yield losses (Hossain, et al. 2025), which makes it advisable to study various aspects of the impact of the disease on plants.

The maximum yield of high-quality sunflower seeds is formed under the condition of an optimal ratio of all structural elements and, above all, due to the diameter of the basket, the mass of 1000 seeds. Studies have established that the seeds of sunflower hybrids of the large fraction have greater vigor and better sowing quality compared to the small fraction (Dedukh, et al. 2025).

Therefore, researching the current state, identifying ways to address urgent issues, and outlining future prospects for sunflower production, especially in the post-war period of Ukraine's agricultural sector recovery, is a relevant issue today.

Materials and Methods

The research was conducted using methodological approaches consistent with international practice and compliant with the state standards of Ukraine.

The reaction of sunflower hybrids to different growing conditions was studied in institute of climate-smart agriculture, national academy of agrarian sciences of Ukraine (Kherson, Ukraine; 46°44'33" N, 32°42'28" E; 50 m above sea level) from 2023 to 2025.

Mathematical processing of experimental data was carried out using Analysis Of Variance (ANOVA) using standard Microsoft office excel tools and software suite Agrostat 2014 (Ushkarenko, et al. 2014). In particular, an assessment of the significant difference between the mean values at the 0.05 probability level Least Significant Difference ($LSD_{0.5}$) for a two-factor experiment was carried out.

Agricultural practices were consistent with standard technologies for irrigated sunflower grain production. Autumn plowing was carried out after harvesting the previous crop (soybean) to a depth of 26-28 cm. Spring tillage included early spring harrowing at the stage of physical soil ripeness followed by pre-sowing tillage to a depth of 6-8 cm (seed embedding depth) (Vozhegova, et al. 2021).

The humus content in the arable layer was 2.61%, the content of available phosphorus (P_2O_5) was 59 mg/kg of soil, exchangeable potassium (K_2O) was 276 mg/kg, and nitrates were 16.3 mg/kg, the pH of the aqueous extract in the arable layer was 7.0.

Crop treatment was carried out using a Euro-Pulve compressor-type boom sprayer (bicycle model) equipped with TeeJet XR11003-VP nozzle. The working fluid consumption was 250 l/ha, the working pressure was 3.0 kPa/atm, with six nozzles and a sprayer boom working width of 3 m.

The grain yield of sunflower hybrids was determined by manually collecting baskets with subsequent measurement of the grain harvesting moisture content, threshing and conversion of yield to standard grain moisture content. The collected sunflower baskets from the plot were weighed, threshed, grain moisture content (by thermostatic drying at a temperature of 103°C to constant weight) was determined, seed yield from the basket was further converted to standard yield. (Vozhegova, et al. 2021).

The experiment involved Ukrainian sunflower hybrids registered in the state register of plant varieties of Ukraine: Ravelin, Slavson, Husliar, Zlatson.

In the plant protection system, the biological preparation "Biospectr BT" from the Biotechnology Engineering Institute was used (https://biotekhnika.od.ua/). The active ingredient of the drug is mycelium, spores of the fungus of the genus Trichoderma and rhizosphere bacteria of the genus Pseudomonas with a titer of not less than 2.0.1010 CFU/cm^3, as well as biologically active substances produced by producer strains. Also used was the synthetic chemical insecticide Bi-58 (active ingredient: Dimethoate; manufacturer: BASF) and fungicide Abacus (Badische Anilin and Sodafabrik).

Results

Therefore, we also paid attention to the effect of preparations on the structural indicators of the yield of hybrid seeds (Tab. 1). The mass of 1000 seeds and the diameter of the basket increased their indicators when using plant protection systems.

Table 1. Productivity structure and yield of sunflower hybrid seeds (*Helianthus annuus* L.) of different maturity groups depending on the protection system (average for 2023-2025 years).

