THE ACADEMY OF MANAGEMENT
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ECOLOGIZATION SYSTEMS FOR PROTECTION OF CULTURAL PLANTS

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Ivan Grygoryuk, Victor Teslyuk, Raisa Kovbasenko, Vasyl Kovbasenko,
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ECOLOGIZATION SYSTEMS FOR PROTECTION OF CULTURAL PLANTS

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TABLE OF CONTENTS

LIST OF ABBREVIATIONS

AA - abscisic acid

AMPA - aminomethylphosphoric acid

AP - anionic peroxidase

AT - adenosine triphosphate

ROS - reactive oxygen species

AC - acetylglyphosate

BAP - benzylaminopurine

BAS - biologically active substances

BSAU - Belarusian State Agrarian University

HA - humic acids

HC - hexachlorane

DNM – dichlorodiphe nyltrichloromethyl methane

DA - deoxyribonucleic acid

EAM is an environmentally adequate method

Computers - electronic computers

JA - jasmonic acid

IAA - indolyl-3-acetic acid

RF - release factor

PPC - possible permissible concentration

MPPP - microbiological plant protection products

MA - methylphosphoric acid

PHA - poly-hydroxybutyric acid$\beta -$

PCR - polymerase chain reaction

LP - lipid peroxidation

RA - ribonucleic acid

PGR - plant growth regulators

DD - the development of the disease

SA - salicylic acid

TE - technical efficiency

TMTD - tetramethylthiuram disulfide

PML - phenylalanine myoclease

FCR- formulations with controlled release

2,4-D-2,4-dichlorophenoxyacetic acid

PREFACE

Currently, agricultural science and agricultural production are going through a difficult period of development. Large-scale and intensive change of the biosphere poses responsible and interconnected tasks, the solution of which depends on the successful overcoming of regional and global problems facing humanity. In particular, the lack of food, reduction of natural resources of the biosphere and environmental pollution due to the intensification of agricultural production [Novikova, 2005].

Intensive development of industrial and agricultural production and active use of chemical protection in various sectors of the economy causes an increase in the volume and quality of crop products, but at the same time stimulates the emergence of a significant number of chemical compounds that pollute the biosphere and adversely affect health. I'm people. One of the global environmental problems arising from human agricultural activities is the harmful effects on the environment and human health of pesticides - chemicals needed to control pests and pathogens in agricultural production and other sectors of the economy (forestry, sanitary and epidemiological surveillance, etc.). As pesticides, use a significant number of chemical compounds

Most of them are synthesized for a specific purpose by organic compounds that act as typical xenobiotics (xenos - alien, biotos - life; Greek) under the conditions of entry into ecosystems. Annually, about 2 million tons of pesticides are used in the world [Shabayev, 2004], which are used in agriculture, by applying directly to agrophytocenoses to achieve economic goals. Local use of pesticides as a source of environmental pollution is marked by some territorial indicators.

Another feature of pesticides is associated with the mandatory presence of pronounced toxicity in relation to individual biological targets or a certain set of them at working concentrations of drugs. Due to the available properties, it is important to develop methodological and methodological aspects of monitoring xenobiotics in agroecosystems on the example of pesticides as a common, but at the same time clearly defined class of xenobiotics. The practical purpose of such studies is to reduce the negative effects of pesticides on the environment and agricultural production. A clear example of achieving this goal is the study of phytotoxic effects of pesticides on crops of economic importance.

The problem of pesticide residues in the natural environment is multifaceted, which is due to the difference between physicochemical and toxicological and hygienic characteristics and the specifics of their behavior, which depends on their properties and natural factors, the possibility of complex application of pesticides for various functional purposes (pests and diseases on the same land), as well as in conjunction with other chemicals and technical equipment of plant protection measures. The existing features are not fully taken into account in terms of creating and implementing departmental systems for monitoring pesticide residues [Antonovich, Humenny, 1981].

Increasing the intensity of environmental pollution and reducing the quality of agricultural products as a result of active use of synthetic pesticides has become a significant stimulus for the development and implementation of biological methods and principles of biocoenotic management of agroecosystems in the practice of crop protection [Dolzhenko et al., 2007]. It becomes obvious that the problems of greening the use of pesticides in crop production are of particular importance.

The monograph reflects the main provisions of scientific research on topics, in particular) "Mycobio- and entomopreparations for organic production of special raw materials" (0113U003851 2013 - 2015); "Develop ways to increase plant adaptation to biotic stresses." "Identify and analyze factors that may limit the use of elicitors for the adaptive potential of plants"; "Creation of compositions of new inducers of tomato resistance to major diseases"; "Study of molecular-biological mechanisms of resistance and adaptation of plants to abio - and biotic stresses"; "Development of methods to prevent the decline of plant productivity based on the assessment and forecasting of the impact of climate change on their metabolic responses and adaptive potential."

CHAPTER 1. ECOLOGICAL AND TOXICOLOGICAL ASPECTS OF THE USE OF PESTICIDES IN AGRICULTURE

With increasing population growth, reducing the loss of agricultural products from diseases, pests and weeds is becoming increasingly important. The simplest measures for plant protection are necessary even at low intensity of plant growing as they intensify, if their importance increases significantly. Plant protection has a whole range of methods and means to suppress the activity of pests, but a significant place belongs to chemicals [Cymbalist et al., 1996]. The creation and widespread use of synthetic organic pesticides has stimulated significant growth in world production of food and raw materials for industry. Due to the use of pesticides, labor productivity in agriculture is gradually increasing and at the same time the energy costs for crop production are significantly reduced. Example, the use of herbicides in sugar beet crops saves energy costs, which is equivalent to 36–66 kg / ha of diesel fuel, in particular in rice crops - 9–26 kg / ha [Slovtsov, 1995]. In the world in the structure of pesticide use, the first place in use is occupied by herbicides (50-55%), followed by fungicides (35-38%), defoliants (8-10%) and insecticides (5-8%). The remaining groups in the amount are 2-3%. In some areas, herbicides account for up to 70% of industrial pesticides. For a long time, the negative effects of herbicides were not recognized. And only a few paraquat poisonings, which practically do not decompose in the soil, and therefore were considered non-toxic, forced scientists and practitioners to evaluate herbicides on the other hand [Belyuchenko, 2005]. 1995]. In the world in the structure of pesticide use, the first place in use is occupied by herbicides (50-55%), followed by fungicides (35-38%), defoliants (8-10%) and insecticides (5-8%). The remaining groups in the amount are 2-3%. In some areas, herbicides account for up to 70% of industrial pesticides. For a long time, the negative effects of herbicides were not recognized. And only a few paraquat poisonings, which practically do not

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Pesticides are considered as an environmental factor, in which two aspects must be distinguished. First, they optimize the energy component of economic activity, and secondly - act as xenobiotics and, in this case, the need for appropriate environmental solutions, part of which is the monitoring of the environment and its individual components. Currently, only a certain part of the potential productivity of crops is realized. For example, in some countries with sufficiently developed agriculture, the average yield of wheat, rice and corn is 5.9, 6.6 and 6.9 t / ha, while in the experiments it reached 14.0, 14.0 and 22.0 tons / ha [Golyshin, 1988].

Comparison of the yield of the main crops and the average density of chemical plant protection products shows that there is a clear positive correlation between these values (Table 1).

Table 1

Yields of major crops and consumption of pesticides [Yurin, 2002]

Region, country	Crop capacity, t/ha	Consumption of pesticides, kg / ha of arable land
Japan	54.8	10.70
USA	26.0	1.49
Europe	34.3	1.87
Latin America	19.7	0.22
Oceania	15.7	0.20
Africa	12.1	0.13

The introduction of new pesticides in agricultural production requires significant financial costs and time. During the period from 1975-1980 to 1990-1995, the financial costs for research and development of a new drug increased from 50 to 250 million German marks, and the time from the beginning of development to market entry to 8-10 years [Weber et al., 2000]. However, the payback of plant protection products remain a fairly profitable area of economic activity [Martynenko, 1988].

Due to the high efficiency, simplicity and availability of the chemical method has become a staple in the field of plant protection. Over time, the negative effects of widespread use of chemicals began to appear: accumulation in soil, water bodies, the emergence of resistant populations of pests, the emergence of new economically significant species of pests, detrimental effects on beneficial flora and fauna, potential threats to human health and disorders natural biocenoses [Edwards, 1986, Sokolov et al., 1994, Chirov et al., 2001, Gulidov, 2003]. As a result, there is an urgent need for a comprehensive study of the ecotoxicology of pesticides and measures to protect the biosphere and human health.

According to world environmental statistics, pesticides, along with heavy metals, radionuclides, oil and petroleum products, are ecotoxicants that make up the so-called "dirty dozen". Pesticide pollution is about 2% of the total percentage of the environment. But this is the average. In certain situations and conditions, ie in regions with intensive use of chemical plant protection products, as well as in rural areas, where the saturation of chemical chemicals is widely practiced, pesticides as contaminants can come to the fore and "compete" with other man-made xenobiotics. . [Lunev, 1992].

Pesticides are also used for other economic purposes, but in most cases their agricultural application is predominant. In the US state of California, agricultural production accounts for 90.9% of the total use of pesticides (in the active substance), post-harvest treatment - 2.7, fumigation - 2.9, maintenance of landscapes (roadsides, lawns, etc.) - 0.7 and other applications - 2.8% [Kishchyap, 1998].

Most environmental and toxicological problems are determined by the low efficiency of pesticides. Under the conditions of using modern technologies of chemical protection of plants only 10-30% of the amount of drugs settles on the plant surface, and in young gardens no more than 10% of the working solution falls on tree leaves, and losses of pesticides can reach 90% [Beshanov, 1987, Spyna, Sova , 1988]. Only 0.1-0.3% of fungicides and insecticides reach the goal and only 5-40% of them destroy weeds [Sokolov et al., 1988]. The effectiveness of pesticides can be 0.03-60% [Graham-Bryce et al., 1978]. Analyzing the volume, scale, technique and effectiveness of pesticide use in the United States, as well as information from special studies, we concluded that in most cases, the targets that must be destroyed with pesticides, reaches only a small proportion of drugs.

In connection with the use of chemical plant protection products, we can highlight the global migration of pesticides in the food chain, the impact on humans directly and through food, the development of resistance in pests and many others. The problem of the impact of pesticides on the environment and humans has temporal and regional aspects that are closely linked. To characterize the action and aftereffects of biocides and other toxicants in the biosphere, it is proposed to use at least 4 forms-stages:

1) local action, which is aimed directly at the object, and the accompanying - the body, soil and water;

2) the next aftereffect - landscape-regional, which differs in duration and efficiency in mountainous, hilly areas, watershed plains and slopes of different steepness;

3) remote aftereffect - regional-basin, during which the time of migration, redistribution and accumulation is 3 - 5 years or more;

4) the aftereffect is too distant - global, covering the planet as a whole and its individual macrocomponents. It is assumed that the latter form of aftereffect manifests itself sharply or slowly over decades [Kovda et al., 1977].

The most characteristic global migrants are persistent organochlorine pesticides and, first of all, dichlorodiphenyltrichloromethylmethane (DDT), which was widely used in European countries, the USA and Japan before 1975 and was actively used in the Asian continent. Thus, DDT has become one of the most common environmental pollutants [Agarwal et al., 1994, Boul et al., 1994]. It is a convenient and effective insecticide (low solubility in water, elasticity of saturated vapors, high solubility in fats and resistance to photooxidation).

Residual amounts of DDT and other fairly common insecticide hexachlorane (GC) are found in almost all natural objects [Brown, 1987], as well as food [Deschamps, Mascoet, 1983, Urek et al., 2000]. Regarding the scale of DDT pollution, the fact that from 1950 to 1970 it was used in the world about 4.5 million tons. The use of this insecticide in some regions continues to this day [Belyuchenko, 2005].

The entry of pesticides into the human body with food, as well as with water and air causes the accumulation of some of them, primarily chlorine-containing in organs and tissues [Karakaya et al., 1987, Pietrzak-Fiecko et al., 2000]. Every year, almost 1 million people register pesticide poisoning, which is used to treat crops, of which about 40 thousand die. Acute poisonings occur in both developing and developed countries [Saito, 1987].

The question arises, what is the place of pesticides among other substances that pose a danger to human health? In the United States in 1983, of the total number of fatal chemical poisonings, pesticides accounted for only 2.6%. According to the same statistics, painkillers caused fatal poisoning in 17.4% of cases, alcohol - 10.5%. Thus, pesticides cannot be classified as chemicals that pose a significant potential and real danger in everyday human life. Despite this, there is a danger of indirect (through migration, food chains) impact on human health and its hereditary apparatus. In other words, the toxicological and hygienic problems that people face when using pesticides are chronic rather than acute [Ware, 1986].

A significant negative consequence of the intensive use of chemical plant protection products is the development of resistance to harmful pests [Streibig, 1986, Bakuniak et al., 1987, Day, Lisansky, 1987]. In 1951, 16 pesticide-resistant species of pests and mites were registered, and in 1968 - 224, while in 1980 their number exceeded 400 [Burt and Beitz, 1988]. By 2000, the International Weed Research Group identified 222 biotypes that are resistant to herbicides [Zakharenko and Zakharenko, 2000].

The environmental risk of pesticide use is due to the same processes as the biological effectiveness of drugs. Therefore, the assessment of the effects of pesticides on the environment according to the criteria of ecological safety of the method and its biological effectiveness is based on a single system of ecotoxicological indicators. Optimization of ecotoxicological indicators can be interpreted as the creation of optimal tactics for the use of pesticides with minimal toxic side effects on the environment and maximum protective effect.

The quantitative effect of optimization of ecotoxicological indicators consists of determining the minimum set of the most informative values that determine the possible degree of toxic effects of pesticides on the components of agrocenosis, which allows to develop optimal regulations for their use and classify according to environmental hazard [Semenova, 2007].

Pesticides, and especially herbicides in the recommended consumption rates under certain conditions cause changes in metabolism, which are accompanied by inhibition of growth, development and reduced potential productivity of crops. The degree of this reduction depends mainly on the sensitivity of the culture to the drug, as well as the duration of its action.

The stress response to the herbicide is associated with a decrease in the level of photosynthetic activity and biosynthesis of carbohydrates and inhibition of the mechanisms of absorption of mineral nutrients, which leads to a weakening of growth processes and crop failure. The study of the aftereffects of herbicides on the sowing qualities of cereals allowed to establish their inhibitory effect on germination energy, laboratory germination and structural and functional characteristics of the photosynthetic apparatus of plants of subsequent reproduction [Gunar, 2009].

To increase the effectiveness of pesticides lintur, lontrel, granstar, sharpai, rogor, altosuper, tilt and reduce their use, it is recommended to apply together with siliplant and zircon, which improves the environmental situation of the agrocenosis [Dobreva, 2015]. Studies in the northeastern United States on winter wheat crops have shown that an excess of nitrogen fertilizers stimulates the development of fusarium wilt. Combined effect of root phytopathogens Fusarium graminearum Schwabe and Fusarium culmorum (WGSm.) Sacc.

increases the harmfulness [Smilley et al., 1986]. It is also important to remember about the timing of nitrogen fertilizers. For example, Gaeumannomyces graminis (Sacc.) Arx & DL Olivier - the causative agent of opioid root rot of winter wheat, grew in space and time under the application of ammonium sulfate for plowing in autumn and was suppressed in spring.

The technique of application and localization of fertilizers in the soil can also induce a pathological process in the agrocenosis. The density of fungi of F. solani (Martin) App species increased in the places of nitrogen fertilizer application. et Wr., Aspergillius sp. Mich. ex Fr., A. niger van Tiegh, A. ustus (Bainier) Thom & Church and Penicillium funiculosum Thom. These species of fungi are phytotoxic, which increase the infectious potential of the soil [Svistova, Stakhurlova, 1995].

It is necessary to determine which of the applied forms of nitrogen fertilizers suppress the pathological process, and which activate. Particular difficulties arise when evaluating fertilizers that contain several forms of nitrogen, such as ammonium nitrate. The ammonium form of nitrogen fertilizers in relation to root rot has higher fungistatic properties than nitrate. Under the conditions of introduction of ammonium ion in the rhizosphere of plants, places of higher soil acidity are created, which cause an inhibitory effect on pathogenic fungi. The population density of phytopathogens in areas close to the root decreases because the fungus develops in a more alkaline pH range [Smiley, Cook, 1973]. Higher availability or additional application of manganese to the soil provides higher resistance of cereals against root rot [McCay-Buis et al., 1995].

The level of soil nitrate supply is closely related to the population density of some pathogenic fungi. It was found that the number of conidia of Bipolaris sorokiniana (Sacc.) Shoemaker. was significantly higher under conditions of introduction of magnesium nitrate into the soil than ammonium nitrate or ammonium sulfate [Durynina, Chicheva, 1978]. When combined with the introduction of sterile soil carbon in the form of glucose and nitrogen and ammonium nitrate, chlamydospores Fusarium solani (Martin) App. et Wr. germinate faster than separate. It becomes obvious that on soils rich in organic matter, the use of nitrate nitrogen provokes the growth of phytopathogens. In the absence of the host plant, the accumulation of infection is inhibited by the rich soil microflora [Durynina, Velikanov, 1984].

The relationship in the system "soil - plant - pathogen" is adjusted not only by forms of fertilizers, but also by different concentrations of nutrients in the environment. Concentrations that are optimal for plant growth can inhibit the pathogen or the development of associated microflora. Thus, the use of a nutrient mixture in half the concentration of the optimal, caused intensive growth of red clover, but inhibited the development of Fusarium sp. and the manifestation of its pathogenicity [Christenson, Hadwiger, 1973]. Thus, mineral nitrogen fertilizers often use pathogens as an easily available source of nutrition, which cause an increase in population density in the soil, even in the absence of the host plant. Organic nitrogen acts through microbial decomposition, and therefore its use is accompanied by an increase in the total number of microbiota in the soil.

The stimulating effect of phosphorus fertilizers is explained by the fact that phosphorus causes increased growth of the root system, increases the resistance of plants against adverse environmental conditions. As a result, there is an intensive synthesis of organic matter, increases the resistance of plants to the penetration of the pathogen, accelerates the development of secondary roots and reduces the viability of pathogens in the soil [Durynina, Velikanov, 1984]. Application of phosphorus fertilizers (120 kg / ha) is most effective in the fight against root rot at a fairly high level of soil contamination with the pathogen (500-600 conidia per 1 g of soil against 20 in the control) [Teplyakov, 1977]. Phosphorus in the soil has been found to be an important nutrient in the fungal community. On acid sod-podzolic soil, phosphorus-containing fertilizers increase biodiversity in the fungal community by stimulating sporulation of Penicillium sp., Mucor sp. and Alternaria sp. [Mineev et al., 1997].

Potassium-containing fertilizers are a means of protection against gray rot of legumes on sod-podzolic soils [Chernetsova, 1983]. It is believed that in the presence of potassium there is a thickening of cell walls, increased strength of mechanical tissues, growth stimulation and differentiation of cambium in higher plants. As a result of such adjustments, an increase in the physiological resistance of plants against phytopathogenic processes is observed [Durynina, Velikanov, 1984]. Phytopathogenic fungi have a fairly wide range of cellulolytic and pectolytic enzymes, and therefore the mechanical strength of tissues is not always an obstacle to the development of the pathological process. Bipolaris sorokiniana (Sacc.) Shoemaker. is characterized by high cellulolytic activity and processes a significant amount of plant residues, which are plowed in the form of straw.

Organic and mineral supplements have different stimulating effects on pathogenic fungi depending on their saprophytic activity. Of the 23 nitrogen and carbon sources tested, only 7 simple compounds inhibited the growth of fungal numbers in the soil, while the remaining 16 reduced development to varying degrees. But none of the studied compounds limited the development of Fusarium solani (Martin) App. et Wr., a 19 caused an increase in the population density of this fungus in the soil [Papavizas, 1967].

An important trend in recent years is the increase in the number of formulations with controlled release of the active substance. Controlled release formulations (FCS) are a formulation containing the active substance and an inert material. The main purpose of such a system is to control the bioavailability of the active substance [Wilkins, 2004]. Existing formulations can be used for plant protection [Park et al., 2010], as well as combined forms of incompatible active substances [Frisch et al., 2001, Krause et al., 2001]. The use of PFCs in agriculture not only increases the effectiveness of pesticides, but also prevents their possible negative effects on humans and the environment.

Along with biopolymers, FCCs widely use nanoparticles (nanospheres, nanocapsules, nanogels, nanomicelles), dendrimers, nanopowders and nanotubes [Elek et al., 2010, Fernandez-Perez et al., 2011, Hellmann et al., 2011, Hayes et al. ., 2011]. Methods of production of FKZ can be conditionally divided into physical and chemical. The release of active substances in most cases is determined by the chemical nature of the formulation. In various polymeric nanomaterials, controlled release occurs by diffusion. The release rate (RR) is determined by the interaction between the carrier and the active substance. More intense interaction will be manifested at lower CV [Hussain, Oh, 1991, Qi et al., 1994].

Preparative FCCs of active substances have many advantages over traditional formulations, which provide high stability of the active substance of the pesticide against the action of various environmental factors. The use of encapsulated pesticides allows to more accurately create effective biological concentrations and prevent the accumulation of persistent organic pollutants in various objects of the environment.

Environmental and toxicological costs of pesticide application make appropriate adjustments to the cost-effectiveness of chemical plant protection. The economic losses from the use of pesticides consist of direct and indirect costs. The direct include:

1) the cost of product certification for the content of residual amounts of pesticides;

2) judicial and punitive sanctions of the bodies of ecological control for violations committed under the conditions of application of chemical plant protection products;

3) lawsuits of individuals affected by the use of pesticides;

4) losses of beekeeping from the use of pesticides;

5) losses from the death of domestic animals as a result of pesticide application;

6) other costs.

Indirect costs are primarily due to the death of beneficial fauna and flora and natural entomophagous [Safin, Nikitina, 2000].

