**Наукова діяльність** **РОСЛИННИЦТВО**


UDC 633.34:631.5:631.67 DOI: 10.32636/agroscience.2025-(4)-4-1

# THE RATIONALE FOR ENVIRONMENTALLY-ORIENTED PLANT PROTECTION STRATEGIES FOR MAIZE AGAINST PESTS AND PATHOGENS

Oleksandr BEZKROVNYI, postgraduate student, ORCID: 0009-0003-8307-1970
Sumy National Agrarian University
H. Kondratieva St., 160, Sumy, 40021, Ukraine
e-mail: vastkon@gmail.com

Among grain crops in Ukraine, the key role belongs to the cultivation of corn. According to the results of recent years, its share in the total volume of grain production is almost 50 %. There is a constant trend towards an increase in the gross production of corn for grain. Modern studies by many scientists have proven that in order to obtain a high yield of corn, it is necessary to pay attention to all components of its cultivation technology. The review of literature sources presented in the article demonstrates the importance of elements of modern technologies for growing corn, in particular the system of protecting crops from harmful organisms. An integrated protection system consists of mandatory, preventive, agrotechnical, organizational and economic measures and techniques that must be used taking into account the distribution and number of harmful and beneficial organisms, as well as the general condition of plants.

In conditions of dependence on adverse weather conditions, constant stressful situations, and reduction of negative external influences on the production of environmentally safe products, the need to continuously conduct phytosanitary monitoring of corn crops in order to identify pests and the most dangerous diseases and timely conduct (if necessary) chemical preventive measures with the most effective and approved preparations is justified.

**Keywords:** corn, plant protection, phytosanitary monitoring, pests, diseases, weeds, yield.


## Introduction

Nowadays, the problem of grain production is a priority in the programs of agricultural development of Ukraine. Its solution has an important impact not only on agricultural production, but also on some branches of light and food industry, as well as on the standard of living of the population. In connection with the need for a stable supply of food and feed grain to the state, this problem must be considered from the standpoint of food security as a priority among all problems of the agro-industrial complex (Kabanets V. M. et al., 2023).

Modern research by many scientists has proven that in order to obtain a high yield of corn, it is necessary to pay attention to all components of its growing technology. If, taking into account the growing conditions, agricultural techniques and field potential, the correct selection of corn seed hybrids is made, the recommended plant density is observed, macro- and microelements are introduced during the growing process and preparations are used that allow obtaining the predicted yield and protecting the crop without harming the plant itself – we have a chance to make the most of the genetic potential of a particular corn hybrid and obtain a high yield and estimated profit when growing competitive corn grain. (Barbosa J. Z. et al., 2022; Zakharchenko E. et al., 2024).

Despite the positive trend towards higher productivity of corn compared to other grain and fodder crops, it should be noted that this crop can form stable yields at the level of 6.0-7.0 t/ha. At the same time, the amplitude of fluctuations in corn yield in agricultural enterprises can reach or even exceed 100 %. Such a large variety and variation in the level of corn yield indicates the presence of significant unused reserves of its growth. This is mainly due to the low technological support for corn cultivation. A large amplitude of fluctuations in corn yield is disadvantageous neither to society nor to an individual producer. The level of this indicator largely determines not only the economic condition of livestock farming, but also of the grain industry as a whole (Hungria M. et al., 2022; Mishchenko O. V. et al., 2024).

Among grain crops, corn is the most widely grown crop in Ukraine. According to the results of 2019-2023, its share in the total grain production was almost 50 %, while wheat – 36 %, barley – 11 %. In Ukraine, there is a steady trend towards an increase in the gross production of corn for grain. If until 2000, the yields of this grain did not reach 4 million tons, then from 2011 to the present they have significantly exceeded the 20 million mark. At the same time, 2013 became record-breaking, when the corn harvest reached 30.9 million tons, and 2018, 2019 – with a harvest of this type of grain of over 35 million tons (Radchenko M. V. et al., 2022; Datsko O. et al., 2024).