Hybrid (factor A)	Protection system (factor B)	Weight of 1000 seeds, g	Basket diameter, r (cm)	Seed yield, t/ha
Slavson	Control (no treatment)	50.2	17.1	1.99
	Chemical protection	53.9	18.2	2.92
	Biological protection	52.1	17.7	2.85
	Integrated protection	55.1	18.6	2.99
	Average	**52.83**	**17.9**	**2.68**
Zlatson	Control (no treatment)	66.5	17.4	2.41
	Chemical protection	68.7	18.4	3.33
	Biological protection	67.5	17.9	3.09
	Integrated protection	70.3	19.9	3.59
	Average	**68.25**	**18.4**	**3.11**
Ravelin	Control (no treatment)	65.7	21.5	2.35
	Chemical protection	69.2	24.7	3.41
	Biological protection	72.7	22.3	3.12
	Integrated protection	76.6	25.1	3.62
	Average	**71.05**	**23.4**	**3.13**
Husliar	Control (no treatment)	55.4	20.4	2.61
	Chemical protection	59.4	22.7	3.54
	Biological protection	57.9	21.8	3.33
	Integrated protection	60.2	23.1	3.91
	Average	**58.23**	**22**	**3.35**
LSD (0.05)	Factor A	1.34	0.87	0.15
	Factor B	2.04	0.68	0.17

Weight of 1000 seeds

The trait "1000-grain weight" in sunflower hybrids under irrigated conditions was studied. Observations conducted in 2023-2025 showed that the weight of 1000 seeds depends on the genotype of the hybrid and treatment with drugs.

Among the hybrids, the lowest 1000-grain weight was observed in the early-ripening Slavson hybrid, ranging from 50.2 (in the control variant) to 55.1 g (in integrated protection). The highest 1000-grain weight on average was shown by the medium-early Ravelin hybrid, averaging 65.7 g in the control variant and up to 76.6 g under integrated protection.

The weight of 1000 grains was significantly increased due to the use of the protection system. In the experiment, all hybrids showed the maximum weight of 1000 grains under integrated protection -55.1-76.6 g, chemical protection showed a weight of 1000 grains -53.9-69.2 g, biological on average - 52.1-72.7 g. Integrated protection increased the weight of 1000 grains the most. Biological protection was the least effective compared to chemical and integrated.

For the maximum manifestation of the trait "weight of 1000 grains" the optimal was integrated plant protection. In the control variant all hybrids showed the minimum manifestation of the trait.

Basket diameter

The results of the research showed that, like the weight of 1000 seeds, the treatment of plants with preparations had a positive effect on the indicator "basket diameter". On average, under the influence of the protection system, the basket diameter increased from

19.1 cm in the control variant to 19.9 cm in biological protection, to 21 cm in chemical protection and reached maximum indicators with integrated protection on average -21.7 cm.

Seed yield

During the 2023-2025 studies, the grain yield of sunflower hybrids ranged from 1.99 to 3.91 t/ha, depending on the protection system.

The yield of the early-ripening Slavson hybrid ranged from 1.99 to 2.99 t/ha, the mid-early Zlatson hybrid -2.41-3.59 t/ha, the mid-early Ravelin hybrid - 2.35-3.62 t/ha, the mid-ripening Husliar hybrid -2.61-3.91 t/ha.

According to the results of the conducted research, it was found that the early-ripening hybrid Slavson (vegetation period 97 days) formed the maximum grain yield under an integrated protection system -2.99 t/ha. The minimum yield (1.99 t/ha) was in the control variant (without plant protection), the decrease in seed yield was 1.00 t/ha, or 33.5%.

The medium-early hybrid Zlatson (vegetation period 110 days) showed the maximum grain yield under the integrated protection system -3.59 t/ha. The minimum yield of 2.41 t/ha was in the control variant, the yield reduction was 1.18 t/ha, or 32.9%.

In the mid-early hybrid Ravelin (vegetation period 110 days), the maximum seed yield was formed under the integrated protection system -3.62 t/ha. The minimum yield of 2.35 t/ha was in the control variant, the yield reduction was 1.27 t/ha, or 35.1%.

The mid-season sunflower hybrid Husliar achieved the highest seed yield (3.91 t/ha) with integrated protection. The minimum yield of 2.61 t/ha was in the control variant, the yield reduction was 1.30 t/ha, or 33.2%.

Discussion

The use of biological plant protection products is a promising direction of modern agricultural production. This direction is supported by the world scientific community and consumers of products. Great hopes are currently associated with the use of biological plant protection products. The biologization of the plant production sector in Ukraine contributes to the synchronization of research with leading innovative structures of the EU countries and the world in the direction of rational use of nature, resource saving, adaptation to climate change (Gadzalo and Luzan, 2023).