CHAPTER 2. BEHAVIOR, STABILITY AND BIOLOGICAL ACTION OF PESTICIDES IN AGROPHYTOCENOSES

Systematic use of pesticides in agriculture leads to the fact that they become a constant environmental factor that changes and forms macro- and microbiocenoses. Pesticides are exposed to agrophytocenoses and their main components: soils of agricultural lands, vegetation, aboveground and soil biota, water bodies and groundwater [Chernikov et al., 2001]. The use of herbicides is accompanied by such adverse events as damage to sensitive crops, temporary depression of soil biological activity, the emergence of stable weed biotypes and more. Pesticides entering agrophytocenoses are metabolized in separate objects and environments and are included in migration chains. This is especially true for persistent pesticides that can be stored in the environment for a long time.

Pesticides in plants can affect the course of biochemical processes occurring in their tissues and the quality of crop production. The possible significant rearrangement of biochemical complexes of plants treated with herbicides can be assessed by how their amino acid composition changes. For example, under conditions of use of dialene and dichlorophenoxyacetic acid (2,4-D) in oats, a decrease in lysine, histidine, leucine, valine and, conversely, an increase in threonine and methionine is observed in the grain of this crop [Gruzdev et al., 1975]. Under conditions of repeated use of herbicides from the group of triazines simultaneously with the deterioration of the biological value of corn grain is a decrease in its protein content [Spiridonov et al., 1973]. Under the influence of the herbicide amine salt 2,4-D in wheat protein increased, but a decrease in the content of essential amino acids was observed. At the same time, the degree of manifestation of the established patterns largely depends on weather conditions [Ladonin, Lunev, 1985].

Compared to other crops, potatoes are more sensitive to the application of pesticides. Even in the absence of banvel D herbicide residues, a significant reduction in the amount of starch in the tubers was observed. Chloramp had a similar effect on potato plants [Nashtein, 1980]. In experiments with potatoes of other researchers, the starch content of tubers increased, but the protein content decreased. Thus, for the treatment of potato crops with aresin, the protein content decreased in the range from 2.91 to 1.42%, and for the use of zenkor and its mixtures with linuron and prometryn - from 2.91 to 1.2-2.43% [Buslovich , Dubenetskaya, 1986].

The change in the biochemical composition of plants occurs due to the transformation of pesticides by their inclusion in the metabolism, resulting in the formation of compounds that disrupt the optimal functioning of metabolic processes. It is likely that pesticides that enter plant tissues primarily interact with enzymes and vitamins that have high biochemical activity. This process can occur in two ways. The first is the participation of enzymes and vitamins in the detoxification of xenobiotics, and the second is their inactivation by pesticides through simple chemical interaction. Therefore, the effect of pesticides on plants should be quite clear by changing their enzyme and vitamin composition [Ovsyannikov, 2000].

A comprehensive survey of natural objects and agricultural products in the areas of use of organochlorine pesticides shows that their residues, as a rule, contaminate not individual components, but all interconnected natural environments and objects, including soils and crops, on which they are grown. Monitoring indicators of pesticide residues in the United States confirm their presence in almost all controlled sites and agrophytocenoses [Kutz, Carey, 1986].

When assessing the possible and actual negative consequences of intensive use of pesticides, it is necessary to take into account changes in soil microbiological communities, its fertility, quality of plant products and groundwater status and phytotoxic effects of herbicides on crops. Agrophytocenoses are often the primary link in local, regional and global pesticide migration chains. Pesticides stored in soils can enter the human body in a variety of ways, including through products of plant and animal origin. An important aspect of pesticide behavior in agrophytocenoses is their physicochemical interaction with environmental components, which determines the state of the pesticide and closely related biological activity, both targeted and general environmental [Weber, 1988].

The use of pesticides disrupts the existing balance of insect species in specific populations. As a result of treatments, not only harmful but also many useful species die, the disappearance of which from the agroecosystem can cause significant changes in the nature of its functioning. Under the influence of pesticides, the species composition of insects and mites often changes, and at the same time some organisms are replaced by others [Balevsky, 1988]. Studies conducted in Germany have shown that pesticides significantly reduce the diversity of flora and fauna. Since herbicides are used mainly on cereals, the most intensive effects are weed species that are characteristic of crops of these crops. Their numbers are reduced by 30-50%, which accompanies a decrease in the diversity of wildlife, especially insects and soil microorganisms [Hant, 1986].

The use of pesticides can reduce the number of bees and other pollinating insects. As a result, the yield of many crops, including buckwheat, can be reduced by tens of percent. Numerous cases of inhibitory and no effect of pesticides on earthworms have been described. Thus, the organochlorine pesticide dildrin in industrial doses delays their growth and slows puberty [Venter, Reinecke, 1985].

Residues of organochlorine pesticides due to their high persistence are stored for a long time in the soil of those agricultural lands where they were intensively used or widely used before. Soils under perennial and industrial crops are especially often polluted [Chekareva et al., 1981]. DDT and its metabolites are more persistent in the environment than isomers, which is found at the level of their content in the environment. In particular, the presence of these organochlorine toxicants in the natural environments of the background continental regions was (given the intervals of values for DDT / HCG): in the air 0.01-2 / 0.005-3 ng / m3, precipitation 0.01-0.2 / 0, 01-0.04 μg / l, surface water 0.001-0.1 / 0.001-0.05 μg / l, soil 0.003-0.1 / 0.001-0.1 and plants 0.015-0.2 / 0.01- 0.15 mg / kg dry matter [Afanasyev et al., 2001]. After the cessation of the use of resistant drugs, they persist for several years, and sometimes decades in the soil, which in this case becomes a source of pollution of adjacent natural objects [Chernikov et al., 2001]. The study of levels of accumulation and behavior of pesticides in the floodplain landscape showed that only 18 years after the cessation of DDT self-cleaning of soils from introduced organochlorine toxicants to a level that allows optimal functioning of floodplain agroecosystems [Strekozov et al., 1998].

The reduction of residual amounts of persistent organochlorine preparations in the natural environment over time leads to a decrease in their supply to agricultural products. Thus, in recent years, a significant reduction in the residual amounts of DDT in feed and livestock products has been identified [Zheltov, 2002]. The level of pesticide residues in the environment and food usually correlates with the volume of its application. Thus, in India, which produces and widely uses DDT, there are fairly high levels of its content in food. Indian soils also accumulate a significant amount of DDT and its metabolites, which were found in almost all soil samples [Yadav, 1981].

Long-term use of simtriazine herbicides stimulates the accumulation of their residues in the soil. Under the conditions of annual application of atrazine and simazine in vineyards (dose 5 kg d.r / ha), the duration of their application had practically no effect on the degree of accumulation of residues in the soil. After 6, 9 and 14 years of annual use, the content of atrazine in the soil layer 0-10 cm was 1.12, 1.05 and 1.09, and simazine - 0.81, 0.80 and 0.61 mg / kg [Damanakis, Daris, 1981]. A significant amount of herbicides under the conditions of their crop treatment is concentrated in the aboveground part. Under conditions of their use as fertilizer, they enter the soil and can have an adverse effect on subsequent crops. Thus, chlorosulfuron, used in the cultivation of cereals, after earning straw into the soil, is dangerous for such crops as beets, mustard,

Soil plays a major role in the self-cleaning of agrophytocenoses from pesticides, which is determined by hydrothermal conditions and biological activity. If the spread of pesticides is extremely slow, even moderate annual application of pesticides over time causes undesirable consequences. Under conditions when the self-cleaning ability of the soil is high enough, for example, in humid subtropics, complete inactivation of resistant pesticides, in high doses, can occur during one growing season [Galnulin, 1994, Zhemchuzhin, 2002]. The destruction of toxic drug residues and the cumulativeness of each of the chemical toxicants separately depends on the chemical structure of the compound, soil type, composition and properties of the microflora and saturation of microorganisms that can destroy toxic substances [Kiev, 2004].

Under the conditions of studying the behavior of pesticides in the objects of agrophytocenosis, it is important to identify the factors that play the most significant role in the detoxification of their residues. The persistence of pesticides in the soil depends on the application rate, formulation and adsorption capacity of the pesticide, type, pH, temperature, soil moisture, pesticide distribution, re-treatments, crops and combination of pesticides. Of soil and climatic factors, temperature (total daily for soil and air), soil moisture (total daily) and precipitation (total daily or precipitation) correlate the most with the rate of detoxification of pesticides. In the case of biological processes, the optimal temperature is important; increase or decrease of which in the direction of optimal causes a decrease in microbiological decomposition of pesticides [Lunev, 2004].

The content of organic matter in the soil has a different effect on the detoxification of pesticides, which increases the adsorption and stimulates a decrease in the rate of detoxification of their residues. This fact is most important for pesticides that can evaporate from the soil. If the degradation of the pesticide occurs mainly due to the microbiological process, which is accelerated by organic matter, then the latter stimulates the detoxification process. Under conditions of close organic matter content, pesticides decompose faster in soils with higher microbiological activity. Diallate, for example, decomposes 2.5-5 times faster in fresh soils with a higher content of biomass of microorganisms than in dry standard [Guth, 1980].

An important environmental characteristic of pesticides is their ability to migrate along the soil profile and create a risk of groundwater contamination. Pesticides are dissolved in the soil solution and mixed by mass transfer. Under the conditions of movement to deeper layers with infiltrating water, the processes of adsorption-desorption of molecules on soil particles occur [Weber et al., 2000]. During periods of intensive evaporation of water from the soil surface, pesticides can be transported from deeper layers to the surface with capillary water [Firsanov, Golovko, 1981].

The state of the pesticide in the soil, to a large extent, also depends on its toxicity, entry into plants, biological effects on pests and other indicators of behavior and activity. It also affects the degree of removal of the pesticide from the soil by solvents. When the pesticide is actively bound by soil components, the true amount of it contained in the soil can be significantly higher than determined by the physicochemical method. This circumstance creates the problem of proper selection of the solvent system and the method of extracting the pesticide from the soil [Gan et al., 1999, Ye et al., 2000].

Modern agricultural production is characterized by intensive use of chemicals for various purposes. As a rule, the detected pesticide is affected not only by physicochemical and biological factors of the soil, but also physicochemical, which is due to the use of other chemicals, including fertilizers, chemical ameliorants, pesticides, etc. [Lunev, 2004] .

According to many researchers, deep violations of microbial coenoses under the influence of pesticides should not be feared. Of the currently available pesticides on the world market, if they are used in the recommended standards, 60% have virtually no inhibitory effect on soil microorganisms. Of the remaining 90% inhibit the activity of microorganisms for no more than 30 days, and 1% - 60 [Davies, Dreaves, 1981, Bayer et al., 1982, Ottow, 1982, Mayorova et al., 1983].

As a result of systematic application of pesticides the biological activity of soil can change. The effect of pesticides on soil microflora is direct and indirect [Kruglov, 1980]. It is also necessary to take into account the reverse effect of microorganisms on pesticides, which largely determines the behavior and duration of storage in the soil of many of them. The ability of microorganisms to decompose pesticides is adaptive in nature, which occurs under conditions of contact with them, and therefore requires some period during which the population of microorganisms adapts to the transformation of a new substance. At the same time there is a restructuring of the enzymatic apparatus, transfer and distribution of hereditary material (plasmids), which determines the decomposition of the pesticide [Kruglov, 1991].

The intensity of microbiological degradation of pesticides is influenced by soil type, pH, temperature and humidity, time and nature of adsorption. One of the most common methods of assessing the action of microbiological factors is a comparative study of the dynamics of residual contents in sterile and non-sterile soils. As a rule, there is a sharp decrease or complete cessation of pesticide decomposition after soil sterilization [Schoen, Winterlin, 1987, Arthur et al., 1997]. In the case where the pesticide decomposes mainly by microbiological means, its persistence in the soil depends on the mass of microorganisms. It was found that the rate of dilatation degradation in soil is directly proportional to the mass of microorganisms [Frehse, Anderson, 1983].

It is important to clarify the patterns of transition of the pesticide into the plant under the action of crops on soils containing pesticide residues. Such a transition or translocation can cause not only the accumulation of residual amounts in the product, which impairs its toxicological and hygienic characteristics, but also affect the biological performance of the crop. As in the case of soil, it is important to consider the condition and forms of pesticides in plants, the formation of toxic decomposition products and other features of their behavior. Crops occupy a special position in the migration chains of pesticides in agrophytocenoses. As an integral part of the biota of agrophytocenoses, they are closely related to the soil, water and air of the atmosphere. Agricultural plants can also play the role of carriers of pesticide residues under the conditions of transportation of plant products (vegetables, fruits, plant feeds, etc.) both within the country and from one to another. The most important factors influencing the penetration of pesticides into plants are the content of organic matter and their residual amounts in the soil, the properties of the drug, species characteristics of plants, their biochemical composition and meteorological conditions of the growing season. Water-soluble pesticides enter plants faster and in greater quantities than low-soluble ones [Czaplicki, 1981]. species characteristics of plants, their biochemical composition and meteorological conditions of the growing season. Water-soluble pesticides enter plants faster and in greater quantities than low-soluble ones [Czaplicki, 1981]. species characteristics of plants, their biochemical composition and meteorological conditions of the growing season. Water-soluble pesticides enter plants faster and in greater quantities than low-soluble ones [Czaplicki, 1981].

There are three stages of testing pesticides:

the first - hydrolysis, oxidation, reduction and other chemical transformations that stimulate the change of activity;

second - there is a conjugation of pesticides and primary products of their metabolism with carbohydrates, amino acids and other compounds, followed by localization of conjugation products;

third - possible polymerization and other transformations of metabolites that stimulate the formation of insoluble products [Chkannikov, 1981].

In plants, pesticide residues can be present in 3 forms:

1) freely extracted;

2) extracted conjugates;

3) non-extracted bound residues included in plant tissues.

They can be considered as analogues of bound pesticide residues in soil [Stratton, Wheeler, 1983]. The rate of decomposition of pesticides in plants is usually higher than in soils, and also depends on a significant number of factors [Braun et al., 1982]. There is also a tendency of faster destruction of pesticide residues by early-maturing varieties of crops compared to late-maturing ones. This phenomenon is due to the higher activity of enzymes, in particular peroxidase, in some plants of early varieties [Petrova, Novozhilov, 1980].

The problem of toxic aftereffects of herbicides on crops occupies a special place in the list of environmental and toxicological problems. It covers 2 most important elements of agrophytocenoses: soil and cultivated plant, its negative aspect can be most accurately assessed economically, and therefore the object of negative action in this case is the culture, for the favorable protection of which use a chemical [Stalder et al., 1982] . The causes of damage to crops by herbicides can be:

1) improper treatment or damage to the sprayer, which can cause repeated overlays, especially when cornering;

2) insufficient mixing of the working fluid in the tank;

3) overdose of the active substance;

4) overdose on light soils of different types in one field;

5) contamination of the sprayer with drug residues from previous treatments;

6) watering with water containing herbicides;

7) accumulation and preservation of herbicide residues in the soil;

8) the use of not those mixtures of drugs and desiccants in the fields where pre-treatment with herbicides;

9) wind removal of drugs to neighboring fields;

10) the use of herbicides on sensitive crops and not in the optimal time, as well as on crops affected by disease, drought or frost [Krause, 1986]. Phytotoxicity can be not only the result of exposure to toxicants, but also as a consequence of the natural process of soil fatigue. They are associated with the accumulation of toxic substances in the process of decomposition of plant residues or lifelong excretion of allelopathic substances by plants [Shcherbakov, Svistova, 2002].

The toxicity of herbicides to crops is significantly affected by weather conditions. Phytotoxicity of a number of herbicides in relation to winter wheat in favorable weather conditions in the conditions of high yields was lower than in unfavorable years [Vanova, Benada, 1983].

Field studies have shown that under the recommended regulations, the insecticides imidacloprid, thiacloprid, thiamethoxam and chlorantraniliprol have low toxicity to the beneficial arthropods of the potato agrobiocenosis, as they do not show a significant effect on the number of Co Coccinellidae), Chrysopa carnea Steph. (Neuroptera, Chrysopidae), fly genus. Syrphidae (Diptera), a genus of bedbugs. Anthocoridae (Hemiptera), a squamous genus. Aphidiidae (Hymenoptera), spiders (Araneae), representatives of soil biota from the families Collembala, Coleoptera (genus Carabidae, genus Falokoridae), Lepidoptera, Diptera and Thysanoptera, mites ser. Oribatei (p / k Akari), the rate of recovery of the original number of beneficial organisms ranged from 7 to 14 days [Dolzhenko, Dolzhenko, 2013, The study of phytotoxic effects of herbicides on cultivated plants and the development of measures for their prevention is one of the priority tasks of hygiene and toxicology, the solution of which will significantly reduce the pollution of agrophytocenoses and increase production efficiency.

CHAPTER 3. MODELING AND PREDICTING THE BEHAVIOR OF PESTICIDES IN THE ENVIRONMENT

Monitoring the state of the environment plays an important role in assessing the environmental consequences of intensive pesticide use. An integral part of it is the establishment of quantitative relationships and patterns that determine the behavior of pesticides: spatial and temporal characteristics of their migration, transition from one environment to another, patterns of degradation and detoxification in nature, entry into biota and action on individual biogeocenoses and biosphere. Modeling and predicting the behavior of pesticides makes it possible to assess and predict the degree of anthropogenic pressure on the environment and humans in connection with the use of pesticides, as well as the effectiveness of pesticides with appropriate adjustments to technology and regulations [Lunev, 1988].

The study of the behavior of pesticides in agrophytocenoses is associated with the analysis of samples of objects studied and the subsequent processing of the results. The process of obtaining the source information depends on the chosen method. There is a point of view that the result of the analysis of a mixed soil sample does not always adequately characterize the degree and nature of land contamination. Comparison of the results of studying the content of simazine in individual and mixed samples showed that physical averaging is not equivalent to mathematical [Samsonova et al., 1985]. An integral indicator of the level of contamination of an object or their combination is the average content of pesticides. Researchers believe that the distribution of pesticides often differs from the optimal. Thus, a detailed statistical analysis of information on the content of amine salt 2,4-D at 70 points in a field of 15 hectares, as well as similar for DDT and HCH showed that the distribution of pesticides in the soil does not comply with the law, which is characterized by asymmetry [Gridasov et al., 1986]. Such an asymmetric distribution is in many cases subject logarithmically to the law, according to which the average pesticide content must be calculated not as an arithmetic mean but as a geometric value.

The dynamics of pesticide content in the soil can be considered as a multi-stage process. Thus, in the microbiological decomposition of 2,4-D in soils with relatively low humidity, there are 2 stages: slow and fast, each of which is described by exponential dependence [Parker, Doxtader, 1983]. Due to the fact that the exponential model does not always allow to satisfactorily approximate the experimental parameters, it is assumed to use for this purpose and other empirical dependencies. The choice of the optimal model is made by evaluating several empirical models according to statistical criteria [Phogat et al., 1984].

The transformation of pesticides in the soil occurs under the influence of numerous factors, the contribution of which is usually difficult to assess (Table 2).

Table 2

The share of evaporation, chemical and microbiological decomposition in reducing the content of hexachlorane in the soil [Rachinsky et al., 1983]

Term, day	Transpiration, g/dm^2 year	Decomposition	
		chemical	microbiological
2	0.72	0.28	-
15	0.51	0.49	-
45	0.42	0,5tsiya6	0.02
67	0.37	0.59	0.04
110	0.34	0.58	0.08

Notes: per unit, losses are taken for each sampling period

Despite this, there were attempts to "dissect" the process of transformation of pesticides in this facility and qualitatively characterize the impact of the most significant factors. Microbiological decomposition begins to play a significant role only after a month and a half, apparently after the adaptation of soil microflora to the pesticide.

Under the study of the rate and nature of detoxification of pesticides in plants, it is necessary to take into account the factor of dilution of pesticide residues, which is due to the growth of plant weight during growth. In a number of cases, this factor determines the direction of the process. Thus, due to the inflow of pesticides from the soil or their redistribution in the plant, the absolute number of residues in its individual parts or organs may increase over time, and the concentration may remain unchanged or decrease. A similar phenomenon was observed in the study of detoxification of 2,4-D in potato tubers [Bristol et al., 1981].

In order to optimize the range of pesticides in terms of preventing their effects on the environment and humans, attempts are being made to quantify their ecotoxicological hazards. To do this, we offer a comparative indicator, according to which the ecotoxicological hazard of the pesticide is directly proportional to its toxicity, volatility and waiting time. With its help it is shown that 50% of s.p. the γ-isomer of HCG is less dangerous than 20% k.e. metaphos, and 30% k.e. carbophos is less dangerous than 40; z.p. bazudin [Stepanov, Ermolenko, 1981]. To compare the levels of possible adverse effects of pesticides on the environment using different indicators of their ecotoxicological hazard [Slovtsov, 1995, Melnikov, Belan, 1997]. An integral index is also proposed,

Physical and mathematical modeling methods are recommended to determine the ecological and toxicological consequences of pesticide use. Physical modeling of pesticide migration and detoxification processes allows to assess in laboratory or field conditions the nature of the action of a factor on the direction and intensity of existing processes. As physical models for studying the processes of leaching of pesticides from the soil use soil columns, and the mobility of pesticides in the soil - soil thin layer chromatography [Draggan, 1979, Hance, Haynes, 1981, Frehse, Anderson, 1983. Troiano, Buttertleld. 1984].

