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THE MAIN MECHANISMS OF ENVIRONMENTALIZATION OF THE AGRICULTURAL PRODUCTION

Havryliuk L.
Doctor of Philosophy in Biological Sciences
Institute of Agroecology and Environmental Management of NAAS (Kyiv, Ukraine)
e-mail: gavriluklilia410@gmail.com; ORCID: https://orcid.org/0000-0001-6 901-0766

Beznosko I.
Candidate of Biological Sciences
Institute of Agroecology and Environmental Management of NAAS (Kyiv, Ukraine)
e-mail: beznoscoirina@gmail.com; ORCID: https://orcid.org/0000-0002-2217-5165

Kichigina O.
Candidate of Agricultural Sciences, Senior Researcher
Institute of Agroecology and Environmental Management of NAAS (Kyiv, Ukraine)
e-mail: ol _ ki@ukr.net; ORCID: https://orcid.org/0000-0003-0879-627X

Solving the issues of environmentalization of agricultural production is an extremely important task in a scientific and applied sense, namely: providing the population with food, preventing crop losses from harmful objects, and protecting the environment from excessive chemical loading. Accordingly, an alternative solution in overcoming the negative consequences of chemicalization of agricultural production and improving the quality of seed products is the use of environmentally safe plant protection measures. An important component of technologies for growing various crops is their protection against phytopathogenic microorganisms. After all, in the agrocenoses of agricultural crops, there is an accumulation of an infectious background of phytopathogenic micromycetes, among which species of the genera Penicillium, Aspergillus, Alternaria, and Fusarium predominate, which can cause outbreaks of many plant diseases (root rot, Alternaria, Fusarium, Phytophthora, Anthracnose, Cercosporosis). Phytotoxic metabolites of necrotrophic phytopathogenic fungi, which are able to accumulate in soil, seeds and plant residues, deserve special attention. Mycotoxins lead to a decrease in the yield and quality of grain, as well as the quality of food products, which negatively affects their ecological safety, and can cause poisoning of humans and animals.

Keywords: *microorganisms, phytopathogens, diseases, plant protection, bacteria, saprophytic fungi, agroecosystem.*

INTRODUCTION

The use of biological preparations based on beneficial microorganisms is an important component of modern agriculture. They serve as a preventive measure against a number of fungal diseases of agricultural crops, optimize plant nutrition, stimulate their development and contribute to increased productivity. Treatment of seeds with biological preparations leads to disinfection of seed material and protection of young plants from various infections.

Therefore, **the goal of the work** was to describe the most useful microorganisms that are part of biological preparations that effectively affect the processes of functioning of agroecosystems.

ANALYSIS OF LATEST RESEARCH AND PUBLICATIONS

The vast majority of researchers suggest using chemicals of chemical origin to disinfect plant seeds and protect them from soil infection [1]. However, they have a number of significant drawbacks: the use of high consumption rates of fungicides, especially of inorganic nature and their phytotoxic effect, which has negative consequences for the agroecosystem and the environment; under their influence, new races and strains of pathogens are formed, which are more virulent and resistant to the action of fungicides; development of resistance of pathogens of crop diseases [2]. At that time, the components of biological technologies of plant cultivation have a positive effect on the rhizosphere, vegetative organs of plants and seeds, causing the dominance of saprophytic species of micromycetes in agrocenoses. Therefore, the development of antifungal plant protection agents is important for understanding the mechanism of resistance to fungicides and the biological factors that cause the resistance of mycelial fungi [2].

According to scientists Retman S. [3] and Tkalenko S. [4], the use of biological preparations is the basis of a strategic ecological and biological control measure of harmful organisms in agricultural crops under organic cultivation. The practical interest in biological preparations is due not only to their effectiveness, but also to the fact that they are created on the basis of microorganisms isolated from natural biocenoses that do not pollute the environment [5]. The use of biological preparations prevents the development of a number of fungal diseases of agricultural crops, optimizes plant nutrition, stimulates their development and contributes to increased productivity [6]. Accordingly, an alternative solution in overcoming the negative consequences of chemicalization of agricultural production and improving the quality of seed products is the use of environmentally safe plant protection measures (microbiological control of phytopathogens) [7].