Previous studies on sunflower without irrigation showed high efficiency of plant treatment with environmentally safe biological preparations, which contributed to reducing the level of damage by pathogenic microflora for all sunflower hybrids. At the same time, drought tolerance was increased, the duration of the growing season was extended, and seed productivity and quality were increased (Domaratskiy, et al. 2023).

Our research has confirmed the prospects for the use of plant protection products of biological origin in agricultural production, which will contribute to a healthy diet for humanity and protect agricultural landscapes from contamination by chemical pesticides.

Conclusion

Biological methods of protecting plants from harmful organisms are a promising direction in modern agricultural production. The use of integrated protection contributes to the formation of the highest seed yield of sunflower hybrids under irrigation conditions in the Southern Steppe of Ukraine. The use of a biological preparation with insecticidal and fungicidal protective action with a growth-stimulating effect provided an increase in seed yield by 0.72-0.86 t/ha. Chemical protection against pests and diseases provided an increase in seed yield of sunflower hybrids by 0.93-1.06 t/ha. The maximum seed yield was shown by the mid-season sunflower hybrid Husliar using integrated protection -3.91 t/ha.

References

Amin MM, Shalaby SIM, Abd-Elbaky AA. (2025). Influence of water source and irrigation system on charcoal rot of sunflower plants. *Australas Plant Pathol.* **54**:73-80.

Dedukh IV, Marchenko TY, Lavrynenko YO, Svitlakova AS, Mishchenko SV, Marchenko VD. (2025). The effectiveness of modern insecticides in the system of protection of sunflower crops from cotton bollworm (*Helicoverpa armigera Hb*) in the conditions of southern Ukraine. *Agrarian Innovations*. **30**:62-68.

Domaratskiy Y, Kovalenko O, Kachanova T, Pichura V, Zadorozhnii Y. (2023). Analysis of the effectiveness of biological plant protection on sunflower productivity under different Cenosis density under the non-irrigated conditions of the steppe zone. *Ecol Eng Environ Technol*. **24**:45-54.

Gadzalo IA, Luzan Yu. (2023). Increasing the role of agricultural science at the stage of European integration. *Bull Agrar Sci*. **12**:5-16.

Hossain MM, Sultana F, Rubayet MT, Khan S, Mostafa M, Mishu NJ, Sabbir MA, Akter N, Kabir A, Mostofa MG. (2024). White mold: A global threat to crops and key strategies for its sustainable management. *Microorganisms*. **13**:4.

Klechkovsky YE, Glushkova SO, Mogylyuk NT, Ignatieva OV. (2017). Harmfulness of the cotton bollworm population and microbiological control of its abundance in tomato crops. *Agrobiol*. **1**:141-146.

Kyryk M, Pikovskyi M. (2010). Protection of sunflower from white and gray rot. *Proposal*. **7**:100-103.

Kyryk MM, Pikovskyi MY, Azaiki S. (2013). Gray mold of plants, biological and ecological properties of its agents (*Botrytis cinerea* Pers.): monograph. Kiyv: *Phoenix*. 209.

Markell SG, Harveson RM., Block CC, Gulya TJ. (2015). Sunflower diseases. In: Martínez-Force E, Dunford NT, Salas JJ. (Eds). Sunflower: Chemistry, production, processing, and utilization. *AOCS Press*. 93-128.

Matusevich GD, Mazur SO, Gorgan TM, Beznosko IV. (2025). Efficiency of fungicidal control of phytopathogenic micromycetes on dormouse (Helianthus annuus L.). *Agroecol* J. **1**:159-168.

Sydiakina OV, Podriezov IO. (2024). Sunflower: Current state, problems and prospects for production. *Tavria Sci Bull*. **136**:124-133.

Ushkarenko VO, Vozhehova RA, Holoborodko SP, Kokovikhin SV. (2014). Methodology of field experiment (Irrigated agriculture). *Kherson*: *Hrin DS.* 448.

Vozhegova RA, Lavrynenko YO, Malyarchuk MP. (2021). Methodology of field and laboratory research on irrigated lands. *Kherson: Grin* D.S. 286.