The importance of interphase interactions as a regulatory mechanism of pesticide migration in soil and vegetation and redistribution between functional compartments is shown. Mathematical and simulation models of pesticide behavior in plants and soil are constructed, which take into account the close connection of degradation and localization processes on the basis of the description of pesticide penetration into plants, vertical migration and soil sorption. A model of pesticide redistribution in leaves has been developed and models of soil sorption of pesticides and their penetration into roots have been analyzed. For nonpolar pesticides, the leading role of lyophilicity in the process of their localization in plants and soil has been revealed. The limits of application of models of different degree of complexity on the basis of sorption coefficient for soil and solubility of pesticides for plants are determined. The value of the homogeneity of the medium under the conditions of using models based on linear relations is demonstrated. There are possibilities of applying generalized and detailed simulation models, on the basis of which simple procedures of comparative assessment of pesticide behavior under given scenarios are constructed, which are typical for a certain situation of soil and weather conditions and formulas for optimal pesticide consumption rates are obtained. To study the behavior and determine the prolongation of pesticide action in specific agro-climatic conditions, it is necessary to involve more complex simulation models [Semenova, 2007]. on the basis of which simple procedures of comparative estimation of behavior of pesticides under the set scenarios which are typical for the certain situation of soil and weather conditions are constructed and formulas for optimum norms of expenses of pesticides are received. To study the behavior and determine the prolongation of pesticide action in specific agro-climatic conditions, it is necessary to involve more complex simulation models [Semenova, 2007]. on the basis of which simple procedures of comparative estimation of behavior of pesticides under the set scenarios which are typical for the certain situation of soil and weather conditions are constructed and formulas for optimum norms of expenses of pesticides are received. To study the behavior and determine the prolongation of pesticide action in specific agro-climatic conditions, it is necessary to involve more complex simulation models [Semenova, 2007].

The behavior and accumulation of pesticides in the environment can be studied using mathematical models of three main classes: physical-mathematical, simulation and regression. The first investigates the processes that determine the behavior of pesticides and identify their mechanisms that establish links between process rates and environmental performance. Simulation models combine elements of physical-mathematical and purely statistical, which include regression [Zakharenko, Zakharenko, 2000].

In practice, the most common regression and simulation models. Content models are developed to a lesser extent, which are used to a limited extent. Other examples of the use of modeling to assess the effects of pesticide use in agriculture are also described [Golubev, 1993, Larina, 1999, Semenova et al., 1999, Satchivi et al., 2000]. An attempt is also made to combine separate models describing the behavior of pesticides in the soil (leaching, evaporation, etc.) and to create a universal model of their persistence in the field. Conceptually, such a model consists of two parts: a hydrological model and hemodynamic submodels [Troestcr et al., 1984].

The models are designed to state and predict the picture of biosphere pollution by pesticides and to calculate the optimal from the point of view of environmental protection technical and technological indicators of their application. There are 2 types of forecasts: perspective - anticipation of possible changes in the future and normative - forecasting the future state of the previously created standards. Depending on the scale of research, forecasts are divided into global, regional and local [Glotfelty, 1985].

Predictions of contamination of agrophytocenoses and environment with highly persistent pesticides are of great practical importance. Prognostic estimates show that DDT contamination remains global for quite some time [Ostromogilsky et al., 1987]. The forecast of behavior of pesticides on agricultural lands should include two independent aspects, in particular removal of substance from an agrocenosis and its behavior within an agrocenosis [Rachinsky and others, 1986].

A significant number of methods for predicting the levels of accumulation and persistence of pesticides in soil and plants are based on regression models of their behavior. Methods based on simulation models are also offered. The main criterion for the reliability and accuracy of mathematical forecasting methods is the ratio of calculated and actual indicators [Walker, Bernes, 1981, Nash, 1988]. Predicting the levels of residual amounts of herbicide in the soil is associated with possible manifestations of its phytotoxicity and recommendations for the timing of sowing or planting of certain herbicide-sensitive crops [Pestemer, 1983].

Methods of electronic pragmatic resonance, slow induction of fluorescence and thermoluminescence can be used for rapid diagnosis of the physiological state of plants under conditions of their cultivation in intensive technologies. They are less time-consuming than traditional research methods, which allow to more fully characterize the physiological state of plants. Along with physiological and biochemical methods, they can be used to study the reactions of plants to the action of biologically active substances (BAS) and external factors [Gunnar, 2009]. The use of modeling and forecasting methods makes it possible to predict negative ecological and toxicological situations and to regulate production processes related to chemical plant protection and taking into account the negative consequences for the environment.

One of the directions of regulated reduction of pesticides in agroecosystems is the introduction of technologies in agricultural production that minimize the use of chemical plant protection products. Global changes in this area must be expected in the context of creating plants with programmable properties. Currently, the creation of transgenic plants that are resistant to pests and diseases and pesticides. Yes, potato and tomato varieties that are resistant to pests and viral diseases have already been proposed. For example, corn is resistant to roundup herbicide, and cotton is resistant to a number of herbicides. But at the same time, the widespread introduction of such crops into production is not indisputable. The main danger when using transgenic varieties that are resistant to some herbicides is the emergence of resistant weeds.

The characteristic of the algorithm for automation of calculation of cost of carrying out of a complex of research field experimental works on an estimation of biological efficiency and regulations of application of pesticides with consideration of the basic calculation formulas, input and output information is modernized. A computer program that implements calculations using this algorithm was developed in Microsoft Excel 2007 (Visual Basic for Applications programming language). Under the conditions of algorithm development, the logic diagrams of cyclic computational processes adopted in programming for electronic computers, as well as the basic provisions and formulas developed earlier by the authors, were used.

CHAPTER 4. MONITORING OF PESTICIDES IN AGROECOSYSTEMS

A key place in preventing the negative consequences of monitoring toxic pesticide residues in the environment is the presence in crop products, feed and food. Monitoring of pesticides includes a system of observations, assessment and forecast of levels of contamination of objects with their residues, followed by the development of measures to improve the environment. The system of observations includes background, local and impact monitoring. The first of them includes a system of observations of general biosphere phenomena and environmental conditions without taking into account the impact of local and impact anthropogenic actions. Impact and local monitoring are systems of observation in the region for the effects of xenobiotics or other harmful agents from established sources [Israel, 1984, Spiridonov, Larina, 1999].

Ecological monitoring of pesticides, part of which should be an economic justification of chemical protection technology, allows at the planning stage to choose the best option for each crop in specific growing conditions and phytosanitary condition of crops [Bublyk, 2004].

The decision to take protective measures to control pests, diseases and weeds should be based on an effective system of diagnosis and phytosanitary monitoring of pests in specific areas of the field. The earlier the harmful object is identified and diagnosed, and the density of its spread in the field, the higher the efficiency and effectiveness of plant protection measures. Scientific and technological progress in the development of computer technology, information technology, the creation of global positioning systems (GLONASS, GPS) laid the fundamental foundations for the development of fundamentally new agricultural technologies [Shpaar et al., 2009].

In the field of plant protection, research is underway to develop remote methods of phytosanitary monitoring of harmful objects and necessary for this purpose optoelectronic sensors, sensors, multispectral cameras, specialized unmanned aerial vehicles, on-board computers with software for the implementation of discrete technology plant protection in the field. Create special software for processing the received information in real time concerning a phytosanitary condition of crops and decoding of the received images [Lysov, Kornilov, 2016].

Control of contamination of soils and other adjacent objects with pesticides is carried out by departments and organizations. The question of developing common principles for the organization of research and methods of their conduct, the form of presentation of research results, processing schemes and interpretation is relevant. These issues can be addressed only by controlling the levels of accumulation in soils of pesticides and their metabolites in the subsystem in the soil monitoring system. The program of this subsystem should be aimed at:

1) analysis and generalization of information on the scale of pesticide use and soil contamination;

2) evaluation of the effectiveness of measures to reduce pesticide pollution;

3) development of models of pesticide migration in soils and forecasting of ecological consequences of pesticide pollution;

4) development of methodical approaches and methods of the complex decision of a problem of pollution of soils by chemical means of protection of plants [Morgun, Grishina, 1989].

To solve the problem of controlled use of plant protection products may have a comprehensive economic and environmental expertise, which is carried out at different levels and the creation of an information bank to carry out full phytosanitary and environmental monitoring and improve the use of pesticides. The environmental significance of the use of plant protection products can be revealed through a comprehensive agri-environmental approach to their use, which significantly reduces the environmental load in agrolandscapes, improves the natural environment with increasing plant productivity, increases agroecological potential of agrobiocenoses and significantly improves economic performance.].

The choice of controlled pesticides is based on their environmental and toxicological classifications. One of such complex classifications provides the characteristic of each separate pesticide on 15 indicators. Among them are resistance in soil, plants and water, bioaccumulation in aquatic and aboveground systems, migration coefficients between different environments, phytotoxicity, effect on soil biocenosis, danger to beneficial insects and fish, formation of toxic and persistent decomposition products [Spyna et al., 1989]. According to another classification, pesticides are marked by some integrated indicator that takes into account the toxicological-hygienic and ecological-toxicological aspects of safety [Vasiliev et al., 1989]. Other approaches to the choice of toxicants are also possible. So,

In the process of monitoring natural objects and products, priority is given to persistent pesticides, especially organochlorine insecticides and simtriazine herbicides [Spiridov, Larina, 1999]. A typical situation of long-term storage of residual amounts of organochlorine pesticides can be traced in the soils of gardens, in which drugs of this class were intensively used until the 70s of the last century. Quite typical results were obtained in the gardens of the Crimea, aged 25 to 68 years. GC isomers were detected in 38% of soil samples and their total content did not exceed half the value (MPC). Residual amounts of DDT and its metabolites were found in the soils under gardens where this drug was used in the past, and at the same time the average content of toxicants ranged from below the MPC and exceeded it by tens and in some cases hundreds of times.

Slightly different results on the distribution of organochlorine toxicants by soil profile were obtained under the conditions of soil survey of agricultural enterprises and subsidiary farms in the conditions of the right-bank forest-steppe of Ukraine. It was found that in both cases there are residual amounts of DDT and HCH, and the content of toxicants in the arable layer is slightly higher than in the subsoil [Sazhenyuk et al., 1997].

In 1994, a mass survey of agricultural products for pesticides was conducted in the United States. The program provided for the detection of residual amounts of about 300 active substances of pesticides. In the process of monitoring plant products, 74 names of toxicants were identified. In total, pesticide residues were found in 37% of samples of US products and 33% of imported ones. Toxicants were most often found in grains and flours of wheat, barley, peas, black currants, raspberries, pears and strawberries [Kishchyap, 1998].

Under the conditions of extended interpretation, monitoring includes not only assessment, control and forecast of the state of biosphere components (landscape elements), but also reasoned recommendations and effective measures to prevent or eliminate undesirable consequences of human economic activity [Sokolov, Terekhov, 1994]. Environmental measures can be grouped into two categories:

- the first includes measures aimed at preventing the accumulation of pesticide residues in agricultural products and agrophytocenoses, as well as their entry into the environment. They can be identified as preventive.
- the second includes measures to reduce the content of pesticide residues in products and objects of agrophytocenoses and the use of products in the presence of residual amounts. Since we have to deal with already contaminated objects, it would be more correct to call the second category of measures "rehabilitation". To ensure measures for both categories, control, study and predict the behavior and accumulation of pesticide residues in agricultural products and environmental facilities [Lunev, 1992].

These measures will be effective only if they are applied in combination with the specifics of agricultural production, the nature of the crop and the peculiarities of natural and climatic conditions. Preservation and accumulation of pesticide residues in agrophytocenoses requires the development and use of detoxification methods. The reduction of pesticide content in natural objects can occur naturally (passive detoxification), as well as under the influence of artificially created conditions and processes (active detoxification).

The choice of one or another method of detoxification depends on the nature and purpose, the level of contamination of the object, time reserve and economic feasibility. Thus, to reduce the migration of pesticides by soil profile, various sorbents are proposed. The use of natural zeolite pegasine at a dose of 300 kg / ha has significantly reduced the migration of pesticides of different classes. For the metaphos, the decrease in migration into the subsoil layer was 50%, bayleton - 30, 2M-4X - 20-40%. Zeolite did not show a significant effect on the content of pesticide residues in barley plants [Vavin, Baklansky, 1992].

Significant efficiency to reduce the pesticide load is provided by technological means that reduce drug consumption rates. The use of silicon compounds, in particular tetraethoxylan, reduces the rates of fungicides by 50%, and insecticides and herbicides - 29-50% without reducing their biological activity. At the same time, the risk of negative environmental consequences from the use of pesticides is significantly reduced [Slastya et al., 1999].

Among the measures to prevent contamination of agrophytocenoses, the problem of reducing the possible phytotoxic effect of residual amounts of herbicides on crops sensitive to them occupies a special place. The maximum and not causing economic losses of agricultural products due to phytotoxicity of herbicide residues in the soil, consider a 10% reduction in yield [Stalder et al., 1982].

The phytotoxicity of herbicide residues against sensitive crops can be reduced by biological or chemical transformation of herbicides in the soil, or by creating conditions for immobilization of its residues. Most often, these methods are combined by adding to the soil various components of organic origin (manure, straw, etc.). Application of 300 t / ha of liquid manure causes a reduction of more than 2 times the content of simazine in the soil and significantly increases the rate of detoxification of its residues [Mayorova et al., 1983]. By applying organic fertilizers, a reduction in the phytotoxicity of the eptam herbicide against ryegrass was also achieved. Reducing the negative effects of persistent phytotoxicants, such as picloram, terbacil, chlorsulfuron is possible through the use of mixtures of drugs with an extended spectrum of chemical detoxifiers, artificial or natural sorbents and other ameliorants, agrotechnical means [Spiridonov, Shestakov, 2000]. Antidotes, plant growth regulators (PPPs) and liquid complex fertilizers are also used to protect plants from phytotoxic aftereffects of herbicides [Ugryumov and Savva, 2000].

An effective measure for soil remediation in terms of the content of residual amounts of herbicide, which are able to show phytotoxic effects on crops, is the use of activated carbon at a dose of 25-100 kg / ha. This prevented the negative effects of chlorosulfuron under the conditions of growing vegetables and corn [Spiridonov et al., 1998].

The use of PPP reduced the negative effect of xenobiotic herbicides on the morphometric parameters of winter wheat seeds. The most effective in leveling the inhibitory effect of xenobiotics on the growth and development of seedlings and root system of winter wheat were PPP epine-extra and silk. Of the studied herbicides, the most noticeable inhibitory effect on the morphogenesis of winter wheat plants was shown by banvel [Dvoretsky, 2012].

A set of measures to restore the biodiversity of agrocenoses in the existing orchards for the functioning of self-regulatory mechanisms, it is advisable to organize long-term controls, which are 2-3 rows of fruit trees of varieties resistant to disease. The controls are adjacent to the forest belt and are not treated against pests that serve as reservoirs of entomophagous local populations. They accelerate the process of biodiversity restoration by 2-3 times. It is also recommended to replace chemical insecticides with biological preparations, at the time when entomophages are most happy - in early spring and in the second half of the growing season. This agricultural measure not only preserves biodiversity, but also reduces the cost of protective activities by 30% or more due to the difference in the price of protection [Storchevaya, 2002].

The ecological risk of chemical protection of the orchard can be reduced by using low-polar low-toxic insecticides - PPP insects, which are used with low consumption rates (0.6-1.0 l / ha), which decompose fairly quickly in the agrocenosis, are moderately dangerous and low-toxic. The use of regulators of growth and development of insects allows to reduce the pesticide load on the agrocenosis and to obtain quality fruit products [Panchenko et al., 2016].

Modern pesticides used in rice cultivation technologies are classified according to the integrated classification according to the degree of danger to moderate and low - risk compounds. The correlation between the polarity, which is a function of the molecular structure of the pesticide, and its decay rate in the environment has been confirmed. It becomes obvious that in improving the range of pesticides there is a significant environmental reserve [Bublyk, Fedorenko, 2004]. The optimal conditions for extraction, qualitative and quantitative determination of imidacloprid and pencicuron in potatoes and soil were determined by thin-layer and gas-liquid chromatography [Bublyk et al., 2004]. Modern pesticides are classified by polarity, the rate constants of their destruction and half-lives in the objects of agrocenosis of the orchard, the weighted average degree of danger of the range,

A hygienic assessment of the behavior of the herbicide fusilade forte under the conditions of its application on vegetable crops in private farms was carried out. The safety of the drug from the standpoint of food hygiene and for people working with it in terms of use in the planting of tomatoes, cucumbers, potatoes, cabbage, carrots, onions, subject to compliance with consumption rates, regulations and instructions for use [Kirichenko et al., 2004].

The behavior of herbicides based on imazethapyr in the system "soil - adjacent media" was studied. It is shown that the potential danger of using herbicides pivot, patriot, DT-03 is determined by the stability of their active substance imazethapyr in the soil and its mobility in the system "soil - groundwater". The processes of migration from the soil to the atmosphere, translocation to agricultural plants and the impact on enzymatic activity and soil microbiocenosis are not decisive in terms of ecological and hygienic assessment of the studied drugs. In field experiments, it was found that residual amounts of imazethapyr in soil and plants gradually decreased, its accumulation did not occur in the commodity parts of plants and no contamination of agrocenosis objects in the area of possible wear was observed. Shown

The working conditions are clarified and the condition of the objects of the environment under the conditions of application of various pesticides with the use of traditional agricultural aviation and new ultralight aircraft is estimated. It is shown that the use of the studied drugs in compliance with hygienic regulations, pesticide consumption rates, frequency of treatments and equipment does not lead to pollution of the environment and is not dangerous for workers and the public [Omelchuk et al., 2004].

An automated quality management system for entomological products with the use of information technology has been developed, which allows to identify technological processes of entomological productions by the criterion of product quality, increases their efficiency and productivity. The use of SCADA-system reduces the processing time of a large array of information, automates the process of obtaining information on technological indicators of production and keeps the obtained indicators in a structured form [Belchenko, Chernova, 2015].

The concept of ecologically adequate method (EAM) of insecticide application is offered. The essence of the method is that the rate of drug consumption is a variable and is determined based on species and population sensitivity to the pesticide and its actual number in each agrocenosis. The main ecological justification of the norms of consumption of insecticides according to EAM is the quantitative dependence of the effectiveness of the drug on the norms of its consumption. For example, the dependence of the effectiveness of the drug lambda-cyhalothrin (B) on the rate of consumption (X) in relation to the dangerous pest of the bedbug pest is shown by the equation: B = 2, 56 Ln x + 87.5. The use of EAM for the use of pesticides provides a significant reduction in the number of pesticides and the ability to stabilize the balance in agroecosystems by maintaining biocoenotic links within ecological pyramids between different trophic chains. In terms of protection against weeds, a system of small application of herbicides and their adequate use is being developed depending on the species composition of the undesirable flora. The use of eco-technologies will reduce pesticide loads and preserve pollinators and entomophages under the conditions of protective measures [Artokhin, Ignatova, 2012].

The features of evolutionary-ecological measures of reproduction, survival and trophic connections of the life cycle of phytopathogens, which serve as a basis for improving the monitoring, forecasting, strategy and tactics of protective measures, have been updated. The inclusion of vital tactics of reproduction, survival and trophic relationships in the model of the epiphytic process provides the key to managing the life cycle of phytopathogens and the level of manifestation of the epiphytic process. The methodology of action and interaction of natural and anthropogenic factors of origin, passage and attenuation of epiphytoses in agroecosystems is determined. The seasonal and long-term dynamics of soil, leaf, stem and seed diseases of agricultural crops and the factors that cause them are specified. The dynamics of epiphytic foci formation and the influence of hydrothermal conditions on the rate and spatial growth of the epiphytic process of leaf and stem diseases (potato late blight, septoria and brown rust of spring wheat, black currant septoria, etc.) were studied. Peculiarities of seasonal dynamics of leaf-stem diseases on annual (spring wheat) and perennial (black currant, garden strawberry) crops have been established. Criteria for optimization of phytosanitary technologies in agroecosystems of the region by periods of formation of crop structure elements on the basis of agrotechnical method of plant protection have been developed [Toropova, 2005]. strawberry garden) crops. Criteria for optimization of phytosanitary technologies in agroecosystems of the region by periods of formation of crop structure elements on the basis of agrotechnical method of plant protection have been developed [Toropova, 2005]. strawberry garden) crops. Criteria for optimization of phytosanitary technologies in agroecosystems of the region by periods of formation of crop structure elements on the basis of agrotechnical method of plant protection have been developed [Toropova, 2005].

Improving methods of analytical control of pesticides in soil, water, plant and animal raw materials and food was one of the issues widely discussed at the International Conference "Problems of registration and use of pesticides in Ukraine" (October 23-25, 2012, Kyiv). The innovative FFPTM (Folded Flight Path) technology presented by Czech colleagues is relevant, which allows the use of mass spectrometry in combination with high-speed gas chromatography (HR-GC), as well as ultra-high pressure liquid chromatography (UHPLC). Researchers have targeted screening of multiple pesticide residues from heavy matrices such as black tea, fruits and vegetables prepared by the QuEChERS sample preparation method [Kovalczuk et al., 2012]. Other methods based on enzyme inhibition, immunological technologies,

A portable biosensor model for the detection of neurotoxic pesticides in water and food has been developed and tested for use in the field. This potentiometric biosensor is based on acetylcholinesterase inhibition, which uses screen-printed electrodes [Alain et al., 2008]. Another electrochemical sensor with printed electrodes using genetically modified acetylcholinesterase and Poly

(3,4-Ethylenedioxythiophene) (PEDOT) has been used to detect organophosphorus pesticides (particularly chlorpyrifos) [Sikora et al., 2011]. But all cholinesterase-based biosensors have one problem in common - organophosphorus pesticides inactivate the enzyme irreversibly. Accordingly, biosensors can be used only once, which complicates and sometimes makes it impossible to calibrate them. A solution to the problem of irreversible inhibition is the use of reactivation of immobilized acetylcholinesterase [Stepurska et al., 2013]. This paper shows the fundamental possibility of reactivation of the bioselective membrane with a solution of reactivator (pyridine-2-aldoxymethyl iodide) after irreversible inhibition by organophosphorus pesticides and analyzes how the concentration of reactivator and the level of inhibition of bioselective element affects the reactivation capacity of bioselective.

Many pesticides have a similar effect on the activity of the same enzyme. Thus, enzyme-based biosensors allow the determination of "total toxicity", but do not provide information on a specific pesticide. Artificial neural networks (ANNs) are designed to solve the problem of identifying inhibitors in the sample. ANNs in combination with microarray technology have been designed (simulated) for the selective determination of chlorpyrifos and chlorfenvinphos [Cortina-Puig et al., 2010].