Sumy region is one of the leading domestic producers of corn. In 2019-2023, the area under grain corn in all categories of farms in the region amounted to 406.7 thousand hectares, and the gross harvest of this type of grain in the balance weight reached almost 3.3 thousand tons. Sumy region ranks fourth in Ukraine in terms of area occupied by grain corn, and fifth in terms of gross production of this type of grain. The region's share in total grain production in Ukraine is 9 %.

In the structure of agricultural crops in Sumy region over the past 5 years, the share of corn for grain has exceeded 34 %. Larger-scale cultivation of this type of grain is observed in agricultural enterprises, which are concentrated in the Forest-Steppe agro-climatic zone (Sumy district – 30.6-37.6 thousand ha and Romensky district 32.3-50.0 thousand ha). The average yield of corn for grain was 8.0-9.1 t/ha.

Existing fluctuations in production volumes do not affect domestic corn consumption in Sumy region and in Ukraine as a whole. For Ukraine, corn is an export-oriented agricultural product. The domestic market demand for food and feed corn is within 20 % of its total production. Therefore, most of the harvest is sold on foreign markets (Kabanets V. M. et al., 2023).

An important element of modern corn growing technologies is an integrated system of crop protection from harmful organisms, the primary focus of which is weed control (Notununu I. et al., 2022).

Corn crops are weedy on 92-98 % of its growing areas. The main reason for this is soil contamination with weed seeds, the average reserves of which in the arable layer exceed 1 billion pcs./ha. The appearance of a particular type of weed is associated with the conditions, beginning and duration of vegetation, features of soil cultivation before sowing and during plant care. The temperature regime of the soil, the level of acidity of the soil solution, etc. are also of great importance for the germination of weed seeds. Depending on the soil and climatic conditions of cultivation, the number of species composition of weeds in corn crops can be represented by 10-19 species, among which the most harmful are monocotyledonous millet (common flatweed, blue mouseweed, green mouseweed, blood-red glove, hemostatic glove, as well as common oat, field foxtail). A significant threat is posed by perennial rhizomatous (creeping wheatgrass) and rhizomatous weeds (pink thistle, yellow field thistle, field birch, creeping bittercreeper) and annual dicotyledons (common primrose, white quinoa, black nightshade, tenacious primrose, odorless chamomile). The harmfulness of weeds in corn crops is extremely high. For With 15 plants per square meter of creeping mustard, the yield is reduced by 80 %, 12 pcs./$m^2$ of ordinary flatbread – by 29 %, and 10 pcs./$m^2$ of ragweed – by 34-41 % (Ahmad I. et al., 2020; Zakharchenko E. et al., 2023a).

Soil compaction is of great agrotechnological importance for reducing weed infestation, especially in the case of moisture deficiency. A characteristic feature of this method is the provoking of weed seed germination, which contributes to their more complete destruction by herbicides or mechanically. The effectiveness of compaction depends on the mass of the rollers and the mechanical composition and moisture of the soil. It should be carried out, as a rule, after sowing or simultaneously with it with ring-spur rollers (the use of other types is not excluded). On soils heavy in mechanical composition and with high moisture of the seed layer, compaction should not be used to prevent the formation of a soil crust and moisture loss (Kalenska S. M. et al., 2018).

**Materials and methods**

When growing corn using herbicide-free technology, after sowing, when annual weeds germinate (thread phase), 1-2 pre-emergence harrowings should be carried out. The working speed of the unit is 5-6 km/h. In the phase of 2-3 and 4-5 leaves in corn, post-emergence harrowing is carried out. The type of harrow is selected depending on the soil compaction and the area being covered, the speed of the unit is 4-4.5 km/h (Skakun V. M. et al., 2022).