Domaratskyi E. and Dobrovolskyi A. studied the mechanisms of the influence of biological preparations on agricultural crops for the purpose of their further use, as mixed preparations capable of showing synergy during their joint use [8]. Thus, the combined drugs simultaneously block both biosynthesis and the realization of the phytohormonal effect of hybrids and varieties of agricultural crops. In addition, the intensive increase in the number of fungicide mixtures is explained by the fact that the combination of several active substances belonging to different classes of biofungicides expands the spectrum of their effects, improves the protective effect and prevents the formation of resistant strains, i.e., the possibilities of synergy are fully used [8].

MATERIALS AND RESEARCH METHODS

An information-analytical method was used to analyze the database of the State Register of Pesticides and Agrochemicals approved for use in Ukraine (Ministry of Environmental Protection and Natural Resources of Ukraine).

RESULTS AND THEIR DISCUSSION

During the last decade, the direction of using plant growth stimulants and fungicides of biological origin in the technology of growing agricultural crops began to develop rapidly in Ukraine [9]. Therefore, the number of drugs of biological origin that are approved for use in Ukraine and included in the "List of pesticides and agrochemicals approved for use in Ukraine" is increasing every year. So, if in 2014 the number of biological drugs included in the "List..." was 97 names of biological means of protection, then in 2018 this number increased to 145, and currently this list contains 153 biological drugs [10].

According to the mechanism of action and their composition, such drugs are divided into stimulators of growth processes, biological preparations, microfertilizers (chelates) and complex multifunctional substances [11]. The composition of a number of biofungicides includes biologically active substances from plant sprouts — a balanced set of starting doses of the main micro- and macroelements, flavonoid substances and active fractions of coniferous extract. As a rule, they are used to treat the seeds of agricultural crops before sowing. Under these circumstances, there is an active process of formation and development of plant crops from seedlings to harvesting, anticipatory growth of plants and activity of the tillering process. Their use helps to increase the biological activity of the soil. Currently, fertilizer systems have been developed for the latest farming systems, in particular for organic farming using microbial preparations, and fermentation complexes for the production of these preparations have been created [12].

One of the promising and modern directions in the use of drugs of biological origin is the creation of complex (combined) drugs that combine in their formulation plant stimulators and restregulators, trace elements and anti-stressors, complexes of free amino acids, as well as antagonistic fungi and products of their metabolism. The use of combined re-regulating drugs is part of the system of mandatory agrotechnical methods for growing agricultural crops and caring for crops and does not require additional costs. Therefore, their use contributes not only to an increase in the gross production of plant products, but also to a decrease in its cost price, which is important under market conditions [11].

The use of biofungicides is primarily aimed at controlling plant diseases and reducing their harmful effects. Seed treatment leads to disinfection of seed material and protection of young plants from various infections [2].

Top arguments for ecological cultivation are highlighted: protection of soil resources (activation of humus formation processes, increase of biomass volume, stimulation of the activity of soil biota, reduction of soil erosion), protection of water resources (reduction of nitrates entering soil and surface water, protection of biodiversity of agricultural animal species and plants) [6].

One of the key tasks of modern agriculture is obtaining high yields of agricultural crops with better quality. However, even now, the use of chemical plant protection agents to combat various diseases is an integral part of the intensive cultivation technology. It is known that with long-

term systematic use of any drug, its effectiveness begins to decrease due to the development of resistance to the main pathogens of plant diseases, which leads to an increase in the range of these drugs [2].