Microbial biosensors avoid expensive methods of purification of enzymes, which are in their natural environment inside the cell, more stable and active. The main limitation of the use of whole cells is the diffusion of substrates and products through the cell wall, which causes a slow response compared to biosensors based on the enzyme. Various strains of microorganisms are used as a biosensor element, in particular Arxula adeninivorans, Bacillus subtilis, Serratia marcescens or mixed cultures. The characteristics of microbial biosensors for the detection of pesticides are considered in the review [Su et al., 2011]. The use of tissues as a source of enzymes ensures the presence of the necessary cofactors and increases the duration of use of the biosensor. So biosensors that used Chlorella vulgaris tissue,

The effects of low concentrations of pesticides accumulating in the human body, as well as their combined effects with other pollutants have not been sufficiently studied. Therefore, more decisively, taking into account the current level of knowledge development, the question of potential danger should be formulated, given the fact that a significant part of pesticides are produced and used to satisfy only economic interests. Appropriate agricultural techniques, the potential of biological agents and pest control agents are needed to improve the phytosanitary situation. Only by implementing the concept of integrated protection of plants, soils and water can the desired result be achieved. Express detection and quantitative analysis of pollutants of natural and anthropogenic origin is an urgent problem of modern medicine, veterinary medicine, environmental monitoring, security and protection systems against bioterrorism. For modern European laboratories, the main standard for determining pesticide residues is the document "Method validation and quality control procedures pesticide residues analysis in food and feed document SANCO / 12495/2011", which, in addition to the requirements for methods, prescribes a validation procedure. In particular, for 2011-2013, Directive SANCO / 10678/2010 was developed and implemented, according to which the control of pesticide residues in products of plant and animal origin is carried out on 184 active substances of pesticides in various combinations. The Ukrainian Laboratory of Product Quality and Safety (ULAB) of the NULES of Ukraine has developed and prepared for certification a method for determining multi-residues of 62 pesticides of different classes in grains of different crops and feeds. The QuEChERS sample preparation method in combination with GC / MS and HPLC / MS / MS was used to identify many pesticide residues. There are a number of approaches to solve the problem of improving analytical systems, as well as the development and implementation of modern promising biosensor methods for the determination of mycotoxins and pesticides for automated rapid assessment of toxicity of agricultural products [Goister et al., 2013].

In modern conditions of planning and implementation of measures for monitoring of pesticides and other xenobiotics of agricultural origin in agroecosystems and products the following objects and processes need priority attention:

1) places of storage and disposal of obsolete pesticides;

2) soils under perennial plantings, on which organochlorine preparations were previously used;

3) agricultural lands on which modern low-dose preparations are used, which are able to show phytotoxic effect and aftereffect on cultivated plants;

4) imported agricultural products from Asia, Africa, South America and the Middle East, which continue to use organochlorine and other "problematic" pesticides;

5) regional and global migration of xenobiotics by air and watercourses, as well as their economic migration with products.

Improving the methodology of monitoring pesticides and methods of analysis of their microquantities and implementation of developments in practice allows to solve the problem of minimizing the effects of this common class of toxicants on the environment and humans, maintain and deepen the positive economic effect of chemical plant protection [Lunev, 2005].

Thus, monitoring of pesticides involves not only control over the content of residues in natural objects, but also to solve the problem of obsolete, which can have a negative impact on the environment as an impactful source in their storage and disposal.

CHAPTER 5. DETOXIFICATION OF PESTICIDES IN THE SOIL BY DESTRUCTIVE MICROORGANISMS

One of the urgent problems of our time is the global chemical pollution of the biosphere, which raises well-founded concerns about the possible violation of the ecological balance in some ecosystems. Of particular danger are synthetic compounds that enter nature - not the environment, as a result of human economic activity. An important place among them is occupied by chemical plant protection products. The use of pesticides to increase plant productivity causes an increase in the range and scope of their use. The second half of the twentieth century is considered the era of synthetic compounds, completely foreign to wildlife. However, regardless of the forms and methods of application, pesticides continue to enter the soil, accumulate and affect microbial communities [Kagan, 1981, Alexander, 1981, Ananieva, 2003]. The need for a systematic study of the interaction of pesticides with soil microflora is due to the important role of microorganisms in creating soil fertility and optimizing growing conditions. Therefore, the usefulness of scientific developments in the microbiological method of soil purification from pesticides is important. Intensive research and construction of pesticide-destroying microbial strains and their introduction into natural ecosystems are currently underway [Edwards, 1969, Matsumura et al., 1972, Fest, Schmidt, 1973, Kaemmerer, 1973, Janke, Fritsche, 1983, Menzie, 1989, Zaborina. et al., 1997; Kochetkov et al., 1997; Plotnikova et al., 2001; Shevelukha et al., 2003]. Also relevant are the issues of replacing toxic drugs with new types of drugs that are less polluting and have the ability to break down under the influence of microorganisms.

Transformation of organic residues of plant, animal and microbial origin is a very important process that determines the existence of the biological cycle of elements in nature. The bulk of organic matter transformed in the soil are polymeric compounds such as cellulose, pectins, chitin, lignin, humus and others. If materials that are easily decomposed are subject to rapid and sufficiently complete oxidation, the polymer compounds are difficult to break down by microorganisms and therefore remain in the soil for a long time as its organic components. Accordingly, the organic matter of the soil consists partly of not completely decomposed residues and partly of humus, which is an amorphous and dark-colored material of biological, mainly microbial origin.

Humus contains compounds that are difficult to decompose by microorganisms - most often lignin, fats, waxes, carbohydrates and protein components. They are transformed into polymeric compounds that cannot be precisely chemically characterized, undergo microbial transformations involving various groups of saprophytic organisms and include representatives of chemoorganoheterotrophic bacteria.

The rate of transformation of polymeric organic substances in the soil and the nature of the microorganisms that carry it out have a significant impact on the processes of structure formation and the level of soil fertility (distribution of humus on the soil profile, etc.). Due to the intensification of agricultural production (widespread use of mineral fertilizers, intensive tillage systems, land reclamation and highly specialized crop rotations), the processes of microbial decomposition of soil organic matter are significantly accelerated. This stimulates the degradation of humus and is accompanied by a decrease in the structure, absorption capacity, buffering and water holding capacity of the soil, which reduces its fertility. Hence the need to slow down the process of transformation of organic matter in the soil. To solve this problem, it is necessary to master some basic principles of microbial transformation of organic matter in the soil, in particular humus, lignin and other polymeric substances. In the resistance to transformation, the chemical structure of organic matter, the nature of the microbial coenosis of the soil and the conditions of its functioning are important. To this day, not only the composition of many polymeric compounds that are part of the soil organic matter, but also the specifics of its transformation by microbial coenosis and its individual representatives remain insufficiently studied. The current level of anthropogenic impact on the soil is accompanied by a significant change in its ecology. This causes a violation of the natural balance in the microbial coenosis of the soil, the restructuring of its functional and taxonomic structure.Bollag, Liu, 1971, Sadovnikova, 1976, Boethling, Alexander, 1979, Silkina, 1983].

The reaction of soil microorganisms to the action of pesticides is extremely diverse, which depends on the chemical nature, persistence of drugs, soil and climatic characteristics of the region, etc. [Gruzdev, 1987; Kruglov, 1991]. The need for a thorough study of the interaction of pesticides with soil microorganisms is due to their extremely important role in creating and maintaining soil fertility and optimizing the growing conditions of plants. Of particular importance are the results obtained under the conditions of application of the microbiological method of soil release from pesticides [Vasilieva et al., 1994]. In this regard, the search for strains of microbes-destructors of pesticides and the possibility of their introduction into natural ecosystems is quite intensive [Zaborina et al., 1997; Kochetkov et al., 1997; Plotnikova et al., 2001; Shevelukha et al., 2003]. The total contribution of soil microorganisms in detoxification processes is estimated from 10 to 70% [Golovleva, Golovlev, 1980; Alferov et al., 2003]. It is believed that this variability is due to the variety of chemical compounds used as pesticides. At the same time, the frequency of detection of individual destructive strains in the soil is low. It has been established that repeated use of pesticides stimulates a change in the microbial coenosis of the soil in the direction of increasing the relative share of microorganisms that are able to decompose these pesticides [Pipke, Amrhein, 1988].

The problem of decomposition of pesticide residues in the soil is an extremely important issue of environmental protection. Microorganisms can most effectively decompose xenobiotic substances alien to the biosphere. This ability is associated with the number and high level of adaptation of biochemical reactions. Methods alternative to microbial treatment of the biosphere from pesticide contamination do not currently exist. The method of cleaning soils contaminated with agrochemicals with the use of microorganisms - biodestructors is characterized by high efficiency and efficiency [Reshetov, Tugaeva, 2012]. In addition, quite importantly, biodegradation is a natural process that makes this method acceptable to the public consciousness [Kruglov, 1991].

There are physical, physicochemical and biological factors of detoxification. Physical factors include sorption of biocides by highly dispersed minerals and organic soil colloids. This process depends on the properties of soils and adsorbent, climatic and environmental factors. Thus, pesticides introduced into the soil during cold and wet weather are bound by the top layer of soil, and therefore are not washed out and do not decompose. During the warming period, they are desorbed and again show their activity. Some time after the introduction of the pesticide into the soil, an equilibrium is established between the sorbed and the fractions of the toxicant in solution. Regarding the degree of desorption of the toxicant, it is customary to assess its content in the liquid phase. Physical factors of detoxification also include evaporation and thermal decomposition. The degree of evaporation of toxicants from the soil significantly depends on its moisture - the sorption of volatile pesticides in dry soil is much higher than wet. Decomposition of the toxicant increases with increasing temperature [Young, 1987].

Of the physicochemical factors, the most significant is photodegradation (photolysis), the main active principle of which is long-wave ultraviolet rays of solar radiation. At the same time, many pesticides and their metabolites are oxidized on the surface of soil, plants and water bodies. At the second stage of photolytic decomposition of the pesticide, its interaction with water molecules becomes especially important. The pH of the solution, temperature, composition of gases and properties of the compounds present in the water also play an important role. Under the action of the short-wave part of solar radiation, a significant amount of phenols and related compounds are able to be converted into hydroquinone and pyrocatechol, which can be hydroxylated to tetraoxybenzene. The latter as a result of oxidative condensation can be converted into stable polymerized products.

Chemical transformations of pesticides in soil and aquatic environment are mainly hydrolytic and oxidative processes. The speed of these processes depends on the type and number of halogen atoms and the length of the hydrocarbon chain. The increase in the contact of the toxicant with the soil accelerates the hydrolysis (for example, the colloidal fraction of the soil catalyzes the reactions of pesticides with various active particles of soil components). A significant role in the chemical decomposition of pesticides belongs to free radical processes. Sources of free radicals in the soil are humic acids, resins, pigments, antibiotics and vitamins [Sokolov et al., 1994].

Biological transformation and decomposition of pesticides in the soil is mainly due to microbiological detoxification. It has been established that microbiological decomposition of pesticides is the main way of detoxification of soils, and any activation of microbiological activity causes the disappearance of pesticides from soils. The rate of microbiological decomposition of pesticides in the soil is determined by the humus content, soil temperature and humidity, the presence of litter, nutrient content and other factors. The rate of decomposition of pesticides in the soil is influenced by the mechanical composition of the soil, the reaction of its environment and hydrothermal conditions. On loamy soils, pesticides decompose faster than on light soils; organochlorine pesticides in acidic soil last longer than alkaline. Soil organic matter binds a significant amount of pesticides in water-insoluble and inaccessible to soil organisms forms, as a result of which toxicants are not hydrolyzed, and despite the high biological activity of humus-rich soils, they remain in them for a long time. The increase in soil temperature promotes the desorption of pesticides bound by colloids. These processes are also influenced by redox soil conditions: some pesticides are metabolized faster under anaerobic conditions, and others - aerobic [Anhalt et al., 2000].

It is believed that the soil, as a biological system, is rich in various microorganisms and enzymes, and is able to transform any natural organic matter. As a result, there is a degradation of synthetic compounds, including pesticides, because they are in their structure and chemical bonds are analogs of natural compounds, and therefore capable of microbiological decomposition [Karasevich, 1982; Vasilenok et al., 2000; Alferov et al., 2003; Kokke, 1970; Chacko, Lockwood, 1987; Grunzi, Bread, 1987]. This prediction was made by the former Soviet microbiologist E.M. Mishustin (1964), who emphasized that chemical compounds of organic or synthetic origin can be used by certain types of soil microorganisms.

The main factor in the degradation of xenobiotics in the soil is the ability of microorganisms to induce enzymes of the preparatory cycle for the successful myrobiological transformation of pesticides [Krivosheeva et al. 2003]. This is confirmed by studies that have shown that the ability to degrade, largely depends on the similarity of the chemical structure of the pesticide molecule and the natural analogue. The author of the study believes that the mechanism of decomposition of pesticides in soil under the influence of microorganisms occurs as a result of chemical processes - dehalogenation, dealkylation, amide or ether hydrolysis, oxidation, reduction, rupture of ether bond, hydroxylation of aromatic ring or its rupture [Gruzdev, 1987.

In chemical reactions that stimulate the decomposition of organic matter, the main factor is the ability of microorganisms to secrete one or another enzyme. Detoxification and degradation of pesticides in natural ecosystems occurs under the action of microorganisms, and therefore they play a leading role in this process. This is due to the huge variety of soil microorganisms, the lability of their cells, the extraordinary adaptability and the enzymatic system, which is quite highly specific against xenobiotics, which causes different ways of decomposition of pesticides. Among them there are two main: a slight modification of the drug molecule, or transformation and its complete decomposition or mineralization [Singirtsev et al., 1994; Leontiev et al., 2000].

It was found that under conditions of increasing soil temperature and humidity there is increased decomposition of herbicides, which is preceded by a lag period during which certain species of microorganisms adapt [Ovchinnikova, 1987]. Under the prevailing microbiological factor of pesticide decomposition on the curve of the dynamics of their content in the soil is usually a lag period, during which the adaptation of the microflora, the number of pesticide residues varies slightly. The presence of such a period is characteristic of herbicides of group 2,4-D [Chkannikov, 1983].

Microorganisms play a decisive role in the decomposition of 2,4-D, provided that the substance is homogeneously distributed in the liquid phase of the soil and is not associated with its organo-mineral colloids, and does not affect the active soil microflora [Galiulin, 1992]. Degradation of 2,4-D can be carried out by many microorganisms, including bacteria of the genera Rhizobium, Corinebacterium, Agrobacterium, Arthobacter, Achromobacter, Flavobacterium, Pseudomonas, as well as actinomycetes and fungi: Nocardia, Penicillium, Aspergillus. In addition, some strains of bacteria have been identified that contain 2.4 – D-specific plasmids that are transmitted from one cell to another and thus transfer the genetic ability of bacteria to decompose 2,4 – D [Chkannikov, 1983; Ausmes et al., 1988]. The process of decomposition of 2,4 – D by microorganisms occurs in different ways. From decomposition products, 2,4-dichlorophenol, 3,5-dichloropyrocatechin, 3-chloropyrocatechin and 4-chloropyrocatechin were isolated from the benzene ring. Bacteria can also dechlorinate aliphatic acids, and THL in the soil can decompose the bacterium

Pseudomonas dehalogens and the fungus Trichoderma viride [Azamatova, Gabrilovich, 1988].

The ability of bacterial strains to biodestruct the herbicide 2,4-D by the residual amount of active substance by liquid chromatography was studied. Analysis of chromatograms showed that the studied strains of microorganisms use 2,4-D as a carbon source for 7 days, and during the first 6 hours of growth they only absorb it. The formed metabolites are then released into the culture fluid [Kozlova et al., 2009]. The intensity of microbiological degradation of pesticides, in addition to biotic factors, is also influenced by abiotic, among which we can distinguish soil type, pH, temperature, humidity and the nature of adsorption [Zhemchuzhin, 2002].

Among the abiotic factors it is necessary to dwell on the question of the influence of soil temperature and humidity. Under conditions of moisture deficiency, the degradation of, for example, DDT insecticide is slowed down by 1.3-1.8 times, compared to soil, where soil moisture conditions are more optimal. Insecticides are the most resistant to microbial decomposition compared to other groups, such as phosphorus-containing compounds and carbamates [Ananyeva, 2001].

The natural process of self-cleaning of the soil from pesticides and other pollutants may be accompanied by a violation of their stability. Therefore, we can predict that self-cleaning of the soil is one of the mechanisms for maintaining a stable state of the natural system. In addition, self-cleaning of the soil from pollutants is a mechanism for overcoming the action, and thus, maintaining the resilience of the natural ecosystem. The resistance of the soil system against natural and anthropogenic actions is associated with their biological stability, which is determined through the functioning of the microbial community. The response of a microbial community to soil stress can be qualitatively and quantitatively recorded using an integrated indicator, which is the ratio of community activity (respiration) to its mass. This indicator reflects the ecophysiological status of the soil microbial community,

Thus, self-cleaning from pesticides and resistance of soils against anthropogenic action occurs through the functioning of microbial communities, which are transformers of organic matter, including pollutants, and stabilizers of terrestrial ecosystems. Self-cleaning of soils from pesticides correlates with the biomass of soil microorganisms, which are determined by the method of substrate-induced respiration. Therefore, for the predicted assessment of soil self-cleaning from pesticides, including in a certain area, it is enough, instead of time-consuming and expensive cost analysis of pesticide content in soils, to measure their microbial biomass. Spatial soil-microbiological indicators (basal respiration, microbial biomass, metabolic coefficient) are presented in the form of computer maps, which can be used as a tool for differential assessment of self-cleaning ability of soils from organic pollutants, as well as biomonitoring and soil monitoring. The resistance of soils against anthropogenic action can be characterized by the value of the microbial metabolic rate. A change in its value, as a rule, may indicate a violation of the stable state of the soil. It is shown that the use of sensitive express and economically justified indicators of soil microbiological condition is possible to characterize the self-cleaning of soils from pesticides, as well as to assess their biological resistance against anthropogenic actions [Ananyeva et al., 1985, 1991, 1993, 1997]. The resistance of soils against anthropogenic action can be characterized by the value of the microbial metabolic rate. A change in its value, as a rule, may indicate a violation of the stable state of the soil. It is shown that the use of sensitive express and economically justified indicators of soil microbiological condition is possible to characterize the self-cleaning of soils from pesticides, as well as to assess their biological resistance against anthropogenic actions [Ananyeva et al., 1985, 1991, 1993, 1997]. The resistance of soils against anthropogenic action can be characterized by the value of the microbial metabolic rate. A change in its value, as a rule, may indicate a violation of the stable state of the soil. It is shown that the use of sensitive express and economically justified indicators of soil microbiological condition is possible to characterize the self-cleaning of soils from pesticides, as well as to assess their biological resistance against anthropogenic actions [Ananyeva et al., 1985, 1991, 1993, 1997].

Microscopic fungi assimilate various carbon compounds and synthesize from them the components of the cell. Some species are extremely omnivorous, which can use a variety of compounds for their diet. Digestibility is determined by the composition, structure and configuration of their molecules. Any organic matter first decomposes into simpler compounds, and those, in turn, are involved in a particular biosynthetic process. The energy generated under the conditions of decomposition accumulates in the form of adenosine triphosphate (ATP) and other compounds that have macroenergetic bonds. Thus, organic substrates provide both energy and constructive aspects of the metabolism of fungi and bacteria [Lilly, Barnet, 1953].

Under the conditions of biodegradation of pesticides terbuthylazine, difenoconazole pendimethalin, different types of fungi were involved - from parasites to saprophytes: Fusarium oxysporum, Aspergillus oryzae, Lentinula edodes, Penicillium brevicompactum and Lecanicillium saksenae. Among pesticides, terbuthylazine is considered the most resistant. The highest percentage of removal of terbuthylazine from the liquid medium was achieved with Aspergillus oryzae - degradation was 80% [Pinto et al., 2012].

Degradation properties of fungi can be dual in nature [Kunanbaev, 2010]. According to American researchers who conducted field studies in Missouri of transgenic glyphosate-resistant varieties of corn and soybeans, the colonization of the rhizosphere of plants by populations of Fusarium and individual bacteria was shown. The frequency of Fusarium colonization increased significantly after the application of glyphosate during the growing season each year at all sites.

Researchers believe that the herbicide served as a nutrient for phytopathogenic fungi and stimulated their growth [Robert, Nathan, 2009].

The monitoring of changes in the number of microbes in the soil containing various pesticides allows us to conclude about their selective effect on the physiological groups of microorganisms. Chlorthiazide, cardboard and nitrolone were destroyed by bacteria of the genus Bacillus (B. mycoides, B. megaterium, B. subtilis) and Pseudomonas fluorescens, which can be used as destructors of these pesticides. Representatives of these genera of bacteria probably cause detoxification of the soil from various xenobiotics. The introduction of optimal doses of destructive bacteria, established experimentally, can have a significant impact on the level of concentration of pesticides in such an important natural environment as soil [Xenofontova, Chirov, 2005].

Soil microorganisms-destructors of organochlorine compounds Pseudomonas putida IMV B-7289, P. putida UKM B-398, Bacillus megaterium IMV B-7287 and Stenotrophomonas maltophilia IMV B-7288 are synthesized and produced in the environment of cultivation. and abscisic acids. Qualitative and quantitative composition of phytohormones synthesized by microorganisms is characterized by strain differences. P. putida UKM B-398 is the most active producer of extracellular gibberellic acid, auxins and cytokinins. Strain P. putida UKM B-398 is important as a promising component of the microbial preparation and can be used in combination with effective destructors of HCG B. megaterium IMV B-7287 and P. putida IMV B-7289 [Yamborko et al., 2016].