During the growing season, if necessary, one or two inter-row cultivations should be carried out together with fertilizing: the first and second in the phase of 3-6 leaves to a depth of up to 8 cm with a gradual decrease in the depth of cultivation with arrow-shaped tines 270 mm wide (220 mm) and razor tines (165 mm), as well as weeding harrows; the last loosening is carried out in the phase of 7-9 leaves to a depth of 4-6 cm with cultivators equipped with arrow-shaped tines and hillers. The speed of the unit during the first inter-row cultivations is 5-6 km/h, and with the latter (with a hiller) – 8-10 km/h. In fields dominated by perennial rhizomatous weeds, the cultivation depth is increased by 2-3 cm (Zakharchenko E. A. et al., 2022).

Preventing the negative impact of weeds in corn crops is possible only by implementing an integrated protection system, an integral element of which is the chemical method (Liu Y. et al., 2022).

**Results and discussion**

Today, there is a wide range of products for reducing weeds in corn crops. These include pre-emergence herbicides (basic) based on the following active ingredients and their combinations: acetochlor, metolachlor, propisochlor, dimethenamid, isoxaflutole, pendimethalin, acetochlor + terbuthylazine, metolachlor + atrazine, metolachlor + terbuthylazine + mesotrione, and others. They are able to protect corn crops from a wide range of annual grass and broadleaf species by effectively controlling both seedlings and weeds that germinate from seeds. The positive aspects of soil herbicide application are low phytotoxicity to the crop, a long application period (before sowing, after sowing, but before the emergence of crop seedlings) and protective action (30-60 days), which makes it possible to ensure the cleanliness of crops during several "waves of weeds" and creates optimal conditions for the growth and development of corn in the initial stages. However, pre-emergence application of herbicides, as a rule, can be used only on soils with a humus content of at least 3-4 %, and their effectiveness largely depends on soil moisture. During drought, they do not work, and during heavy rains on lighter soils, their phytotoxic effect on seedlings and young corn plants may manifest. Pre-emergence herbicides require high-quality soil preparation (soil aggregate diameter no more than 1 cm) and are not used in No-till and Strip-till corn growing

technologies. In addition, depending on the conditions of the growing season, the species composition of weeds can change significantly, which determines the tendency to replace soil herbicides with post-emergence herbicides (Polyvanyi A. et al., 2024).

Post-emergence herbicides (insurance), unlike pre-emergence ones, are able to control perennial rhizome and root-shoot weeds. At the same time, if the structure of the sown areas of large farms contains 20 % or more of corn, it is not possible to ensure effective weed control by applying insurance herbicides at the required times. In addition, the effectiveness of post-emergence preparations largely depends on weather conditions, the phase of development of the crop and weeds, as well as the herbicidal period of competitive relationships in agrocenoses. If these requirements are violated, the effectiveness of chemical weeding decreases, as cereal weeds (blue mouseweed, common flatweed) grow again from the tillering node or corn plants are damaged (Tyagi J. et al., 2023).

The need to use post-emergence herbicides is due to cases where the effectiveness of pre-emergence herbicides has been reduced due to weather conditions or high weediness of the field or when using them before emergence (Vanissa T. T. G. et al., 2020).

When planning a system for protecting corn crops from weeds, it is necessary to take into account the competitiveness of the crop, the phase of development, the dynamics of appearance and species composition of weeds, the type and degree of weediness. Young weeds that are in the phase of active growth are most sensitive to herbicides. For annual cereal species (common flatweed, blue mouseweed) it is 1-4 leaves, for annual dicotyledons – 2-6 leaves. Thistles are most vulnerable in the phase of 6-8 leaves (rosettes), creeping wheatgrass when it reaches a height of 10-15 cm, field birch – when the length of the shoulder blade is up to 15 cm (Xu Y. et al., 2020).