But the current state of the ecosystem requires the latest technologies to protect plants from diseases based on environmentally safe methods. The use of biological fungicides is optimal in solving this issue [12]. Thus, the effect of biological preparations is based on the regulation of biotic relationships in agrocenosis, which makes it possible to solve the issue of ensuring balanced nutrition of plants, their resistance to phytopathogenic micromycetes, the formation of competitive relationships with indigenous microorganisms and the induction of natural systemic resistance [2].

Microbial preparations based on strains from various physiological groups of microorganisms are widely used to protect plants from diseases. It has been established that phylogenetically different microorganisms can be antagonists of phytopathogens [13]. Antagonist microorganisms are used to improve the soil and protect plants from harmful microflora. The growth and development of phytopathogenic microorganisms can be restrained by treating seeds before sowing with a biological preparation based on antagonistic microorganisms. The biological method of plant protection includes three main groups of measures: preservation and enrichment of natural populations of entomophages and microorganisms useful for plant protection in agrocenoses; releasing entomophages bred in laboratory conditions into the fields; use of pathogenic organisms and products of their vital activity. Each of the measures of the biological method has its own specificity and shows its effectiveness under certain conditions. Biological control of plant pathogens is based on the use of such relationships between organisms as antagonism, competition, and hyperparasitism. Mushrooms have gained the widest practical use among antagonists. The main studies in the field of microbial allelopathy were conducted with micromycetes and bacteria. On the basis of fungi of the genera: *Candida*, *Ampelomyces*, *Trichoderma*, *Coniothyrium* and bacteria of the genera: *Agrobacterium*, *Bacillus*, *Pseudomonas*, *Streptomyces*, commercial biological preparations have been created to protect agricultural crops from pathogens [14].

One of the promising microbial agents for protecting plants from phytopathogens is bacteria of the genus *Pseudomonas* [14]. Fluorescent pseudomonads are able to suppress the development of fungi of the genus *Fusarium* (the causative agent of plant wilt). It was shown that the bacteria *Pseudomonas aureofaciens* and *P. putida* were characterized by high antagonistic activity against the causative agents of septoriosis and fusarium head of wheat. In the scientific works of V. Kuptsova, to protect leguminous crops from phytopathogenic micromycetes, it is recommended to use the bacterium *P. aurantiaca* S-1, which actively suppresses the growth of phytopathogens — the causative agents of soybean and lupine anthracnose (*Colletotrichum lupini*); fusarium (*Fusarium* sp.); gray rot (*Botrytis cinerea*); bacterial spotting (*Pseudomonas syringae*). The conducted studies showed the phytoprotective effect of this strain against anthracnose and fusarium of lupine (90–100%), gray rot (60%), soybean bacteriosis (63%) [14].

Scientists investigated the effectiveness of the *Bacillus subtilis* 26D strain, which reduced the spread of root rot by 1.8 times, the development of the disease by 4.7 times, and contributed to an increase in the above-ground mass of plants by 55.5% [15]. *Bacillus subtilis* bacteria are effective against phytopathogens belonging to the genera *Fusarium*, *Rhizoctonia*, *Botrytis*, *Pythium*, *Verticillium*, *Phytophtora*, *Ascohyta*. The antagonistic effect of bacteria of the genus Bacillus on phytopathogenic fungi is due to the ability of bacilli to produce various antibiotics: bacillisin, mycobacillin, polymyxin, surfactin, lichenisin, mycosubtilin, iturin, etc. These substances can disrupt the structure of the cell wall and cause other membranotropic effects that harm phytopathogenic micromycetes. However, despite the effectiveness of using antagonistic substances in agroecosystems to protect plants from phytopathogenic micromycetes, their use can be problematic. This is due to the ability of these substances to induce resistance of phytopathogens to these compounds, as well as the possibility of their negative impact on the quality of food products and human health [16].