Bacterial strains resistant to organophosphorus pesticides were isolated from soil samples in the Kirov region (Russia). It was found that the selected cultures are able to grow on simple synthetic media containing malathion (up to 4000 mg / dm3), dimethoate (up to 500 mg / dm3) and trichlorophone (up to 100 mg / dm3). According to the combination of morphological-cultural and physiological-biochemical features, 6 strains of bacteria belong to the genus Pseudomonas. It was found that they can use malathion as the only source of carbon and energy (malathion utilization in nutrient media is shown by chromato-mass spectrometry), while the indicators of deep cultivation, critical concentrations of malathion and maximum growth rates are determined. For two strains (Pseudomonas sp. M1 and Pseudomonas sp. M2) it is shown that they do not show phytopathogenic activity against germinating radish seeds. All this allows us to consider the available strains in further studies in order to create drugs for bioremediation of soils that are contaminated with organophosphorus compounds [Vasilkova et al., 2008].

The main component of pesticide detoxification is the decay rate constant. The degree of danger was established and ecotoxicological characteristics of their use in different soil and climatic zones of Ukraine were carried out. It is proved that the use of moderately dangerous heterocyclic pesticides with low consumption rates is a rational measure of their safe use [Kavetsky, Andrienko, 1986, Andrienko, 1999].

Detoxification of pesticides in the soil and plants of spring crops depends on the energy saturation of their cultivation technologies. It was found that the detoxification of pesticides in the soil is the highest in the variant with energy-saturated, and the lowest - in the control. The decomposition of pesticides in plants has a similar dependence on their detoxification in the soil. In plants of wheat, barley and oats, the decay rate constants of pesticides are the highest, and the half-lives are the lowest in the variant with energy-intensive technology. It is confirmed that the resistance of pesticides can be characterized by their polarity, ie the magnitude of the dipole moment. The idea of the influence of pesticides on the enzymatic activity of soil is deepened, according to the results of researches of determination of activity of enzymes of oxyreductase class.

According to the integrated classification, pesticides used in technologies for growing spring crops using energy-intensive technology were characterized by a lower degree of environmental hazard compared to control. The pesticides basagran, grodil ultra, alto 400 and dividend Star had the 5th degree of danger under control, which allows to classify them as moderately dangerous compounds, on the variant with energy-intensive technology - the 6th (low-hazardous compounds). The risk assessment of pesticide application was performed according to the agroecological index - AETI. It is shown that the rate of decomposition of pesticides in intensive technologies for growing spring crops is higher than in the control, which, in turn, reduces the load of drugs on the agrocenosis of spring crops. With energy-intensive technology for growing spring crops, the risk of pesticide use is reduced by 1.5-2 times,

Among agrotechnical measures on dark gray podzolic soil of the Western Forest-Steppe of Ukraine, under conditions of use of various quantity of organo-mineral fertilizers in combination with liming, the most effective influence on decrease in level of organochlorine pesticides and their derivatives and productive qualities of ear and grain of barley. with joint application of mineral fertilizers on the background of organic (manure) and in combination with liming (CaCO3 (1.5 Ng) + N90 P90 K90 + 10 t / ha of manure). The results of the research are of practical importance and can be used during the cultivation of spring barley on soils contaminated with organochlorine pesticides. Their introduction into production will help solve environmental problems of protection of agro-landscapes of the Western Forest-Steppe of Ukraine [Ivankiv, 2015].

In the conditions of the Right-Bank Forest-Steppe of Ukraine intensive models of technology with introduction N 60-90 P 60-90 K 60-90 at optimum terms and norms of introduction of means of protection of plants, cause increase of speed of detoxification and disintegration of pesticides in plants that provided reception of qualitative on ecological indicators of production spring triticale [Piskunova, Egupova, 2012].

Basidial fungi - lignin destructors capable of growing in the presence of thiomorpholine derivatives - a mixture of 1,4-perhydrotizans, in particular strain Bjerkandera adusta VKM F-3477, with the maximum growth rate in the presence of these compounds, were selected and its destructive ability against thiomorpholine was studied. It is shown that the strain Bjerkandera adusta VKM F-3477 does not use a carbon source, but transforms into thiomorpholine sulfoxide, which accumulates in the environment [Ermakova et al., 2008]. As for glyphosate, a significant amount of research is aimed at isolating glyphosate-degrading microorganisms and identifying ways of their metabolism. From the soil identified microorganisms of different taxonomic groups - Achrobacter, Flavobacterium, Pseudomonas and others that are able to decompose glyphosate under conditions of cultivation on artificial nutrient media [Balthazor, Hallas, 1986; Jacob et al., 1988; Pipke, Amrhein, 1988]. A significant number of bacterial isolates utilize glyphosate as a source of phosphorus [Balthazor, Hallas, 1986; Liu et al., 1991].

Gas chromatographic analysis showed that during the exponential growth phase of the bacterial culture of Acinetobacter sp. K7 is complete decomposition of glyphosate from the culture medium. In biomass extracts collected on the 4th day of growth, less than 1% of the applied glyphosate was registered [Kryuchkova et al., 2010]. The strain Ochrobactrum anthropi GPK 3 proved to be a more intense destructor of glyphosate in nutrient media compared to known analogues.

Glyoxylate and aminomethylphosphoric acid (AMPK), which are products of the enzyme glyphosate oxidoreductase, were detected in the cytoplasm of GPK strain 3. Under growth conditions, AMPK was metabolized with a rupture of the CP bond, due to which the cells supplied themselves with orthophosphate. Subsequently, the strain Achromobacter sp. Kg16, which provided more efficient destruction of glyphosate in soil conditions, compared to Ochrobactrum anthropi GPK 3. This phenomenon was associated with the previously not covered in the literature ability of Achromobacter sp. Kg16 decarboxylate glyphosate and rapidly convert it to physiologically neutral N-methyl AMPA. Achromobacter sp. Kg16 could not use this compound as a source of phosphorus, which explains its low growth characteristics in liquid minimal media compared to soils.

Thus, the identified differences in the behavior of glyphosate destructive strains allowed to propose a scheme of interaction in the microbial community in glyphosate-contaminated soil. Active strains*Ochrobactrum anthropi*GPK and a number of others in this consortium are able to destroy glyphosate through glyphosate oxidoreductase, and the products of destruction - AMPK and orthophosphate, to support the growth of Achromobacter sp. Kg16. In turn, the function of Achromobacter sp. Kg16 may consist in the rapid conversion of glyphosate to a non-toxic form of bacteria and available for cleavage by most glyphosate destructors, which in turn supplies Achromobacter sp. Kg16 orthophosphate [Epiktetov et al., 2014]. Under the conditions of growth of the strain Achromobacter sp. Kg 16 in a medium with glyphosate is the acetylation of the herbicide and the accumulation of acetylglyphosate (ACGF), which can be used by bacteria as the only source of phosphorus. Study of glyphosate metabolism in the strain Achromobacter sp. Kg16 showed the functioning of a new mechanism for the conversion of glyphosate to ACGF and the subsequent utilization of the latter, associated with the rupture of the CP bond, which confirms a significant number of ways to destroy the herbicide by microorganisms along the phosphonate and sarcosine pathways. However, the physiological role of glyphosate acetylation in Achromobacter sp. Kg 16 remains unclear. The obtained results can be used under the conditions of creating transgenic plants that are resistant to the herbicide glyphosate. In addition, the high destructive activity of the strain Achromobacter sp. Kg 16 in the soil allows us to consider it as a basis for the development of methods for biological treatment of liquid media and soil from glyphosate contamination in industry and agriculture [Shushkova et al., 2015]. which confirms a significant number of ways of destruction of the herbicide by microorganisms along with phosphonate and sarcosine pathways. However, the physiological role of glyphosate acetylation in Achromobacter sp. Kg 16 remains unclear. The obtained results can be used under the conditions of creating transgenic plants that are resistant to the herbicide glyphosate. In addition, the high destructive activity of the strain Achromobacter sp. Kg 16 in the soil allows us to consider it as a basis for the development of methods for biological treatment of liquid media and soil from glyphosate contamination in industry and agriculture [Shushkova et al., 2015]. which confirms a significant number of ways of destruction of the herbicide by microorganisms along with phosphonate and sarcosine pathways. However, the physiological role of glyphosate acetylation in Achromobacter sp. Kg 16 remains unclear. The obtained results can be used under the conditions of creating transgenic plants that are resistant to the herbicide glyphosate. In addition, the high destructive activity of the strain Achromobacter sp. Kg 16 in the soil allows us to consider it as a basis for the development of methods for biological treatment of liquid media and soil from glyphosate contamination in industry and agriculture [Shushkova et al., 2015]. The obtained results can be used under the conditions of creating transgenic plants that are resistant to the herbicide glyphosate. In addition, the high destructive activity of the strain Achromobacter sp. Kg 16 in the soil allows us to consider it as a basis for the development of methods for biological treatment of liquid media and soil from glyphosate contamination in industry and agriculture [Shushkova et al., 2015]. The obtained results can be used under the conditions of creating transgenic plants that are resistant to the herbicide glyphosate. In addition, the high destructive activity of the strain Achromobacter sp. Kg 16 in the soil allows us to consider it as a basis for the development of methods for biological treatment of liquid media and soil from glyphosate contamination in industry and agriculture [Shushkova et al., 2015].

Under the study of sorption and microbial destruction of glyphosate - the active substance of the herbicide ground bio - it is shown that in the process of inoculation of native suspension of sod-podzolic soil cells of selected strain-destructor Ochrobactrum anthropi GPK 3 total soluble and extracted 25% as in the uniculated suspension did not exceed 5.5%. The possibility of using a selected bacterial strain to intensify the processes of glyphosate destruction in soil systems was also demonstrated [Shushkova et al., 2009].

Rhizosphere strain of Acinetobacter sp. K7 was isolated from Jerusalem artichoke rhizoplast, which retained the ability to grow on glyphosate medium during repeated reseeding. Analysis of the culture fluid by gas chromatography showed a significant reduction in the peak area of glyphosate, compared with the control (agar medium according to Murashige and Skuga + glyphosate without bacteria). The decrease in the concentration of the herbicide in the medium after 5 days of culturing the bacteria was 50% of the original. The method of thin-layer chromatography of the culture fluid allowed to establish the presence of two main metabolites: sarcosine and glycine, which are formed during the degradation of glyphosate by the C-P-lyase pathway. At the same time, aminomethylphosphonic acid, which is formed under the conditions of glyphosate cleavage by the C-N pathway, was not detected in the culture fluid. Anyway, the results obtained allow us to conclude about the ability of the strain Acinetobacter sp. K7 degrade glyphosate and use it as a source of phosphorus [Kryuchkova et al., 2009].

Changing the tillage system with a tendency to minimize stimulates its compaction, reduced macroporosity, aeration and permeability, resulting in changes in qualitative and quantitative indicators. Leaving plant residues in the field determines the concentration of microbial biomass in the layer from 5 to 15 cm and, thus, the survival of pathogenic microorganisms [Sturz et al., 1997]. It is shown that phytopathogenic fungi Alternaria, Bipolaris and Fusarium are able to form a pathocomplex and show hyperparasitic properties [Rukavitsina et al., 2002].

The main product of the destruction of organophosphorus pesticides in the soil is extremely stable methylphosphoric acid (IFC), which can accumulate in the soil and plants and be completely mineralized by a number of microorganisms that use it as a source of phosphorus for growth. IFC and its acid esters are capable of forming insoluble salts of calcium, aluminum, iron and others in the soil. The maximum ability to dissolve these salts was found in strains of Pseudomonas aureofaciens KR31, Pseudomonas fluorescens 2-79, Pf-5, P54, 1C7 and Pseudomonas aureofaciens KR31, IG1 and OV17. Encouraging results have also been obtained regarding the use of the bacterial strain Alcaligenes sp. Sm11 [Skorobagatova et al., 2010].

The most resistant to contamination with different concentrations of the pesticide tetramethylthiuram disulfide (TMTD) are heterotrophic bacteria that live in common chernozem. The presence of this pesticide in the soil stimulates the growth of bacteria, the number of which by the 30th day of the experiment exceeded the control by 1.5 times. Actinomycetes and, to a lesser extent, fungi are the most sensitive to soil contamination by the TMTD pesticide. Different concentrations of this pesticide have a toxic effect on the population of actinomycetes and soil fungi, inhibit their growth and development during the experiment. From the aboriginal microflora of common chernozem, three dominant strains of bacteria using the pesticide TMTD, ie the only carbon source, and one strain of bacteria as a pesticide cosubstrate were isolated. Under the conditions of cultivation of strain Tm4 in a liquid mineral carbon-free environment, containing 300 mg / l of pesticide as the only source of carbon, clear changes in the spectral characteristic were obtained, which indicates the transformation of the pesticide. The apparent number of the isolated strain of microorganisms within 7 days was also established. One strain of bacteria was obtained, which has the most active destructive potential. The identification of the isolated strain of TMTD pesticide destructor was carried out on the basis of the study of phenotypic traits, which allowed to classify it as a species of Pseudomonas putida. Therefore, in case of contamination of common chernozem, which occurred under conditions of high doses of TMTD and long-term use in the same area, violation of deadlines, application technology and emergencies, it is recommended to apply to the soil biodestructor of this pesticide strain Pseudomonas putida Tm4. clear changes in the spectral characteristic were obtained, which indicates the transformation of the pesticide. The apparent number of the isolated strain of microorganisms within 7 days was also established. One strain of bacteria was obtained, which has the most active destructive potential. The identification of the isolated strain of TMTD pesticide destructor was carried out on the basis of the study of phenotypic traits, which allowed to classify it as a species of Pseudomonas putida. 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Chemical-analytical studies of soil samples containing the pesticide TMTD at a concentration of 100 MPC showed that the use of agricultural products (watering, loosening, mixing), as well as the introduction of the strain Pseudomonas putida Tm4 cause rapid degradation of this xenobiotic. The results of toxicity assessment of experimental samples of common chernozem by biotesting methods using Daphnia magna Straus biotests revealed high toxicity of samples of soil contaminated with TMTD pesticide for up to 30 days of the study. The results of experiments on samples of soil contaminated with pesticide and applied biodestructor, showed a low degree of toxicity at 7 and 30 days. This indicates the absence of acute toxicity in the samples, which can not be considered harmless in terms of toxicity [Tugaeva, 2013].

It is established that the transformation of organic matter in the soil is carried out by both aerobic and anaerobic microorganisms. Among anaerobic bacteria it is necessary to allocate a group of microorganisms belonging to the genus Clostridium. It is one of the most common groups in almost all soils, actively involved in soil processes that involve the transformation of simple and complex organic compounds, including carbohydrates, polysaccharides, proteins, nucleic acids, purine and pyrimidine bases, lipids, humic substances, petroleum products and other substances [Mishustin, Emtsev, 1974, Emtsev et al., 1977, Emtsev, 1982, 1985, 1986, Ruchko, Tuev, 1984]. The participation of bacteria of the genus Clostridium in the transformation of xenobiotics, insecticides and herbicides in the soil has also been proven [Emtsev, 1982]. And since the genus Clostridium includes a number of physiological subgroups of microorganisms,

Sugar (Clostridium pasteurianum) and proteolytic anaerobes (Clostridium sprogenes) are characterized by the ability to transform the herbicides 2,4-D and pyramine and use them as a source of nutrients. It has also been shown that cosubstrates (glucose, peptone, straw) enhance the ability of anaerobes to decompose pyramine, especially with increasing numbers of cosubstrates. The transformation of different fractions of fulvic and humic acids by pyrino- and proteolytic anaerobes of the genus Clostridium has been established. More labile fulvic acid fractions of humus are transformed more intensively than humic acids. Changes in humic compounds as a result of their transformation by anaerobic bacteria occur by oxidation-hydrolytic way, as a result of which the share of peripheral part in humus macromolecules decreases, its carbonization, oxidation and aromaticity increase. Under conditions of transformation of humus fractions by purinolytic bacteria, not only the aliphatic but also the nuclear part of the molecules is destroyed, while proteolytic anaerobes use only the peripheral part of the humus molecules without disturbing their aromatic nucleus. Sucrolytic anaerobes of the genus Clostridium have the ability to transform lignin, which is accompanied by carbo- and hydroxylation of molecules of this substance, an increase in the content of lignin in the carbonyl groups and a decrease in methoxils. Microbial transformation of lignin primarily affects the aliphatic part of its molecules and, to a lesser extent, is found on aromatic fragments. The ability to transform xenobiotics, herbicides into sugar and proteolytic anaerobes was also revealed.

The effectiveness of production and experimental doses of pesticides cartocide, nitrolone, semihinone, chlorothiazide, juglon, herbicide 3249, clay and karate on soil microorganisms was studied. The effect of pesticides on the growth of some phytopathogenic microorganisms in pure culture was evaluated. Bacterial strains that are able to use pesticides in the process of life have been identified. Their growth and destructive indicators in relation to pesticides of different chemical nature are found out. The effect of production and experimental doses of pesticides on the number of shunt microorganisms, which are recommended for accounting under the conditions of development of optimal conditions of their application, is characterized. The pesticides karate, cartocide, chlorothiacid and herbicide 3249 have been shown to undergo microbial decomposition by bacteria of the genera Bacillus and Pseudomonas. Proven destruction of 100 mg / l of chlorothiacid in 96 hours,

A study of the transformation of atrazine in a homogeneous system of lactase - atrazine - humic acids (HA) showed that laccase reduced the level of adsorption of the herbicide, this effect is associated with the modification of HA by the formation of their complexes with laccase. It was found that the process of transformation of atrazine in a homogeneous system of lactase - atrazine - HA

- redox mediator, largely determined by the used redox mediator, which causes 60% transformation of the herbicide in the test system, is 1-hydroxybenzotriazole. The transformation in the heterogeneous system of lactase-atrazine-immunomobilized HA was studied.

In the presence of the enzyme, the binding of atrazine to soils occurs by the mechanism of oxidative binding, which confirms the analysis of isotherms of ad- and desorption, as well as an increase in the amount of irreversibly bound herbicide. Laboratory and vegetation experiments showed the possibility of detoxification of atrazine in soil conditions by its binding to humic acid (HA) by the mechanism of oxidative binding with lactase; for this purpose, the redox mediators necessary for the process are present, apparently, in the soil [Davydchyk et al., 2003].

The use of HA reduces the residual amounts of pesticides in the soil and prevents their accumulation in plants and reduces the number of pesticides under pre-sowing seed treatment [Stepchenko, Sedykh, 2010]. It is known that HA affect the behavior of various organic pollutants in the environment. They are able to bind xenobiotics and non-toxic complexes [McCarthy, Jimenez, 1985, Oris et al., 1990, Misra et al., 2000], or cause their decomposition [Zeng et al., 2002]. Since the binding of toxicants and their decomposition stimulates a decrease in the concentration of free xenobiotic, in the presence of HA there is a decrease in the toxicity of the environment, and its protective properties in the presence of toxicants are often called detoxifying. GC soils can affect the toxicity of herbicides by forming inaccessible to plants complexes and caused the chemical transformation of toxicants. HAs have been shown to cause hydrolysis of triazines and stimulate the formation of non-phytotoxic oxy derivatives [Gamble, Khan 1988].

The intensity of accumulation of organochlorine pesticides and their derivatives in different organs of spring Tselinka barley and the influence of different amounts of organomineral fertilizers in combination with liming on the content in agrobiogeocenoses and grain yield were studied. It is shown that the roots, straw and grain of spring barley differ significantly in the accumulation of organochlorine pesticides (DDT and HCH). Studies on dark gray podzolic soil in the Western Forest-Steppe of Ukraine have shown that when using mineral fertilizers on the background of organic in combination with liming (CaCO3) (1.5 Ng) + N90 P90 K90 + 10 t / ha of manure reduces the level of DDT and HCH in the vegetative parts and increases the grain yield of barley [Ivankiv, 2015].

The rate of decomposition of treflan depends on the method and depth of application, weather conditions and soil type. The half-life of the pivot herbicide in agroecological conditions of the Amur region was 120 days. By the end of the growing season in the soil of the arable layer remained the drug in the amount of 40% of the original, the herbicide during the fall and winter did not decompose and was detected in the spring. During the next growing season there was a gradual decomposition of pivot, but 1.5 years after application, the residues from the norms of 75 and 100 g / ha were 20-30% of the applied. Accordingly, the drug remained in the soil for more than 2 years. The optimal dose of pivot under conditions of application to the soil and treatment of vegetative plants is not more than 50 g / ha. Under favorable weather conditions, the drug, applied in these doses, decomposed in one growing season. Detoxification of 2,4-D in the soil depended on weather conditions. Herbicide at a dose of 1.2 kg / ha d.r. under favorable weather conditions did not contaminate the soil. Treflan did not migrate deeper than 40 cm along the soil profile and did not enter groundwater, which is of important environmental importance [Kharina, 2000].

Detoxification of pesticides in the soil and plants of spring crops depends on the energy saturation of their cultivation technologies. Decomposition rate constants (k, day-1) and half-lives (T50, days) of pesticides in the soil under spring crops on the variant with N90 P90 K90: dialyan super k - 0,144-0,151, T50 - 4,6-4,9 (2,4-D); controls k - 0,077–0,082, T50 - 8,5–9,0 (2,4 – D);

dividend old k - 0.118–0.139, T50 - 5.0–5.9 (difenoconazole); control k - 0,069-0,072, T50 - 9,0-9,6 (difenoconazole); vitavax 200 FF - k - 0,071-0,086, T50 - 8,1-9,2 (carboxin); control k - 0,043-0,046, T50 - 15,1-16,0 (carboxin); basagran k - 0,173, T50 - 4,0, controls k - 0,087, T50 - 7,9; grodil ultra k - 0,193-0,198, T50 - 3,5-3,6, controls k - 0,103-0,108, T50 - 6,4-6,7; alto 400 k - 0,141-0,147, T50 - 4,7-4,9, controls k - 0,097-0,102, T50 - 6,8-7,0; tilt k - 0,120-0,126,

The biocoenotic effect of bactophyte-antidepressant was manifested in the restoration of herbicide-damaged bacterial soil microflora, which is responsible for nitrogen mineralization and immobilization. The consequence of improving the state of the microbiocenosis and nitrogen regime in the soil is a decrease in its oligotrophicity by 4.4-9.8 times. Live culture of Bacillus subtilis in the bactophyte limits the development of phytopathogens from the genera Fusarium and Bipolaris. In the aftermath, by the spring of the following year, the use of bactophyte improved the ecological situation in the soil, by reducing the content of toxigenic fungi and overall phytotoxicity [Kholdobina, 2013].