The emergence of the main number of weed seedlings (about 80 % of the total number that appears during the growing season) in corn crops usually begins simultaneously with the emergence of crop seedlings, reaches a maximum in the 3-6 leaf phase and ends in the 8-10 leaf phase of the crop. It is from the 2-3 leaf phase and until the appearance of 8-9 leaves that crop contamination can cause a sharp decrease in yield – up to 40 %. During this period (20-30 day) corn crops must be free of weeds. This effect can be achieved by using pre-emergence preparations, however, in case of complex type of contamination, when the crops simultaneously develop slender-legged, dicotyledonous, perennial weed species, a combination of pre- and post-emergence application of herbicides is effective, such as acetochlor in combination with nicosulfuron, rimsulfuron, aborimsulfuron + thifensulfuron-methyl. In case of contamination with yellow thistle, pink thistle, the most economical is the combined application of acetochlor with preparations of the 2.4-D group and dicamba. Treatment of corn crops in the post-emergence period with the protective herbicides foramsulfuron + iodosulfuron + thiencarbazone-methyl or rimsulfuron + mesotrione against the background of applying acetochlor to the soil ensures clean corn crops from weeds throughout the growing season (Zakharchenko E. et al., 2023b).

An important condition for applying herbicides to corn crops is compliance with the regulations for their use, as well as recommendations from companies producing plant protection products. The main requirements for the use of herbicides are compliance with the norms for the consumption of drugs, application times, the growth and development phase of the crop, taking into account the condition of the crops and weather conditions. The appearance of deformed shoots, disruption of the normal growth and development of both the above-ground part and the root system of corn is a typical sign of toxicity due to the action of pre-emergence herbicides of the chemical group of chloroacetanilides: acetochlor, metolachlor, pendimethalin, dimethenamid.

This is due to herbicide application exceeding the maximum recommended rate, overlapping, or application immediately before corn emergence. Excessive pendimethalin application rate leads to impaired development of the corn root system in the form of shortened roots thickened at the ends. Subsequently, the development of the plant root system is stopped, and as a result, lodging occurs (Ribeiro V. P. et al., 2020; Kabanets V. M. et al., 2023).

The optimal phase of corn plant development for applying post-emergence herbicides is the 3-5 leaf phase. This is due to the peculiarities of organ formation in the process of passing through the stages of organogenesis of corn plants. With reference to the visible morphological changes, which are commonly called phases of growth and development, the panicle in development goes through 9 stages of organogenesis (from the appearance of shoots to full flowering), the ear – 12 (from the formation of the 3rd leaf to physiological ripeness). Violation of the regulations for the use of herbicides at any of these stages can slow down the entire subsequent process of formation of generative organs. Such an impact can be especially noticeable in the early stages of plant development before the formation of the 11th leaf. Thus, by the time the 3rd leaf appears, the formation of nodes, internodes and tiers of the nodal root system occurs. Spraying corn crops with 2.4-D derivatives, dicamba, clopyralid during this period causes a slowdown in the development of the secondary root system. In the future, a complete stop of its development and death may be observed. Corn plants in such crops massively lodge. The period of formation of 3-5 leaves is the most acceptable for the application of preventive herbicides. At this stage, the formation of the vegetative parts of the stem is completely completed. However, at the time of the formation of the fifth leaf, the laying of future ears begins (Soto-Gómez D. et al., 2022).

Exceeding the rates of consumption of post-emergence preparations against the background of

plants being in a state of biotic stress (high or low temperatures, waterlogging of the soil, damage by pests, etc.) can lead to the absence of ears on the plant (plant barrenness) or the formation of additional shoots from one node. The phase of 5-7 leaves is characterized by segmentation of spikelet blades and laying of rows of grains. The use of herbicides from the group of synthetic auxins during this period causes a decrease in the number of rows of grains, twisting of leaves (onion leaf effect). In the phase of 7-9 leaves, rudimentation of the ovary occurs, the formation of pollen grains in the anthers, and the number of grains in the row is laid in the ear (Zakharchenko E. A. et al., 2022).

The application of herbicides derived from 2.4-D and ALS inhibitors in violation of the requirements for their use causes leaf curling, excessive tillering, a decrease in the degree of graininess of the ears (the number of rows of grains) and the phenomenon of gynandromorphism (the formation of a cob on a panicle).