It has been established that biological control of phytopathogens in agroecosystems occurs under the influence of certain types of micromycetes. Thus, saprophytic fungi of the genus *Trichoderma*, which affect phytopathogenic micromycetes found in the rhizosphere of plants, produce hydrolytic enzymes and antibiotics [17]. These fungi can parasitize a number of phytopathogens. Fungi of the genus *Trichoderma* can cause various effects on plants: stimulate growth, induce their resistance to phytopathogens, compete for nutrient substrates, and also be parasites of phytopathogenic fungi. Some strains of micromycetes of the genus Trichoderma became the basis for the production of commercial drugs. Micromycetes of the genus *Verticillium* Nees show hyperparasitic activity in relation to the phytopathogen *Rhizoctonia solani*.

Gliocladium catenulatum fungi are hyperparasites of phytopathogens of the genera *Sclerotinia* and *Fusarium*. During the contact of these fungi, hyphae of the hyperparasite disintegrate the walls of the phytopathogen. The species *Stachybotrys elegans*, *Penicillium*, *Ampelomyces*, *Fusarium* are also capable of suppressing phytopathogenic fungi and mycoparasitism. Thus, the functioning of phytopathogen antagonist microorganisms in the soil is an important factor in preventing the spread of diseases of agricultural crops [17].

Another direction in modern agroecology is the development of environmentally safe ways to increase the productivity of cultivated plants and protect them from the influence of adverse environmental factors, namely the use of the potential of endophytic bacteria. They can increase the immunological status and participate in the protection of plants from diseases caused by phytopathogens, from the harmful effects of heavy metals and radionuclides, and help plants adapt to adverse environmental conditions, as well as improve plant growth and development by supplying them with nutrients [18].

There are at least 220 species of endophytic bacteria belonging to 71 genera [18]. They are found both in the root and in the aerial parts of plants (flowers, seeds). Scientists have researched that the processes that take place inside plants are directly related to such processes in the life of plants as phytoimmunity, regulation of growth and development, and adaptation to changing living conditions [20]. For example, leguminous plants are distinguished by the fact that both rhizobial and endophytic microorganisms play a role in their physiological state, which support their adaptive capabilities. [19]. Endophytic bacteria are able to protect plants from diseases, fix nitrogen, synthesize and catabolize plant growth regulators, and have antagonistic activity against nematodes. Endophytic bacteria in a relationship with leguminous plants, thanks to the process of symbiotic nitrogen fixation, make a significant contribution to maintaining the nitrogen balance in agrocenoses. Not only nodule-forming, but also various endophytic bacteria typical for the rhizosphere can inhabit nodules [20].

Biologically active metabolites are synthesized by endophytic bacteria, which are characterized by an antimicrobial effect on phytopathogens or are inducers of systemic plant resistance, thereby preventing the development of their diseases [21]. Therefore, today's urgent issues are conducting research on the study of evolutionary, genetic and physiological aspects of the interaction of endomycorrhizal fungi and legume-rhizobial symbiosis, physiological mechanisms of the interaction of pathogenetic and endophytic systems. And the use of endophytic bacteria for the production of biological preparations aimed at increasing the resistance and productivity of plants is one of the factors of increasing biosecurity in agroceroses.

CONCLUSION

An important component of crop cultivation technologies is their protection from phytopathogenic micromycetes using environmentally safe plant protection measures, namely beneficial microorganisms included in biological preparations, the use of which will effectively affect the functioning of agroecosystems.

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ОСНОВНІ МЕХАНІЗМИ ЕКОЛОГІЗАЦІЇ СІЛЬСЬКОГОСПОДАРСЬКОГО ВИРОБНИЦТВА

Л.В. Гаврилюк
доктор філософії в галузі біології
Інститут агроекології і природокористування НААН (м. Київ, Україна)
e-mail: 410agroeco@gmail.com;
ORCID: https://orcid.org/0000-0001-6901-0766

І.В. Безноско
кандидат біологічних наук
Інститут агроекології і природокористування НААН (м. Київ, Україна)
e-mail: beznoskoirina@gmail.com;
ORCID: https://orcid.org/0000-0002-2217-5165