The ability to utilize the herbicides quinelorac and benzulfuronmethyl was demonstrated by the bacterium Ochrobactrum sr. At the initial concentration of the drug 1.5 mg / l utilization reached 90% [Zhen-Mei et al., 2008]. Studies of herbicides in the field and at high soil moisture, in particular oxadiazone and oxyfluorophene (consumption rates of 0.4 and 0.12 kg / ha), revealed the ability of phosphate-mobilizing microorganisms to use them as a power source [Chandra et al., 2003].

The current generation of insecticides decomposes intensively with the help of soil microflora and direct sunlight. Studies using biprofezin, pyrimicarb, pyrimiphos methyl and pyridaben have shown that insolation stimulates the growth of their degradation, which can serve as an additional tool for the restoration of soils contaminated with insecticides [José et al., 2011]. The example of diazinon has shown that the greatest contribution to pesticide emissions is made by soil temperature, which is directly dependent on soil surface resistance [Reichman et al., 2013].

Bacifor and exophore - drugs of complex action that accelerate the degradation of pesticides and stimulate plant growth, increase 4-10 times the rate of decomposition of organophosphorus pesticides, including Gordon, carbophos and actelic in closed soil [Solovyov et al., 2011].

The values of octanol-water ratio [Kawamoto, Urano, 1990], soil adsorption pesticide constants [Kanazawa, 1989], medium pH [Hiltbold, Buchanan, 1977] and the chemical structure of the pesticide compound [Boethling et al. , 1989].

One of the ways to clean chemically contaminated soils is phytoremediation - a highly effective technology for cleaning soils from various pollutants used directly in contaminated areas [Karthikeyan et all, 2004; Autukhovich, 2010; Nurzhanova, Seilova, 2011]. Phytoremediation is recognized in the world as one of the most cost-effective and environmentally friendly technologies [Yanin, 2014].

An important component of the technology of restoration of soil contaminated with organochlorine pesticides with the help of plants is phytoextraction and phytostabilization. The phytoextraction potential of the plant organism depends on the hydrophobicity of the pollutant. The degree of hydrophobicity largely determines the efficiency of absorption and transport of the pollutant in plants. To increase the efficiency of phytoremediation technology, it is necessary to select favorable environmental conditions [Kalugin et al., 2016].

Given the urgency of ensuring the reduction of environmental impact on the environment, the problem of studying the migration of pesticides in the soil is considered extremely relevant. Of particular concern are areas of persistent pollution where pesticides have accumulated in significant quantities. Here the microflora changes, and therefore the process of natural degradation is disrupted. Existing migration models can be applied only to agrocenoses, so the task is to develop an effective model for predicting the movement of pesticides from sources of persistent pollution [Nazemtseva, Laznenko, 2013].

CHAPTER 6. SIGNS OF DAMAGE AND ASSESSMENT OF PLANTS AND SOIL BY ENVIRONMENTAL POLLUTANTS

Sensitive plants respond to the presence of contaminants in the air or soil by early morphological reactions, including leaf color, chlorosis, yellow, brown or bronze color, various forms of necrosis, premature wilting and leaf fall. In perennial plants, contaminants cause changes in size, shape, number of organs, direction of stem growth or fertility. Such reactions are usually nonspecific [Melekhova, Egorova, 2007]. In plants, under the influence of harmful substances there is an increase in the number of stomata, cuticle thickness, pubescence density, develops chlorosis and necrosis and early leaf fall.

Plants of the second type are battery plants that accumulate in the tissues of pollutants or harmful metabolic products. Under conditions of exceeding the toxicity threshold of a toxic substance for this species, various reactions are manifested - responses consisting in changing the growth rate and duration of phenological phases, biometric indicators and reduced productivity [Vlasyuk, 1983].

It is impossible to obtain reliable quantitative information on the dynamics and magnitude of stress on the basis of morphological changes, but it is possible to reliably determine the magnitude of product losses, and having a graph of dose-effect, calculate the magnitude of stress.

Indicator traits of plants are classified as floristic, physiological, morphological and phytocenotic [Vinogradov, 1964]. Floristic features are differences in the composition of vegetation of areas that are formed due to certain environmental conditions. The presence and absence of a plant species is indicative. Physiological features include features of metabolism, anatomical and morphological - features of internal and external structure, various anomalies of development and neoplasm, phytocenotic - features of the structure of vegetation, including the number, scattering, stratification, mosaic and degree of closed plant species [Melekhova, Egorova, 2007].

For the purpose of bioindication use various anomalies of growth and development of plants - deviations from the general laws. Gigantism and dwarfism are considered ugly. For example, an excess of copper in the soil halves the size of the California poppy, and lead stimulates the dwarfism of tar [Smirnova, 1978].

The use of a functional condition diagnostics system can evaluate various plant protection systems against pests and identify the most effective ones. Express assessment of the functional state on the basis of a set of indicators - photosynthetic activity of leaves and dispersion within one plant allows you to adjust the number of treatments without reducing the effectiveness of protective measures against major pests and diseases [Tsukanova, 2007].

Biomonitoring can be carried out by observing individual indicator plants, the population of a particular species and the state of the phytocenosis. At the species level, a specific indication of a single pollutant is performed, and the population or phytocenosis is the general state of the natural environment [Melekhova, Egorova, 2007].

Some plants respond more intensely to the nature and degree of air pollution, which can serve as living indicators of the environment. Plants can be used both to assess individual air pollutants and the quality of the environment. Detect and measure the amount of specific pollutants in the air by various methods [Smirnova, 1978].

Under the action of the fungicide flexite on chernozem samples of typical and artificial urban soil, hydrolase activity, respiration intensity and number of colonies of forming units of mycomycetes are significantly inhibited. Heavier in particle size distribution and less enriched with organic matter urban soil shows higher resistance to fungicidal action in terms of respiratory intensity and the total number of myxomycetes [Akulova, 2013].

The relative rate of slow chlorophyll fluorescence is more sensitive than the rate of rapid, and more responsive to anthropogenic effects. The results showed differences in the functioning of the photosynthetic apparatus of Scots pine in areas with different anthropogenic loads. Bioindication of the state of the environment using the fluorescence of chlorophyll of pine needles is a fast, relatively cheap, innovative and promising method for operational control of the state of the environment [Andreev, 2013]. Pesticide-infected modifications of Scots pine seedlings allow their use to visually assess the degree of soil contamination of forest nurseries. It is proposed to use pine as a test object for bioindication of pesticide contamination instead of traditional methods, for example, using radishes,

Soil oxidase enzymes (arylomidase, -glucosidase) can be used as an early indicator of soil contamination with pesticides to assess their stability after anthropogenic disturbance [Carine et al., 2011]. Biological assessment of the quality of the environment gives a comprehensive description of its suitability for wildlife and human cultivation of certain crops, such as Scots pine in forest nurseries [Freiberg, Stetsenko, 2013].β

The principle of the method of functional diagnostics of plants in the conditions of industrial crops is to assess the change in the reaction of chloroplasts in response to the agent (battery), which has an activating or inhibitory effect. To do this, pre-investigate the phytochemical activity of the initial suspension of chloroplasts isolated from the leaves of diagnosed plants, then add the evaluated agent in a certain concentration and again determine the photochemical activity. In the case of increasing photochemical activity of chloroplasts in relation to control (without adding test elements) formulate a conclusion about the lack of this element, and when reduced - excess, with the same activity - the optimal concentration of the evaluated agent in the nutrient medium [Komarov et al., 2013].

The use of phytotesting in field experiments during the growing season allows to determine the dynamics of total toxicity, which is due to physico-chemical and biological processes and is accompanied by changes in the structural-microbial community. The use of phytotesting allows for expressive control, which should be used for expert assessment and restoration of the ecological state of the agrocenosis during the growing season. Its practical application provides the cultivation of high quality agricultural products [Voronina, 2013].

Nostoc commune natural biofilms, which are multi-species natural microbiocenoses, show a clear reaction to soil pollution. Under the conditions of pollution, the structure of the community of biofilms changes: the species diversity of algae and cyanobacteria sharply decreases, the density of their cells decreases. The dominant role of Nostoc commune and other heterocystic cyanobacteria is gradually shifting to heterocystic species, and the number of heterotrophic nitrogen-fixing bacteria is also decreasing. The contribution to the structure of myxomycete biofilms, especially their mechanized forms, is significantly increasing. It is shown that a simple expressive and accurate method of biotesting the toxicity of pollutants is to determine the viability of cells of pure cultures of nitrogen-fixing heterocystic species of cyanobacteria of the genus Nostoc by their dehydrogenase activity [Domracheva et al., 2013].

For ecotoxicological assessment of bioremediation processes in soils contaminated with toxic chemicals, biotesting for daphnia and earthworms can be recommended. It allows you to quickly and efficiently determine the integrated toxicity of the soil in the process of bioremediation and the effectiveness of biotechnology, the decomposition of pollutants are low-toxic to the environment [Zharikov et al., 2013].

Therefore, soil enzymes oxidase (arylomidase, β-glucosidase) can be successfully used as an early indicator of soil contamination by pesticides to assess their resistance after anthropogenic disturbance [Carine et al., 2011].

CHAPTER 7. THE ROLE OF THE BIOLOGICAL METHOD OF PLANT PROTECTION IN THE SPREAD OF ROOT ROT

The essence of the biological method of control of phytopathogens is to use microorganisms or products of their activity to inhibit the development of pathogens. In recent times, this method is receiving more and more attention due to the fact that the widespread use of the chemical method poses a danger to humans and disrupts environmental processes in nature. Even in the last century, a significant number of researchers have paid attention to the antagonistic properties of microorganisms.

Antagonism is quite common among various groups of microorganisms, which is found in bacteria, actinomycetes, fungi, algae and others. The causes of the phenomenon of antagonism are quite diverse, and may be due to the use of different organisms that grow together, the same nutrients. In this case, there is a competition between species for food sources. Under conditions of co-development on the same substrate of life forms that have the same needs for nutrients, the advantage will be in the one that has a more intense growth rate [Buckley, Schmidt, 2003]. For example, under conditions of joint simultaneous seeding of bacteria and actinomycetes on a substrate equally used by them, the displacement of actinomycetes by bacteria is observed.

Bacteria, as organisms with a more intense rate of growth and reproduction, inhabit the substrate faster and use nutrients more fully. As a result, actinomycetes remain growth potential and are gradually displaced from the substrate. However, inhibition of actinomycete growth may not occur if it secretes specific metabolic products that inhibit bacterial growth. Under natural conditions, antagonism of this type is most often observed in the soil, where there is a competition between microorganisms for food sources. Phytopathogenic microorganisms also take part in this process, the vital activity of which is quite often suppressed due to the active reproduction of saprophytic microorganisms [Popkova, 2005].

Applying green manure to the soil, especially crushed rye plants, inhibits the development of the pathogen of common potato scab Streptomyces scabies. This is due to the fact that in the presence of green mass of fertilizers in the soil there is a rapid accumulation of saprophytic microorganisms that use it as a nutrient substrate. Both mycelium and bacterial populations of microorganisms grow significantly in the soil, as a result of which competition for nutrients and antagonistic relationships in the microbiocenosis increases significantly. In this competition, the pathogen - the causative agent of potato scab - does not have favorable conditions for growth and development, and its number in the soil is significantly reduced [Popkova, 2005].

Antagonism of microorganisms can also be caused by the formation of antibiotics. This form of antagonism is the most common among microorganisms. Specific metabolic products of some species that inhibit or completely inhibit the development of others are called antibiotics. These are specific products of life that have high physiological activity against certain groups of organisms, including viruses, bacteria, fungi, actinomycetes and others. Antagonism between microorganisms is widely used in the fight against phytopathogens. The most important are the following areas of use of antagonists to suppress pathogens: 1) creating conditions conducive to the accumulation in the soil of microbial antagonists; 2) the use of cultures of antagonists for the localization of phytopathogens [Leontievskaya, 2014].

Root rot is one of the most common and harmful diseases of cereals. The signal of the trouble of agrocenoses is the high density of infectious agents of the pathogens of this disease in the soil and on the seed material, which does not comply with the principles of ecological plant protection. The use of traditional methods and protection systems in these conditions does not always reduce the harmfulness of the disease. In this regard, the fight against root rot pathogens in recent years has become problematic, and the use of only a chemical method of protection does not always give the desired results, as reduced species diversity of microorganisms in the agrocenosis with the emergence of resistant forms of pathogens.

Pathogens of root rot produce hydrolytic enzymes and toxins: Bipolaris sorokiniana (Sacc.) Schoemaker - helminthosporosis, helminthosporal, victoxin, cytokinin [Velikanov, 1978; Pringle, 1977; Vadavs, Mandahar, 1981], and species of the genus Fusarium spp. fusaric acid, isomarticin, zearalenone, etc. [Bilay, 1977]. An important point in the life cycle of Bipolaris sorokiniana (Sacc.) Schoemaker is its presence on plant residues in saprophytic form. This pathogen has a competitive advantage and is displaced in the soil by other fungi, especially bacteria [Chumakov, 1948].

Mycological studies of the root system of winter wheat indicate a change in the dominant species in the pathogenic complex. Currently in Belarus, Fusarium species (F. avenaceum, F. equiseti and F. oxysporum) predominate, the frequency of which depends on the variety, region of cultivation, soil and weather conditions. The fungus Exserochilum pedicellatum, previously unidentified in the conditions of the republic, was isolated from the root system of winter wheat [Sklymenok, 2015]. It is established that the main factors for the defeat of root rot of winter wheat varieties of Bila Tserkva selection are the genotype of the culture and hydrothermal weather coefficients in the main phases of plant development. Hot dry weather during germination, tillering and tube emergence is optimal for the development of common root rot. Selected varieties with high resistance to the disease - Olesya, Elegy,

The modern concept of protection of grain cereals from damage by pathogens of root rot brings to the fore the improvement of ecological principles and development on their basis of ecologically safe phytosanitary technologies for growing these crops. It is necessary that the developed technologies are optimally adapted to the local conditions of the region, reflect a scientifically sound level of anthropogenic impact on the structure of the population of pathogens and the functioning of communities of microorganisms [Borisenko, 2011].

The problem of ensuring environmental safety of protective measures can be solved by timely implementation of phytosanitary monitoring, proper agricultural techniques, reasonable use of pesticides and fungicides, taking into account the economic threshold of harmfulness, as well as extensive involvement of biological methods to reduce pesticide exposure.

Soil is a habitat and storage of infectious structures of pathogens, which is significantly different from air. It does not contain sharp fluctuations in temperature and humidity due to its buffering, as a result of which a significant part of the year maintains almost optimal conditions for microbiological processes that have a significant impact on the viability of phytopathogenic fungi.

Active agents of microbiological processes can be bacteria, fungi and viruses that cause damage to unwanted organisms. The main mechanisms of action of mycobiopreparations on harmful organisms are the production of antibiotic compounds and enzymes, competition with pathogens for food sources and living space.

Microbiological plant protection products (MZZR) are able to show growth - stimulating effect on crop yields, improve the quality of products and accumulation in the crop of basic nutrients from fertilizers and their utilization rate of 1.5-2.0 times [Tikhonovych et al., 2005; Zavalin, 2005, 2011; Vincent et al., 2007; Bizyukova, 2012, Yashchuk et al., 2015].

Microbiological pesticides are considered an integral part of the system of integrated protection, not replacing but supplementing the range of chemicals. In addition, the ecological orientation of plant protection involves the creation of conditions in agrocenoses that are unfavorable for pests and favorable for the formation of the main elements of the crop structure [Hall, Menn, 1999, Toropova, 2005].

In the United States, the widest range of commercially available biologicals can be traced, where 72 microorganisms are registered as active: 36 of them with fungicidal and bactericidal, 27 - insecticidal, 4 - nematicidal, 4 - herbicidal activity and 1 - antiviral action [Bizyukova, 2012].

Along with biopesticides with biocidal action, elements of biological control may be substances that act on the pathogen through the plant and increase its resistance to disease. They belong to different classes of organic compounds of natural origin, synthetic, organic and inorganic chemical compounds (amino acids and their analogues, oligosaccharides, carboxylic acids, organosilicon compounds of the atran series, etc.). Stability inducers are important for the creation of ecological systems of integrated plant protection system due to the lack of inhibitory effect on the biocenosis [Kovbasenko, 1995, Tyuterev, 2002, Koshevsky et al., 2004, Kucherenko et al., 2004, Dmitriev et al., 2010 , Kovbasenko et al., 2006, 2008, 2010 a, 2010 b, 2014 a, 2014 b, Yarovoy et al., 2006, Lapa et al., 2011, 2012, 2013].

Information on the feasibility of using biopesticides and PPPs to protect cereals from disease is contradictory. A significant number of researchers emphasize certain advantages and disadvantages of biopesticides. Disadvantages include lower compared to chemical fungicides, biological efficiency, significant dependence of effectiveness on weather factors, insufficient effectiveness in the long-term development of diseases and a narrow focus of protective effects [Kuznetsova, Monastyrsky, 2012)]. Biopesticides can be used for pre-sowing seed treatment to control the development of seed and soil infections, as well as spraying plants during the growing season against leaf and stem infections and diseases of the ear. In terms of biological and economic efficiency, they are inferior to modern chemical fungicides, but due to the low cost often, to a small extent, differ in economic efficiency [Sanin et al., 2012].

Vincite and planris have proven to be the most effective for protecting spring wheat against root rot [Gushchina, 2001].

Biologics are often used to mitigate the adverse effects of pesticide use due to weather and technical conditions that occur during the growing process. Various substances produced by the rhizosphere microbiota increase seed germination and stimulate growth and development of the crop. At the same time, they improve the structure and gas exchange of soil and water supply of plants, which creates favorable conditions for optimizing the production process and increasing crop yields and grain quality [Grishechkina, 2012].

Many years of practical experience show that biological products are usually used to control root rot of crops. Antagonistic relations of the rhizosphere microbiota are aimed at inhibiting the activity of phytopathogens by producing toxic products of their activity, competition for nutrients, accelerating the lysis of fungal cell walls, where the antagonist parasitizes [Pavlyushin et al., 1999].

Pre-sowing treatment of cereal seeds with the drug Elena, created on the basis of the bacterium Pseudomona aureofaciens, increased the yield by 13.3%, and the protein content in the grain - 6.1% [Loginova, Silietsev, 2005]. Microbiological drugs reduce the development of root rot of fusarium-helminthosporic etiology and cause an increase in yield by 21%. [Grishechkina et al., 2010].

The use of biologicals is widely used. It was found that the treatment of grain that was in storage, but affected by fusarium wilt, inhibited the development of fusarium wilt and aspergillosis and had a certain inhibitory effect on the development of alternaria, as well as maintaining a higher protein content in wheat grain compared to unprotected control during storage. et al., 2012]. It is shown that the development of root rot on spring barley under the conditions of using Elena and Planriz biopreparations is 1.4-2.1 times lower than in the variant with seed treatment with the chemical fungicide Tebu 60 [Kuzina et al., 2011].

To increase the sowing qualities of wheat seeds and prevent seedlings from fusarium wilt, it is recommended to treat the seeds using a composition of drugs Furolan and Methionine with a rate of 5 g / t [Yablonskaya, 2015]. Treatment of seeds and plants of winter wheat with new biological products (Bacillus subtilis BZR 517 and Bacillus subtilis BZR 336g.) Reduces the harmfulness of fusarium wilt and provides additional yields. The conducted researches open wide prospects of use of new agents of biocontrol of causative agents of root rot of fusarium etiology of winter wheat in agricultural practice [Asaturova et al., 2014].

Pre-sowing treatment of wheat seeds with biological products reduces the diversity and frequency of phytopathogenic fungi, as well as inhibits the development of some of them, including Oidium, Chaetomium, Aureobasidium, Rhodotorula and other seed infections. The mechanism of antagonistic activity of endophytic strains of Bacillus subtilis is associated with their production of chitinase. Endophytic bacilli are able to increase the activity of phosphatase, invertase and other enzymes in the wheat rhizosphere, associated with the identification of mineralization processes in soil organic matter. Based on the studied biological properties, activity and mechanisms of action of endophytic strains of Bacillus subtilis created drugs

The optimal rate of consumption of PPP cresacin 0.5 g / t stimulated metabolism, growth processes and increased resistance to root rot, biological efficiency was 36.4 - 42.8%, which allows to obtain a 15.7% higher yield. Biological biofungicide Fitosporin-M at a consumption rate of 1 l / t caused an increase in germination, protection against root rot, biological efficiency was 30.1-42.0% and allowed to obtain a 12.1% higher yield [Glinushkin, 2004].

To protect against root rot and increase the yield of cucumber plants in closed soil, the integrated use of biological products based on fungi of the genus

Trichoderma is recommended (when sowing in a hole in the phase of 4-5 true leaves of 200 ml of 0.5% suspension for each plant) using PPP Zircon for soaking seeds in the working solution at a rate of 12.5 ml / l / kg and spraying the culture in the budding phase at a rate of 30 ml / ha [Senatorova, 2012].

The use of peat humic preparations as inducers of resistance of spring wheat has reduced the spread and development of root rot. Unlike fungicides, they did not inhibit the soil microflora of the wheat rhizosphere and, to a large extent, induced its development. The use of peat preparations caused an increase in yield by 2.1–3.8 c / ha and an improvement in the quality of wheat products [Sysoeva et al., 2010].