The optimal temperature for spraying corn crops with herbicides is from +12 to +25°C. When using sulfonylurea herbicides and their combinations rimsulfuron, prosulfuron, thifensulfuron-methyl, foramsulfuron, iodosulfuron-methyl sodium, as well as hormonal preparations of 2.4-D and dicamba derivatives, when corn plants are under stress, yellow or white spots appear, and leaves are deformed. Sometimes, when applying foramsulfuron, iodosulfuron-methyl sodium, thiencarbazone-methyl on the eve or during a decrease in temperature (+5°C), anthocyanin coloration of corn leaves appears, which usually disappears after the appearance of the sixth leaf and does not affect corn productivity (Synytsia O. M. et al., 2023).

The strategy for protecting corn from weeds should be based on the biological characteristics of hybrids and weeds, the species composition of weeds, their number and dynamics of appearance. Given the low competitiveness of corn against weeds in the early stages of growth and development, the mixed type of weed infestation and its large sown areas, the combination of pre- and post-emergence application of herbicides remains the most effective. Only post-emergence application does not always provide the desired result, and violation of the regulations for the use of herbicides and recommendations of manufacturer companies causes toxicosis of cultivated plants and a decrease in productivity (Hryhoriv Y. et al., 2023).

An integrated protection system consists of mandatory, preventive, agrotechnological, organizational and economic measures and techniques that must be used taking into account the distribution and abundance of harmful and beneficial organisms, as well as the general condition of plants (Renoud S. et al., 2022).

In this case, the correct placement of crops in crop rotation is important. Sowing corn after corn, especially when it is grown in the same place for several years in a row, leads to an increase in the incidence of plants with flying soot, root and stem rot; to a lesser extent - with solid soot, contributes to an increase in the number of corn moth. In order to avoid harmful effects, the accumulation of pathogens in the soil, it is advisable to alternate it with other crops. It should be noted that winter wheat and barley, as a precursor of the crop, provoke the beginnings of fungi - pathogens, which leads to their death, including - to the purification of the soil from infection. At the same time, with a large amount of flying soot, peas, as a precursor, are inappropriate due to the preservative effect of its root secretions in relation to chlamydospores, which are in the soil at rest (Mishchenko O. V. et al., 2024).

Phosphorus and potassium fertilizers increase the resistance of plants to diseases and pests both in crop rotation and in permanent crops. Nitrogen fertilizers (in moderate doses) also help reduce the incidence of diseases in plants, but the degree of their effect depends on the form of fertilizer. In the fight against fly ash, root and stem rot, it is more rational to apply nitrogen in nitrate form, and if there is a threat of mold development in germinating seeds and seedlings, the use of nitrogen fertilizers should be limited or used in ammonium form (Govenko R. V. et al., 2022).

In the fight against pests and diseases, basic tillage is of great importance. With deep autumn plowing, the number of corn (stem) and meadow butterflies decreases, and pathogens of sooty mold, root and stem rots die. In the basic tillage system, agrotechnical measures are supplemented by chemical ones.

High-quality seed preparation for sowing is one of the conditions for obtaining a high corn yield. Currently, the main amount of corn seed is processed at corn factories. In cases where seeds prepared outside the factory are used for sowing, farms must treat the seeds. When storing corn, the grain moisture should not exceed 14 %.

When corn borer appears in crops (18-20 % of plants with egg laying), insecticides are used, or Trichogramma is released (70-100 thousand specimens per 1 ha). The deadline for the last treatment of crops with insecticide is 20 days before harvesting (no later).

The pathogens of almost all diseases and partly the populations of the corn borer overwinter in post-harvest corn residues. Therefore, low cutting of plants during harvesting, removal of post-harvest residues from the field, combined with tillage with heavy disk harrows and deep fallow plowing in the winter, significantly reduce the degree of infection of future crops with diseases and pests (Chen L. et al., 2021; Zakharchenko E. et al., 2023b).