О.О. Кічігіна
кандидат сільськогосподарських наук, старший дослідник
Інститут агроекології і природокористування НААН (м. Київ, Україна)
e-mail: ol_ki@ukr.net;
ORCID: https://orcid.org/0000-0003-0879-627X

Надзвичайно важливою в науково-прикладному напрямі є проблема екологізації сільськогосподарського виробництва, основним завданням якої є забезпечення населення продуктами харчування, запобігання втратам врожаю від шкідливих об'єктів, захист навколишнього середовища від надмірного хімічного навантаження. Відповідно, альтернативним рішенням у подоланні негативних наслідків хімізації сільськогосподарського виробництва та покращенні якості насінницької продукції є застосування екологічно безпечних заходів захисту рослин. Важливою складовою технологій вирощування різних сільськогосподарських культур є захист від фітопатогенних мікроорганізмів. Адже в агроценозах сої відбувається накопичення інфекційного фону фітопатогенних мікроміцетів, серед яких переважають види родів Penicillium, Aspergillus, Alternaria, Fusarium, які можуть спричиняти спалахи багатьох хвороб рослин (кореневі гнилі, альтернаріоз, фузаріоз, фітофтороз, антракноз, церкоспороз). Особливої уваги заслуговують фітотоксичні метаболіти некротрофних фітопатогенних грибів, які здатні накопичуватися в ґрунті, насінні та рослинних рештках. Адже мікотоксини призводять до зниження врожайності та якості зерна, а також якості харчових продуктів, що негативно впливає на їх екологічну безпеку, а це може спричинити отруєння людей і тварин. Застосування біофунгіцидів спрямоване на боротьбу з хворобами та зменшення їх шкідливої дії. Протруювання насіння призводить до знезараження насіннєвого матеріалу й захисту молодих рослин від різних інфекцій. Тому актуальним є використання корисних мікроорганізмів, що входять до складу біопрепаратів, які ефективно впливають на процеси функціонування агроекосистем.

Ключові слова: *мікроорганізми, фітопатогени, хвороби, захист рослин, бактерії, сапрофітні гриби, агроекосистема.*

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ВІДОМОСТІ ПРО АВТОРІВ

Гаврилюк Лілія В'ячеславівна, доктор філософії в галузі біології, Інститут агроекології і природокористування НААН (вул. Метрологічна, 12, м. Київ, Україна, 03143; e-mail: gavriluklilia410@gmail.com; ORCID: https://orcid.org/0000-0001-6901-0766)

Безноско Ірина Володимирівна, кандидат біологічних наук, Інститут агроекології і природокористування НААН (вул. Метрологічна, 12, м. Київ, 03143, Україна; e-mail: beznoskoirina@gmail.com; ORCID: https://orcid.org/0000-0002-2217-5165)

Кічігіна Ольга Олександрівна, кандидат сільськогосподарських наук, старший дослідник, завідувач Незалежної лабораторії екології насінництва, Інститут агроекології і природокористування НААН (вул. Метрологічна, 12, м. Київ, Україна, 03143; e-mail: ol_ki@ukr.net; ORCID: https://orcid.org/0000-0003-0879-627X)

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На одеському узбережжі спостерігається опріснення моря та велике завищення показників по вмісту заліза. Через теракт на Каховській ГЕС спостерігається значне забруднення узбережжя Чорного моря в Одесі. Як повідомила Державна екологічна інспекція Південно-Західного округу, 10 червня фахівцями інспекції відібрані проби морської води в Одесі у Новій Дофінівці (причал 243), на пляжі «Ланжерон» та на 16 ст. Великого Фонтану. «За результатами лабораторних досліджень виявлено перевищення. Нова Дофінівка в 1,6 раза перевищено вміст завислих речовин та загального заліза — в 9 разів. На «Ланжероні» залізо завищено в 5,2 раза, на Великому Фонтані – в 3,4 раза, а завислих речовини — в 1,1 раза», — розповіли в інспекції.