Bacterization of spring wheat seeds with bactophyte in the first 2 months after treatment increased the proteolytic and urease activity of the soil, and in July up to 7.6 times - its mineralization activity, which creates favorable conditions in the agroecosystem to provide mineral nitrogen to producer plants. The biocoenotic effect of bactophyte - antidepressant was manifested in the restoration of damaged by herbicides bacterial microflora of the soil, which is responsible for the mineralization and immobilization of nitrogen. The consequence of improving the state of the microbiocenosis and nitrogen regime in the soil is a decrease in its oligotrophicity by 4.4-9.8 times. Live culture of Bacillus subtilis in the bactophyte limits the development of phytopathogens from the genera Fusarium and Bipolaris. In wheat seeds, the drug suppresses their number by an average of 80.5%. In the soil, the population of the pathogen of common rot after the application of Bactophyte is reduced by more than 2 times, which is important for cereals of the next growing season. The use of bactophyte increases the resistance of spring wheat plants against soil infection, reduces their damage and regulates biological productivity [Kholdobina, 2013].

A mixture of strains of bacteria Bacillus subtilis (strain VKPM B-10641) and Bacillus amyloliquefaciens (strain VKPM B-10643) with a titer of not less than 1x109 CFU / ml of each strain of the microorganism was studied. The tests were carried out in field experiments on soft spring wheat in farms of the Novosibirsk region and North Kazakhstan. The mixture of strains was used by the method of pre-sowing treatment of seeds at a consumption rate of 2.0 ml / t. It was found that pre-sowing treatment of seeds with bacterial strains reduces the development of root rot by 43.1-83.0%, and the prevalence of the disease - 12.5-66.7%. Grain yield increased by 2.1–7.1 c / ha, and the fiber content in grain - 1.8% [Korobov et al., 2015]. Treatment of seed material with Phytosporin-M 10 days before sowing, compared with other terms of treatment and biological preparation Planriz,

Modern drugs based on fludioxonil (Maxim, Maxim Extreme, Maxim forte) effectively suppress the pathogens of solid smut and root rot. Pre-sowing treatment of spring wheat seeds increases the productivity of grain crops and provides a guaranteed increase in yield [Grishechkina et al., 2015]. Of the studied microbiological preparations in terms of the effectiveness of protection of spring wheat plants from hard smut and root rot, as well as increasing grain yield, the most effective were biofungicides based on new endophytic antagonistic strains Bacillus subcilis 1 IBM (VNIISHM 871, 2012).

The influence of spring wheat seed treatment with Bacillus sp. Inoculum was analyzed. 15001 on the biological activity of the rhizosphere, the degree of damage to plants by myxomycetes and the accumulation of plant biomass during the growing season. It was found that bacilli-antagonists are more effective than the chemical pesticide Vitavax, inhibit the development of phytopathogens, increase the biological activity of the soil, reduce the degree of its phytotoxicity and damage to plants by root rot [Oturina et al., 2008].

Biological plant protection products Trichodermin liquid and grain as disinfectants caused the growth of saprophytic myxomycetes and a decrease in pathogens, which activated the rhizosphere microflora of winter wheat. The highest effect under the conditions of suppression of root rot pathogens showed liquid Trichodermin [Glazyrina, 2003]. The biological activity of the drug

Trichodermin in various formulations against barley pathogens is at the level of the systemic pesticide phenoram. Trichodermin in liquid formulation, introduced into the soil with seeds, reduces the damage of the root system of barley by soil pathogens and inhibits their development on plants until the milk ripeness of the grain. Thus, by the end of the growing season, the amount of fusarium and helminthosporium sporogul in the variant with Trichodermin in liquid formulation was 1.6 times lower than in the variant where the seeds were treated with phenorama and also amounted to 100 thousand pieces / g of soil. In control, the magnitude of the infectious potential by the end of the growing season reached 690 thousand pieces / g of soil [Martynova, 1998].

Restriction of viability of phytopathogens is connected with activation of protective functions at plants. Some of the drugs, such as Albit, enhance the development and reproduction in the soil of nitrogen fixers, phosphate-mobilizing and other beneficial bacteria. This optimizes mineral nutrition and increases plant yields [Grishechkina, 2012; Melkumova, Klimkin, 2005]. Seed treatment with Albite and Immunocytophyte reduces the damage of barley plants by root rot in the tillering phase by 51.7 and 44.8%, and earing - 44.7 and 47.0%. The biological efficiency of biological products Phytonordbacter and phytosporin-M in the tillering phase reaches 38.4 and 47.4%, and milk-wax ripeness - 45.2 and 39.2% [Samsonova, 2011].

To protect cereals from a complex disease, which are root rot, in regions of sufficient water supply, it is advisable to use a complete mineral fertilizer, which is balanced in nitrogen and potassium. Undoubtedly, on soils of light granulometric composition violation of phytosanitary conditions in the agrocenosis occurs at lower doses of nitrogen fertilizers and is 60 kg / ha [Mineev et al., 1995; Scott et al., 1992; Popov, Burova, 1994; Linderman, 1994; Kashemirova, 1995; Kruglov, 1997]. Nitrogen fertilizers, especially at a dose above 100 kg / ha, have a stable tendency to increase root rot. This is due to the stimulating effect of nitrogen fertilizers directly on the population density of Bipolaris sorokiniana and Fusarium sp. and decreased immunity of host plants.

As shown by the assessment of the chemical composition of plants in normal and pathology, unilateral application of nitrogen fertilizers or exceeding the ratio of nitrogen to phosphorus and potassium fertilizers provokes the entry of iron and manganese, but reduces the absorption of silicon, potassium and sulfur [Belousova. 1985]. It is becoming clear that nitrogen fertilizers can reduce the physiological immunity of cereals, despite the minimum nitrogen. Thus, the use of nitrogen fertilizers in high and super high doses prolongs the maturation and vegetation of pathogens on plants.

The leading link of the improved integrated plant protection system is a set of agrotechnical measures. Introduction to crop rotation of sanitary crops - precursors (peas, corn, perennial legumes, oats, vetch-oats) reduces the infectious potential of pathogens in the soil to a safe threshold (6.4-29.6 viable conidia g / soil), which limits the development disease and causes an increase in the yield of spring wheat to 2.7-3.3 t / ha. The introduction of resource-saving technologies of basic tillage provides an increase in the density of populations of root rot pathogens at the beginning of the growing season, which creates a risk of reducing the field germination of seeds and increasing the damage to its germinal organs. At the end of the growing season, there is an increase in the development of root disease by 2.4–2.5 times under conditions of dump loosening and decrease in the process of no-dump cultivation.

Mineral fertilizers significantly change the soil composition of micromycetes. At the beginning of the growing season, their total number in the rhizosphere of spring wheat decreases under the conditions of application of all types of fertilizers. This is more true in the case of nitrogen fertilizers. The use of phosphorus fertilizers limits the viability of pathogens in the soil and has a stimulating effect on the development of the root system, resulting in an index of disease development by the end of the growing season does not exceed 14.1%.

The action of nitrogen-phosphorus fertilizers is similar. The application of a full range of mineral fertilizers significantly increases the efficiency of previously applied, due to which the disease development index is reduced to 12.8%. The use of only nitrogen fertilizers inhibits the formation of roots with a simultaneous increase in the index of disease development to 14.6-18.6%. Studies to study the effectiveness of biologicals have shown that against the background of low and medium seed contamination, high fungicidal activity is shown by biologicals agate-25K, albite and trichodermin. Their use inhibits the development of phytopathogenic microflora on seeds by 62.8–67.9%, increases field germination and elements of crop structure and yield by 0.21–0.28 t / ha. A high degree of recovery of seed material and crops of spring cereals against diseases is achieved by combining seed treatment with double spraying of vegetative plants with Planriz, Agate-25K or Albite. This system of fungicides reduces the development of root rot by 73.3-79.6%, dark brown leaf spot - 61.0-66.7% and simultaneously increases grain yield by 9.3-16.7% [Lyapina, 2014] . that against the background of weak and medium seed contamination, agate-25K, albite and trichodermin biopreparations show high fungicidal activity. Their use inhibits the development of phytopathogenic microflora on seeds by 62.8–67.9%, increases field germination and elements of crop structure and yield by 0.21–0.28 t / ha. A high degree of recovery of seed material and crops of spring cereals against diseases is achieved by combining seed treatment with double spraying of vegetative plants with Planriz, Agate-25K or Albite. This system of fungicides reduces the development of root rot by 73.3-79.6%, dark brown leaf spot - 61.0-66.7% and simultaneously increases grain yield by 9.3-16.7% [Lyapina, 2014] . that against the background of weak and medium seed contamination, agate-25K, albite and trichodermin biopreparations show high fungicidal activity. Their use inhibits the development of phytopathogenic microflora on seeds by 62.8–67.9%, increases field germination and elements of crop structure and yield by 0.21–0.28 t / ha. A high degree of recovery of seed material and crops of spring cereals against diseases is achieved by combining seed treatment with double spraying of vegetative plants with Planriz, Agate-25K or Albite. This system of fungicides reduces the development of root rot by 73.3-79.6%, dark brown leaf spot - 61.0-66.7% and simultaneously increases grain yield by 9.3-16.7% [Lyapina, 2014]. Their use inhibits the development of phytopathogenic microflora on seeds by 62.8–67.9%, increases field germination and elements of crop structure and yield by 0.21–0.28 t / ha. A high degree of recovery of seed material and crops of spring cereals against diseases is achieved by combining seed treatment with double spraying of vegetative plants with Planriz, Agate-25K or Albite. This system of fungicides reduces the development of root rot by 73.3-79.6%, dark brown leaf spot - 61.0-66.7% and simultaneously increases grain yield by 9.3-16.7% [Lyapina, 2014]. Their use inhibits the development of phytopathogenic microflora on seeds by 62.8–67.9%, increases field germination and elements of crop structure and yield by 0.21–0.28 t / ha. A high degree of recovery of seed material and crops of spring cereals against diseases is achieved by combining seed treatment with double spraying of vegetative plants with Planriz, Agate-25K or Albite. This system of fungicides reduces the development of root rot by 73.3-79.6%, dark brown leaf spot - 61.0-66.7% and simultaneously increases grain yield by 9.3-16.7% [Lyapina, 2014]. A high degree of recovery of seed material and crops of spring cereals against diseases is achieved by combining seed treatment with double spraying of vegetative plants with Planriz, Agate-25K or Albite. This system of fungicides reduces the development of root rot by 73.3-79.6%, dark brown leaf spot - 61.0-66.7% and simultaneously increases grain yield by 9.3-16.7% [Lyapina, 2014]. A high degree of recovery of seed material and crops of spring cereals against diseases is achieved by combining seed treatment with double spraying of vegetative plants with Planriz, Agate-25K or Albite. This system of fungicides reduces the development of root rot by 73.3-79.6%, dark brown leaf spot - 61.0-66.7% and simultaneously increases grain yield by 9.3-16.7% [Lyapina, 2014].

Laboratory studies of the biological activity of antimicrobial polypeptides isolated from black cumin seeds or black seed (Nigella sativa L.) against a complex of fungi-micromycetes - pathogens of root rot of cereals - on natural and artificial infectious backgrounds. It was found that pre-treatment of spring wheat grain by ultra-low-volume application of solutions of total fractions enriched with target antimicrobial proteins and black cumin peptides, causes a significant reduction in the development of pathogens (species of the genera Fusarium, Bipolaris, Ophiobolus, Rhizo). The obtained results can be the basis for further development of the system of pre-sowing biotreatment of grain from pathogens, taking into account environmentally friendly compounds of plant origin [Rogozhin, Smirnov, 2016].

Original experimental samples of biological products of multifunctional action based on aboriginal strains of bacterial antagonists of the genus Bacillus (BZR 336 g B. subtilis, BZR 517 B. subtilis for protection of wheat plants from root rot pathogens: their spectrum of antifungal action is 23–71% et al., 2015].

The preparation bioklad, created on the basis of alcoholic extract of lichens of the genus Cladonia, has a high efficiency, the use of which provides a significant increase in the density of spring wheat plants, aboveground biomass, leaf area, height and bushiness of plants, reducing root rot and increasing grain yield without harm for the environment [Yegorycheva et al., 2010].

The effects of the multifunctional biostimulator Stimmunol EF were found in the early stages of plant development, which increases the germination of cereal seeds, length and weight of seedlings, reduced root rot, and the primary root system [Ryabchinskaya et al., 2016].

Biological and economic efficiency of complex use of polyfunctional biologicals on the basis of strains of microbes-antagonists Alirin-B, Baktofit, Pseudobacterin-2 under the conditions of presowing processing of seeds and spraying at the end of tillering or at the beginning of tubing for protection of winter wheat carbendazim and propiconazole in combination with cyproconazole 1.5 times and reaches 40–60%, provides a yield increase of 0.31–0.73 t / ha [Shutko, 2013].

In the laboratory of biotechnology of the Belarusian State Agrarian University (BSAU) the isolated endophytic antagonistic strains of Bacillus subtilis are promising as a basis for new multifunctional biofungicides for the treatment of spring wheat seeds. Among them is a strain of Bacillus subtilis 11BM [Irgalina, Khairullin, 2014].

Bacillus subtilis strains show varying degrees of antagonistic activity against fungi of the genus Fusarium, which, in turn, are sensitive to them. Three strains of Bacillus subtilis (11PH, 49PH and 89PH) have been identified, which show the highest antagonistic activity against the studied fungal species. Treatment of spring wheat seeds with Bacillus subtilis 11PN reduces the spread of fusarium infection by an average of 42% and increases grain yield by 18% compared to control, which is not inferior to the biological effectiveness of the fungicides Raxil or Terrasil [Kutluberdina, 2010].

The use of natural rubber 20 seeds and synthetic growth regulators Krezacin under pre-sowing treatment can reduce the degree of development of root rot pathogens in wheat crops and increase crop yields without disturbing the ecological state of the agrocenosis. The microelements used in protective and stimulating mixtures can significantly increase the efficiency of seed treatment against root rot pathogens and crop yields. At the same time, it should be noted that for each growth regulator or chemical pesticide it is necessary to select the optimal combination with a certain trace element [Isaev, Irgalina, 2014].

The effect of chemical pesticides, BAS and biological products (antagonists of pathogenic fungi and microflora) on the damage of spring wheat by root rot has been studied. It was found that the protective properties of chemicals are directly related to the suppression of the pathogen. Under the influence of BAS optimizes the functional state of the plant itself, which induces an increase in its resistance to disease. In addition, systemic chemicals have an adverse effect on the plant, inhibiting, to some extent, its growth [Karnaukhova, Shkalikov, 2004; Grekhova, 2013]. Fodder bean seeds treated with Chitosan reduce plant root rot by 10% [Erokhin, 2015].

Introduced into the soil saprophytic fungus Chaetomium cochliodes 3250 with seeds of spring wheat is able to take root in the root zone of plants and show antifungal activity against the causative agents of helminthic spores and fusarium root rot. It was found that the spread of root rot decreased on average over 6 years by 2.8 times, and the intensity of the disease - 3.8 times with a biological efficiency of 82.7% [Kopylov, 2010].

Our long-term field studies have shown a sufficiently high efficiency under the conditions of plant protection against root rot by seed treatment before sowing (Table 3).

Unbalanced doses of mineral fertilizers, especially with increased nitrogen, caused the development of root rot, and the introduction of nitrogen in the second half of the growing season, on the contrary, increased resistance to them [Pakhnenko, 2001].

In the conditions of extensive agriculture and intensive cultivation of many crops on gray soil under conditions of low biological activity of soil and high density of fusarium, verticillium wilt infection and common root rot only application of fresh organic matter reduces infectious tension of gray soil [Orazov, 1988]. On sod-podzolic poorly cultivated soils, such an agricultural measure stimulates temporary soil toxicosis and growth of infectious potential [Marfenina, 1976; Durynina, Velikanov, 1984; Belousova, 1985]. Moreover, it is unacceptable in the presence of white rot in the agrocenosis and the use of manure directly for sowing crops. On cultivated sod-podzolic soils and chernozems, the phytosanitary effect is more pronounced [Belousova, 1985].

Under the conditions of extensive agrocenosis, high and infectious soil level and saturation of monoculture, which takes place during the period of growing plants in limited suitable areas, such as wheat, lupine, rice and cotton. At the same time, phytosanitary cleaning of the soil is possible only by applying high-dose organic fertilizers [Orazov 1988; Romanov, 1995; Sanginov, 1995; Marin, 1996; Kruglov, 1997].

Table 3

The effectiveness of biological drugs on crops against root rot

Preparation	Control (without processing),%		Processing,%	
	RH	THAT	RH	THAT
Winter wheat, variety Myronivska 61				
Albite, 30 ml / t	10.2	0	7.5	26.5
Biosil, 10 ml / t	10.2	0	8.2	19.6
Vermistim D, 8 l / t	10.2	0	7.8	23.5
Humin, 7 l / t	10.2	0	8.1	20.6
Humifield BP-18, 1 l / t	10.2	0	7.7	24.5
Emistim C, 10 ml / t	10.2	0	8.0	21.6
Cucumber, grade Source				
Albite, 30 ml / t	5.6	0	3.5	37.5
Biosil, 10 ml / t	5.6	0	4.0	28.6
Vermistim D, 8 l / t	5.6	0	3.7	33.9
Humin, 7 l / t	5.6	0	3.9	30.4
Humifield BP-18, 1 l / t	5.6	0	3.6	35.7
Emistim C, 10 ml / t	5.6	0	3.8	32.1

Notes: RH - development of the disease; TE - technical efficiency

As early as 1953, the so-called soil fungistasis was discovered, the effect of which is manifested in limiting the mycelial growth of fungi and inhibiting the germination of dormant forms of pathogens. Fungistasis is characteristic of all types of soils, which prevents plants from damage and fungi-pathogens -

germination and prevents the prevention of soil from infection [Nikanorova, 1992]. There is no doubt about the biological nature of fungistasis, as the inhibitory effect of the soil disappears under conditions of sterilization and can be restored again by adding non-sterile or individual microorganisms or their communities. And, probably, therefore fungitasis is weakly shown in the lower layers of soil where insignificant number of microorganisms and degraded [Berestetsky, etc., 1986].

The biological nature of fungistasis is recognized by all researchers, but interpreted differently. The main views on this issue are as follows:

1) the main factor of fungistasis - trophic competition between fungi and the corresponding microflora in conditions of nutrient deficiency in the soil;

2) the presence in the soil of volatile inhibitory substances, which are represented by ethylene, nitrous oxide, ammonia and alcohols, which are mainly formed by bacterial microflora [Berestetsky, 1984; Nikanorova, 1989].

Fungistasis is formed due to a number of other factors, including phytotoxic metabolites of soil microbiota, toxins of plant and microbial origin, physiologically active substances and phenols. In the combined system "soil - plant - pathogen - microbiota" soil is the most important factor that regulates the phytosanitary state of the agrocenosis and determines the infectious potential [Ryabchikova, 1992; Kruglov, 1997; Durynina et al., 1993]. The ability of soil to inhibit the development of soil pathogens and inhibit the development of the epiphytic process has attracted the attention of researchers especially in recent decades [Lagutina et al., 1990; Cook, Veseth, 1991; Linderman, 1994; Chulkina, Chulkin, 1995].

In the literature, use the term "soil suppression" [Chulkina, 1985, Tindall, Dewer, 1987, Nikanorova, 1992; Sidorov et al., 1992, etc.], ie its ability to inhibit the phytopathogenic microbiota and inhibit the development of the epiphytic process due to chemical, biological, physicochemical, physical properties of the soil and agronomic measures. The main factors determining the suppression are the type of soil, the activity of microbiological processes, fertilizer application and the intensity of agricultural use [Gantimurova, Kasinova, 1992; Marinescu et al. 1992; Garifulina, 1994].

In soil conditions, the suppression of the activity of pathogenic fungi and limiting their development is quite difficult. These processes are influenced by the nature of clay materials, acidity, humic acid content, carbon dioxide and oxygen, temperature and water regimes. Existing environmental factors can limit the development of the population and the activity of phytopathogens in the soil, but do not cause their death [Chicheva. 1979; Chernetsova, 1983; Belousova 1985].

At weak and average defeat of grain crops by root rots on 1 hectare of plowing in crop rotation it is necessary to bring 4 t of qualitative organic fertilizers [Chulkina, Chulkin, 1995]. It is established that only the systematic application of organic matter at a dose of not less than 10 t / ha creates the conditions necessary for the functioning of soil oxidases [Gulko. 1995]. The highest stability of the microbial complex was found on typical deep chernozem, but even in these comfortable conditions under conditions of 214 t / ha of manure and an equivalent dose of mineral fertilizers, the overall biogenicity was higher using organic matter [Filon, Mitropolenko, 1995].

The resistance of plants against root rot and other diseases is much higher if nitrogen fertilizers are used in physiologically justified doses, which are recommended by the regional system of agriculture [Efimova, 1990; Ishkova, Manukyan, 1990; Makarenko, 1990; Popov, Burova, 1994]. Not only types and doses of fertilizers, but also the technique of their application can induce a pathological process in the agrocenosis. One of the ways to apply nitrogen fertilizers is their localization in the soil. It was found that the density of fungi of Fusarium solani, Aspergillius sp., A. niger, A. ustus and Pénicillium funiculosum species increases in nitrogen fertilization centers [Svistova, Stakhurlova, 1995]. All available species of fungi are phytotoxic, which increase the infectious potential of the soil.

In the state of Pennsylvania (USA), encouraging results under the conditions of protection against root rot were obtained under conditions of low seed yield, high seeding rate. The studied doses of nitrogen fertilizers from 0 to 100 kg / ha of each of the elements of the disease did not provoke [Brossions, Franc, 1986]. According to scientists from the state of Oregon (USA), in the western provinces, the defeat of cereals by opioid root rot was 50%. Plant protection was ensured by the application of NPK - 100 kg / ha of each of the elements, but small: 60 kg / ha was applied during sowing, and the rest - fertilization. Ammonia form has been found to be more promising for reducing root rot, which can be considered natural [Hart, Christenson, 1994].