Early corn crops suffer more from mold, root and stem rot, wireworm and false wireworm, Swedish fly, bearfly, tailor's knot; late crops suffer more from sooty mold diseases, helminthiasis and nigrosporiasis. If the harvest is delayed, especially in years with rainy autumn, the infection of the cobs with nigrosporiasis and mold increases, and losses from pests increase (Govenko R. V. et al., 2022).

**Conclusions**

The analysis and synthesis of literature sources presented in this paper substantiate that achieving high and stable maize yields in Ukraine's modern agricultural landscape is possible only through the implementation of a comprehensive plant protection system. The most effective approach is not the unilateral use of chemical agents, but rather their harmonious integration with essential agrotechnical, organizational, and preventive measures. This research clearly demonstrates that constant phytosanitary monitoring is a key element, enabling the timely detection of harmful organisms and the implementation of informed decisions. It was proven that violating herbicide application regulations can lead to phytotoxicity, plant deformities, and significant yield losses. Consequently, the management of weeds, pests, and diseases must be based on a deep understanding of the biological characteristics of both the hybrids and the harmful organisms. Furthermore, adherence to proper crop rotation, quality tillage, and timely seed preparation is crucial. Only by integrating all these protective elements is it possible to fully realize the genetic potential of the crop and ensure a stable, environmentally safe, and economically viable maize harvest.

**References**

Ahmad I., Jiménez-Gasco M. D. M., Luthe D. S., Shakeel S. N., Barbercheck M. E. Endophytic Metarhizium robertsii promotes maize growth, suppresses insect growth, and alters plant defense gene expression. *Biological Control*. 2020. Vol. 144. P. 104167. https://doi.org/10.1016/j.biocontrol.2019.104167

Barbosa J. Z., Roberto L. D. A., Hungria M., Corrêa R. S., Magri E., Correia T. D. Meta-analysis of maize responses to *Azospirillum brasilense* inoculation in Brazil: Benefits and lessons to improve inoculation efficiency. *Applied Soil Ecology*. 2022. Vol. *170*, 104276. https://doi.org/10.1016/j.apsoil.2021.104276

Chen L., Li K., Shang J., Wu Y., Chen T., Wanyan Y., Wang E., Tian C., Chen W., Chen W., Mi G., Sui X. Plant growth–promoting bacteria improve maize growth through reshaping the rhizobacterial community in low-nitrogen and low-phosphorus soil. *Biology and Fertility of Soils*. 2021. Vol. 57. № 8. P. 1075–1088. https://doi.org/10.1007/s00374-021-01598-6

Datsko O., Kovalenko V., Yatsenko V., Sakhoshko M., Hotvianska A., Solohub I., Horshchar V., Dubovyk I., Kriuchko L., Tkachenko R. Increasing soils fertility as a factor in the sustainability of agriculture and resilience to climate change. *Modern Phytomorphology*. 2024. Vol. 18. P. 110–113.

Govenko R. V., Antal T. V. Corn productivity depending on the type of nitrogen fertilizers, foliar feeding and weather conditions. *Agrarian Innovations*. 2022. №. 15. P. 22–29.

Hryhoriv Y., Butenko A., Masyk I., Onychko T., Davydenko G., Bondarieva L., Hotvianska A., Horbunova K., Yevtushenko Y., Mykola V. Growth and Development of Sweet Corn Plants in the Agro–Ecological Conditions of the Western Region of Ukraine. *Ecological Engineering & Environmental Technology*. 2023. Vol. 24(4). P. 216–222.

Hungria M., Barbosa J. Z., Rondina A. B. L., Nogueira M. A. Improving maize sustainability with partial replacement of N fertilizers by inoculation with *Azospirillum brasilense*. *Agronomy Journal*. 2022. Vol. 114(5). P. 2969–2980. https:// doi.org/10.1002/agj2.21150

Kabanets V. M., Sobko M. G. Scientific and practical recommendations for growing agricultural crops in the conditions of the Sumy region in the post-war period. *Sad: Institute of Agriculture of the North East*. 2023. 160 p.

Kalenska S. M., Taran V. G. Yield index of corn hybrids depending on plant density, fertilizer rates and weather conditions of cultivation. *Plant Varieties Studying and protection*. 2018. Vol. 14(4). P. 141–149.

Liu Y., Yang Y., Wang B. Entomopathogenic fungi *Beauveria bassiana* and *Metarhizium anisopliae* play roles of maize (*Zea mays*) growth promoter. *Scientific Reports*. 2022. Vol. 12. № 1. P. 15706. https://doi.org/10.1038/s41598-022-19899-7

Mishchenko O. V., Gangur V. V., Danilenko E. V. Formation of productivity of corn hybrids depending on plant density in the conditions of the Left-Bank Forest-Steppe. *Scientific Progress & Innovations*. 2024. № 27(2). P. 16–21. https://doi.org/10.31210/ spi2024.27.02.03.

Notununu I., Moleleki L., Roopnarain A., Adeleke R. Effects of plant growthpromoting rhizobacteria on the molecular responses of maize under drought and heat stresses: A review. *Pedosphere*. 2022. Vol. 32. № 1. P. 90–106. https://doi.org/10.1016/ S1002-0160(21)60051-6

Polyvanyi A., Butenko A., Mikulina M., Zubko, V., Kharchenko S., Dubovyk V., Dubovyk O., Sarzhanov B. Genotype prediction in maize (*Zea mays* L.) progeny using different predictive models. *Agronomy Research*. 2024. Vol. 22. https:// doi.org/10.15159/AR.24.063

Radchenko M. V., Trotsenko V. I., Butenko A. O., Masyk I. M., Hlupak Z. I., Pshychenko O. I., Terokhina N. O., Rozhko V. M., Karpenko O. Y. Adaptation of various maize hybrids when grown for biomass. *Agronomy Research*. 2022. Vol. 20. № 2. P. 404-413. https://doi.org/10.15159/AR.22.028

Renoud S., Abrouk D., Prigent-Combaret C., Wisniewski-Dyé F., Legendre L., Moënne-Loccoz Y., Muller D. Effect of Inoculation Level on the Impact of the PGPR *Azospirillum lipoferum* CRT1 on Selected Microbial Functional Groups in the Rhizosphere of Field Maize. *Microorganisms*. 2022. Vol. 10. № 2. P. 325. https:// doi.org/10.3390/microorganisms10020325

Ribeiro V. P., Gomes E. A., De Sousa S. M., De Paula Lana U. G., Coelho A. M., Marriel I. E., De Oliveira-Paiva C. A. Co-inoculation with tropical strains of Azospirillum and Bacillus is more efficient

than single inoculation for improving plant growth and nutrient uptake in maize. *Archives of Microbiology*. 2022. Vol. 204. № 2. P. 143. https://doi.org/10.1007/s00203-022-02759-3

Skakun V. M., Marchenko T. Yu. Yield structure of corn hybrids depending on the elements of agricultural technology. *Agrarian innovations*. 2022. № 16. P. 135–142.

Soto-Gómez D., Pérez-Rodríguez P. Sustainable agriculture through perennial grains: Wheat, rice, maize, and other species. A review. *Agriculture, Ecosystems & Environment*. 2022. Vol. 325. P. 107747. https://doi.org/10.1016/j.agee.2021.107747

Synytsia O. M., Onychko V. I., Pyrih O. V. Destruction of corn plant residues by the action of microbial preparations in the conditions of the North-Eastern Forest-Steppe of Ukraine. *Bulletin of the Sumy National Agrarian University. Series: Agronomy and Biology*. 2023. № 53(3). P. 79–84. https://doi.org/10.32782/ agrobio.2023.3.11

Tyagi J., Mishra A., Kumari S., Singh S., Agarwal H., Pudake R. N., Varma A., Joshi N. C. Deploying a microbial consortium of Serendipita indica, Rhizophagus intraradices, and Azotobacter chroococcum to boost drought tolerance in maize. *Environmental and Experimental Botany*. 2023. Vol. 206. P. 105-142. https:// doi.org/10.1016/j.envexpbot.2022.105142

Vanissa T. T. G., Berger B., Patz S., Becker M., Turečková V., Novák O., Tarkowská D., Henri F., Ruppel S. The Response of Maize to Inoculation with *Arthrobacter sp*. And *Bacillus sp*. In Phosphorus-Deficient, Salinity-Affected Soil. *Microorganisms*. 2020. Vol. 8. № 7. P. 1005. https://doi.org/10.3390/microorganisms8071005

Xu Y., Zhang J., Shao J., Feng H., Zhang R., Shen Q. Extracellular proteins of Trichoderma guizhouense elicit an immune response in maize (*Zea mays*) plants. *Plant and Soil*. 2020. Vol. 449. № 1–2. P. 133–149. https://doi.org/10.1007/ s11104-020-04435-1

Zakharchenko E. A., Petrenko S. V., Berdin S. I., Podhaietskyi A. A., Kravchenko N. V., Hnitetskyi M. O., Hlupak Z. I., Bordun R. M., Tiutiunnyk O. S., Tryus V. O. Response of maize plants to seeding rates under conditions of typical black soil. *Modern Phytomorphology*. 2023. Vol. 17. P. 71–74. https://doi.org/10.5281/ ZENODO.7966139

Zakharchenko E., Datsko O., Butenko S., Mishchenko Y., Bakumenko O., Prasol V., Dudka A., Tymchuk N., Leshchenko D., Novikova A. The Influence of Organic Growing of Maize Hybrids on the Formation of Leaf Surface Area and Chlorophyl Concentration. *Journal of Ecological Engineering*. 2024. Vol. 25. № 5. P. 156–164. https://doi.org/10.12911/22998993/186162

Zakharchenko E., Datsko O., Mishchenko Y., Melnyk A., Kriuchko L., Rieznik S., Hotvianska A. Efficiency of biofertilizers when growing corn for grain. *Modern Phytomorphology*. 2023. Vol. 17. P. 50–56. https://doi.org/10.5281/ ZENODO.7966053

## ОБҐРУНТУВАННЯ ЕКОЛОГІЧНО-ОРІЄНТОВАНИХ СПОСОБІВ ЗАХИСТУ РОСЛИН КУКУРУДЗИ ВІД ШКІДНИКІВ ТА ПАТОГЕНІВ

Олександр БЕЗКРОВНИЙ, ORCID: 0009-0003-8307-1970
Сумський національний аграрний університет

Серед зернових культур в Україні ключова роль належить вирощуванню кукурудзи. За підсумками останніх років її частка в загальних обсягах виробництва зерна становить майже 50 %. Спостерігається стала тенденція до збільшення валового виробництва кукурудзи на зерно. Сучасними дослідженнями багатьох науковців доведено, що для отримання високого урожаю кукурудзи, необхідно звертати увагу на всі складники технології її вирощування. Наведений у статті огляд джерел літератури засвідчує важливість елементів сучасних технологій вирощування кукурудзи, зокрема системи захисту посівів від шкідливих організмів. Інтегрована система захисту складається з обов'язкових, профілактичних, агротехнічних, організаційно-господарських заходів та прийомів, які необхідно використовувати з урахуванням розповсюдження і чисельності шкідливих і корисних організмів, а також загального стану рослин.

В умовах залежності від несприятливих погодних умов, постійних стресових ситуацій та зниження негативного зовнішнього впливу на виробництво екологічно безпечної продукції обгрунтована необхідність безперервно проводити фітосанітарний моніторинг посівів кукурудзи з метою виявлення шкідників та найбільш небезпечних хвороб і своєчасного проведення (при потребі) хімічних профілактичних заходів найбільш ефективними та дозволеними до використання препаратами.

**Ключові слова:** кукурудза, захист рослин, фітосанітарний моніторинг, шкідники, хвороби, бур'яни, урожайність.



Отримано: 14.5.2025
Погоджено до друку: 28.10.2025
Опубліковано: 30.12.2025