Among the non-traditional means of protection, the combined use of mulching the soil with graphite or ash for rapid melting of snow and urgent application of urea or ammonium nitrate ensures the growth and preservation of grain yield from pathogens. This method of plant protection is quite successfully implemented in the foothills of the western United States [Tindall, Dewey, 1987].

Scientists who have been working on the problem of root rot for many years confirm that the reduction of the infectious potential of the soil can be realized by means of its solarization. Under such conditions, 80–90% of the infectious base is destroyed, and widely practiced stubble burning disinfects the soil by 50%, and the grain yield increases by 19 and 14% [Cook et al., 1987].

Abiotic factors can also provoke root rot. High soil moisture content of heavy mechanical composition, low heat capacity and low activity of bacterial microflora by combination with high acidity causes the development of root rot [Rush et al., 1986; Hering et al., 1987]. Significant harmfulness of root rot was found in cool and damp soil, especially with its minimal and anti-erosion treatment [Scott et al. 1992]. Early onset of cold, especially after rainy and cold autumn, increase the infectious background of the soil. Crop residues and grain stubble are a natural source of infection and under adverse conditions pathogenic fungi do not have time to grow, as well as in the absence of the host plant [Smilley et al., 1990; Chulkina. Chulkin, 1995].

Excess nitrogen fertilizers provoke the development of fusarium neck rot on winter wheat crops in the northeastern United States. Crops were surveyed in almost 300 rainfed areas [Smilcy et al., 1986]. It was found that higher harmfulness of root pathogens can be traced under the combined effects of Fusarium graminearum and Fusaryum culmorum [Cook, Veseth, 1991]. In addition to the phenomenon of synergism, it is important to significantly expand the range of optimal temperatures, in particular pathogens for the development of the infectious process. The ammonium form of nitrogen fertilizers against root rot has higher fungistatic properties than nitrate [Tindall, Dewey, 1987; Scott et al., 1992, Hart. Christenson, 1994]. This is due to the fact that under the conditions of introduction of ammonium ion in the rhizosphere of plants, foci of high soil acidity are created, which adversely affects pathogenic fungi that are adapted to neutral root exudates. High availability, or additional application of manganese to the soil provides increased resistance of cereals against root rot [Huber, 1993; MSSau-Buis et al, 1995], which is characteristic of agrocenoses on fertile and buffer soils. And nitrogen, which is formed by the association of microorganisms with a positive effect on the crop, exhibits fungistatic properties and inhibits the growth of Alternaría spp. Botrytis cinerea Fusarium solani [Umarov, 2001]. High fungistatic activity of biological nitrogen is shown in field experiments on barley [Zlotnikov, 1998] and winter wheat [Naumova, 1970]. or additional application of manganese to the soil provides increased resistance of cereals against root rot [Huber, 1993; MSSau-Buis et al, 1995], which is characteristic of agrocenoses on fertile and buffer soils. And nitrogen, which is formed by the association of microorganisms with a positive effect on the crop, exhibits fungistatic properties and inhibits the growth of Alternaría spp. Botrytis cinerea Fusarium solani [Umarov, 2001]. High fungistatic activity of biological nitrogen is shown in field experiments on barley [Zlotnikov, 1998] and winter wheat [Naumova, 1970]. or additional application of manganese to the soil provides increased resistance of cereals against root rot [Huber, 1993; MSSau-Buis et al, 1995], which is characteristic of agrocenoses on fertile and buffer soils. And nitrogen, which is formed by the association of microorganisms with a positive effect on the crop, exhibits fungistatic properties and inhibits the growth of Alternaría spp. Botrytis cinerea Fusarium solani [Umarov, 2001]. High fungistatic activity of biological nitrogen is shown in field experiments on barley [Zlotnikov, 1998] and winter wheat [Naumova, 1970]. 2001]. High fungistatic activity of biological nitrogen is shown in field experiments on barley [Zlotnikov, 1998] and winter wheat [Naumova, 1970]. 2001]. High fungistatic activity of biological nitrogen is shown in field experiments on barley [Zlotnikov, 1998] and winter wheat [Naumova, 1970].

Phosphorus, as a nutrient, is quite high for fungi on nutrient media. On acid sod-podzolic soil, phosphorus-containing fertilizers increase biodiversity in the fungal community by stimulating sporulation of Penicilium ssp., Mucor ssp., Alternaria ssp. [Mineev et al., 1997]. The introduction of superphosphate increases the infectious potential in these soils against Bipolaris sorokiniana (Sacc.) Schoemaker [Chicheva, 1979]. It has also been determined that the use of phosphorus fertilizers in high doses on soils disrupts homeostasis [Karamschuk, 1995].

Potassium has a depressing effect on the development of many fungi, and therefore potassium fertilizers generally significantly reduce the infectious potential of the soil. The inhibitory effect of forms of potash fertilizers was found in relation to barley sown on sod-podzolic soil. In these conditions, the predominant value is potassium salt, the phytoprotective effect of which increases with a deficit of moisture or soil drought [Belousova, 1985].

Thus, the use of biological means of protection indicates their effectiveness, which is aimed at restoring and maintaining the biocoenotic balance in agrocenoses.

CHAPTER 8. THE PLACE OF SEX PHEROMONES IN THE INTEGRATED PROTECTION OF CULTIVATED PLANTS

The chemical communication of the sex of insects is based on one of the oldest types of sensitivity, which is produced, starting with the reactions of the simplest unicellular organisms, to attractive or frightening substances [Schneider, 1971]. Pheromones are generally called BAR, which are released into the environment by some individuals, which are then perceived by other members of the same species. These substances are formed in special glands from precursor compounds [Jacobson, 1976; Shorey, 1977].

The term "pheromone" (from the Greek pherein - to transfer and horman - to excite, stimulate), which was proposed in 1959 by German researchers Carlson and Luscher, met with a significant number of opponents, but was adopted instead of the term "attractant" (from the Latin. Attractio - attraction). Sex pheromones are often referred to as sex attractants - attractive pheromones or pheromone components that cause sex to meet and attract individuals of one sex to another [Barton Brown, 1977].

Along with sexual attractants, sexual repellents also include sexual repellents and antipheromones. Sex repellents are pheromones or their components that are released at a certain stage of sexual behavior and scare away other individuals of the same species. Sex antipheromones (inhibitors of sex attractants) are pheromones or components of sex pheromones that prevent the meeting of sexes for mating at a certain stage of sexual behavior and inhibit the action of sex pheromones [Saad, Scott, 1981, Smetnik et al., 1983].

Unlike chemical plant protection products, insect pheromones are safe for the environment. The main advantage of pheromones is their specificity, which are able to attract individuals only of their kind and without touching others, including entomophagous. This selectivity is especially important for the conservation of beneficial insects, as traditional pesticides are generally nonselective, which can act on harmful and beneficial species. Due to the high volatility of pheromones are not delayed on plants and other natural objects. These volatile substances are quite labile, destroyed by sunlight, moisture and temperature. Therefore, they do not accumulate in the treated area. All these qualities open wide prospects for the use of pheromones in plant protection.

The use of pheromone traps is effective for calculating the economic thresholds of harmfulness of many pests that have flown into the equipment. Thus, for apple orchards and other pests, pheromones allow to determine the timing of the onset of flight of overwintering generations, and the implementation of protective measures on different crops [Grodsky, Manko, 1997].

One of the important ways of practical application of pheromones to control pests is to monitor the state of the population and record the number of pests with the help of traps. The original method is called "auto-confusion", the essence of which is that the male is attracted to a mixture containing pheromone and electrostatic powder, with the ability to stick to the cuticle and other parts of the body of insects. After contact with this mixture, the male, flying away, carries a pheromone. on the body of which causes the adaptation of its receptors and disorders of the sensory system, after which he can not find the female. Pheromone-treated females are mobile pheromone dispensaries that create a "false pheromone trail." Untreated pheromones, males want to come into contact with treated males, as with females, and take on part of the pheromone mixture, distribute,

To increase the efficiency of the disorientation method, fundamentally new pheromone-elongating agents and equipment have appeared. An attempt to use a spray that provides 20 times faster pheromone emission than traditional dispensaries has been quite successful. The spread of the pheromone is achieved by mobile equipment, which is equipped with a timer that allows you to use the pheromone only during the hours of activity of insects and in those areas where their accumulation is detected. Use 4-5 equipment for cultivation of 1 hectare. In 2000-2002, apple and oriental fruit eaters and other leafhoppers were used to control the available drugs in Italy. The consumption of pheromone was 160-220 g / ha per season, and the results of disorientation - at the level of standard technologies for garden protection with insecticides [Ignatova, Pyatnova. 2013].

The method of disorientation of apple fruit eater, which was tested in industrial conditions, showed a high degree of violation of sexual chemical communication in pest populations, which was 95-100%, which led to a decrease in fruit damage to 3-4% compared to 11% in the reference version [Agasyeva , 2003].

The basis of integrated plant protection is a successful combination of various tools and methods, the use of which reduces the number of harmful insect species to an economically insignificant level. To achieve this goal, a whole set of methods of action on insect populations is being developed.

Insect sex pheromones facilitate the monitoring of species diversity of cenoses and are included in the scientific substantiation of integrated control systems. Their use allows you to quickly change the tactics of protection depending on changes in the number and dynamics of flight of pests [Kovalenkov et al., 2006]. They are widely used and are the basis for the biologization of quarantine pest control. The use of sexual attractants by the quarantine service allows to detect primary foci in a timely manner and to establish the distribution areas of quarantine pests [Smetnyk, Shumakov, 1986; Lebedeva et al. 2004; Zinovieva 2008]. Sexual pheromones of insects, taking into account trophic and communication links in cenoses at the biochemical level may also have kairomon activity in relation to beneficial fauna. So,

The use of sex pheromones is not the only way to monitor the number of harmful insect species. Under the conditions of their correct application and depending on features of phenology and ecological and geographical conditions, horizontal and vertical migration of pests, in combination with other methods of protection of plants for a number of cultures, use of pheromones forms the basis of integrated phytosanitary monitoring which, in turn, is the basis of integrated plant protection systems against major pests [Grichanov 1995, Emelyanov, 1995; Kharchenko, Devyatkin, 1995; Black, 1995; Azhbenov, 2005].

Sex repellents are pheromones or their components that are released at a certain stage of sexual behavior, scaring other individuals of the same species. For example, the sexual attractant of female cotton moths, which attracts males, is also a sexual repellent for other females of the same species [Saad, Scott, 1981; Grichanov et al., 1991].

Studying the degree of resistance of phytophagous to insecticides was initially a time-consuming process, and under the conditions of pheromone traps significantly reduced the cost of time and resources to develop a rapid method of resistance, which is to assess the sensitivity of the pest to toxicants they have adhesive tabs with the investigated insecticide in different concentrations [Pralya, Burov, 1990]. Comparison of the number of dead insects in the experiment and control allows to calculate the main toxicological indicators of action of drugs [Haynes et al., 1986; Chekalova, 2004].

The use of pheromone traps in combination with other factors allows for long-term predictions of the development and harmfulness of insects, including fruit crops. Thus, the catch of males in conjunction with information on heat and humidity allows to predict the development and harmfulness of the pest, as well as to adjust and plan the release of entomophages and parasites [(Zhukov, 1990, Makhotkin, Pavlyushin, 2002].

Selected species-agents - carriers of the pheromone label and pathogens of the target species - apple fruit fly. The selection criteria are based on the adjacent flight dynamics and vertical distribution in the station, the high number of target species in the station, the availability of means of attracting amplifying equipment (synthetic analogues of sex pheromones) and the lack of inhibitory interaction of pheromones of selected species. . It is also possible to use beetles of the genus Agriotes and California thyme. Interspecific chemical communication of the target species with selected species - agents allows to identify the degree of mutual influence of pheromones of different species. The maximum number of types of agents and the target species was attracted at a height of 3 m, which is optimal for the location of the application equipment [Pachkin, 2015].

Evaluation of the biological efficiency of SHEN-ETSU pheromones MD STT, D and Breeze (vapor-forming product in the dispensary), used by the method of male disorientation, showed that their single location at the rate of 500 dispensaries / ha allowed to protect apple and apple plants from apple. phases of separation of buds before harvesting), as well as to reduce the damage to the fruits of the new crop [Dolzhenko et al., 2016].

Of the pheromone preparations, the film film dispensaries with an internal black polyethylene membrane 135 μm thick, containing 1-2 mg of codlemon and isopropanol as a solvent, showed the highest attractiveness. Such dispensaries are characterized by long and stable attractive action, which allows to use them without replacement during the season, which is impossible with the use of traditional rubber dispensaries. Involvement of additional "minor components" in the composition of the pheromone preparation did not stimulate the growth of their attractiveness [Savushkin, 2009]. The use of pheromone preparations and glue traps, which are characterized by sufficient attractiveness and species specificity, proved to be effective for monitoring the apple fruit fly. The use of dispensaries also has significant prospects [Tretyakov, 2006].

Measures for mass restoration of natural populations of oocytes in natural conditions have been developed. It was found that the smell of mature virgin and copulated females of the harmful turtle intensifies the search for eggs by her ovipositor and increases the infection of the host eggs with them, compared to the control by 2.9–4.8 times. Chloristomethylene extracts of the pectoral glands of female pests were noted to have the highest attractive ability. Their smell increased the infestation of egg-laying parasites by 5.5–6.0 times than that of kairomon [Marus, 2003].

Determining the optimal timing of treatments and reducing their multiplicity by accurately studying the phenology of insects and controlling the dynamics of numbers does not preclude the use of pheromones to directly reduce the number of pests by various methods, including attractive-sterilizing traps. The complete replacement of insecticides by pheromones and attractive-sterilizing traps has been proved, which carries significant opportunities to maintain and develop self-regulatory mechanisms of agrocenoses and reduce the negative environmental consequences of active use of chemical insecticides [Sazonov et al., 1992, Bulyginskaya, 1995, Voisnyak, Voinyak 1995].

CHAPTER 9. THE USE OF ENTOMOPATHOGENS TO PROTECT PLANTS FROM PESTS

Pathogens of insect diseases as a factor in reducing the number of harmful species and the need to find ways to use them can be found in the works of II Mechnikov, who drew attention to the need for artificial creation of "epidemics of insect diseases" (epizootics), the effectiveness of which will be higher than natural [Sternishis, 2010].

There are a large number of bacteria in the environment that can infect insects. Under conditions of bacterial infection, there is an interaction of bacterial metabolites and insect defense systems. In these conditions, of particular importance is the composition of the feed substrate, the components of which can affect both the body of insects, and specifically on the functioning of protective mechanisms, and the activity of metabolites of entomopathogenic bacteria. Bacillus thuringiensis bacteria are effective against insects of different families [Simpson et al., 1997; Rausell et al., 2000; Zhong et al., 2000]. Their pathogenic action on insects is associated with toxins and other metabolites that synthesize these bacteria [Burtseva et al., 2001]. It is now recognized that the main factor of insecticidal action of the bacterium is a crystalline protein endotoxin,

An important role in the formation of the relationship of plants with insects is played by secondary metabolites of plants or allelochemics [Shapiro et al., 1986; Chernyshov, 1996]. Of particular interest are the antagonistic effects of secondary metabolites of plants on the body of insects. Among the hundreds of thousands of secondary metabolites of plants, undoubtedly the most common class of substances that play a major role in protection against phytophagous are phenolic compounds, which have a diverse effect on insects [Geibel et al. 1994, Feucht, Treutter 1999; Gatehouse, 2002]. Studies on the effects of these substances on the physiological state of insects are still fragmentary [Martin et al., 1987; Harborne, 1991; Appel, 1993].

It is proved that the action of β-endotoxin and other metabolites of Bacillus thuringiensis on intestinal epithelial cells is combined with a violation of the integrity and functional activity of cell membranes, which can lead to uncontrolled enhancement of radical oxidative processes due to the development of oxidative oxidation reactions. ., 1983; Boctor, Salama, 1983; Knowles, Ellar, 1987; Sternshis, 1995]. Secondary metabolites of plants are able to have a toxic effect on insects and bind to the epithelial cells of the intestine, as well as due to prooxidant properties. Oxidation of phenols to quinones can initiate the formation of activated oxygen metabolites in the intestine [Appel, Martin, 1990; Appel, 1993; Zenkov et al., 2001]. It is possible,

Insects have a powerful antioxidant system [Felton and Summers, 1995], the components of which are to stabilize radical oxidative processes in the early stages of bacteriosis or by secondary metabolites of plants may be one of the mechanisms to protect insects from the damaging effects of radicals. Published work to study the effects of infections caused by entomopathogenic fungi, viruses and microspores on the processes of generation of active components of metabolites and the activity of the antioxidant system in insects [Serebrov, 2000; Wang et al., 2001; Lozinskaya et al., 2003]. The effect of secondary metabolites of plants and other xenobiotics on the body of insects, which are considered as a change in the activity and spectrum of esterases, has been studied [Cohen et al., 1992; Snyder, Feyereisen, 1992; Cuevas, Niemeyer, 1993; Xu, Bull, 1995; Mukanganyama et al., 2003]. Few studies of the antioxidant system of insects have been conducted under conditions of feeding food with high phenol content [Jonson, Felton, 2001; Barbehenn et al., 2001; Barbehenn, 2002; Barbehenn et al., 2003], as well as development on a less forage plant [Peric-Mataruga et al., 1996]. Unfortunately, work on the study of the antioxidant system of insects under conditions of bacteriosis and the action of plant allelochemists on the activity of antioxidants is rare.

In the process of evolution, insects have a number of protective devices that prevent or limit the penetration and development of fungi in the body of hosts. The first physical and chemical barrier to the penetration of fungi into the body of insects is the cuticle, the epicuticle of which contains various compounds (waxes, fats, LCD), which prevent their adhesion and growth. In addition, the cuticle of insects contains enzymes that can inhibit the development of fungi. First of all, these are enzymes that are combined into a profenolocascade cascade, the activation of which triggers melanogenesis. As a result of these enzymatic reactions, melanin is formed (yellow, brown and black pigment of vertebrates and some invertebrates, humans and plants), which is characterized by high strength, chemical resistance and causes the localization of the penetrated pathogen. In addition,

With the development of mycosis in the body of insects, the systems of cellular (phagocytosis, encapsulation, granulation) and humoral (antimicrobial proteins, coagulation, phenol oxidase) immunity are activated. One of the defining immune responses is encapsulation, a process in which the pathogen is sucked into a capsule formed by hemocytes, followed by melanization [Rosales, 2011]. In the body of insects, fungi produce enzymes and toxins that can destroy the tissues and organs of the hosts. Detoxifying enzymes, in particular glutathione-β-transferases, esterases and monooxygenases, may also be involved in the degradation and inactivation of these fungal metabolites [Serebrov et al., 2003].

The anamorphic ascomycete Metarhizium anisopliae (Metch.) Sorokin is one of the most common entomopathogenic fungi, capable of infecting hundreds of insect species from different families. In addition, this fungus is actively used in the world to create mycoinsecticides [Wraight et al., 2007].

The susceptibility of insects to entomopathogenic fungi depends on a number of factors. First of all, it is the properties of the pathogen that determine its aggressiveness (production of enzymes, toxins, etc.). Second, it is the amount of infectious material needed to successfully infect insects. The available factors can change the nature of mycoses, which range from a sluggish passage to a rapidly developing one - with maximum death in the first few days after infection. At the same time, the question of the role of the immune and detoxifying systems of the insect's body under the development of different types of fungal infections remains insufficiently studied. In addition, the pathogenesis of mycoses can be significantly affected by background infection of the hosts with other entomopathogens. Given that mixed infections are extremely common in nature, they can significantly affect the size of host populations [Mwamburi et al., 2009, Yaroslavtseva, 2012]. However, the main protective mechanisms of insects in mixed infections have not been studied.

The interaction of the host insect and its baculovirus is due to a complex of bio- and abiotic factors. The nature of the interaction is determined by the biological characteristics of the host insect and its physiological status, as well as the number of infections and pathogenicity of the virus [Ilyinykh, 2006].

At present, it is recommended to use microbial preparations to control the number of insects - pests of crops and forest plantations in only three cases:

1) when the insect is resistant to the pesticides used (according to the FAO, there are about 300);

2) when the use of pesticides degrades the quality of products, for example in the production of baby food;

3) when the insecticide does not penetrate into the habitats of insects [Dyatlova, 2001]. Bacterial insecticides include the entomopathogenic Thuringian bacillus Bacillus thuringiensis. This species forms two toxins - β and δ, and β-toxin has a broad spectrum of action on insects, but dangerous for mammals [Elinov, 1995].

Bacillus thuringiensis bacteria can cause intestinal toxicosis, which in turn affects the immunity and general physiological condition of insects. Bacteria in the process of vegetative growth synthesize toxins that act directly on the epithelial cells of the intestinal tract of insects and cause dysfunction and their lysis. In the process of evolution, insects have formed various protective mechanisms that prevent the penetration and development of infection directly in the intestine (peritrophic matrix, enzymes that digest food, epithelial regeneration), and formed a strong immune system that prevents the development of most microorganisms. The penetration of bacteria into the intestine of insects causes not only the lysis of intestinal epithelial cells and disruption of digestive processes, but also changes in the activity of antioxidant enzymes, as well as the ratio of non-enzymatic antioxidants. In addition, there is a decrease in the activity of enzymes of the detoxifying system, in particular, nonspecific esterases. It is possible that the hemolymph releases activators of the immune system, the source of which may be intestinal epithelial cells. This process can occur primarily in mild infections. During acute toxicosis, hemolymph may also receive components of destroyed epithelial cells and representatives of the vulgar microflora.

Under the action of mediators of the immune system secreted by intestinal epithelial cells, components of the destroyed intestine and infiltrated microorganisms, there is an increase in phenol oxidase activity, phagocytosis reactions and encapsulation in hemolymph, as well as antibacterial activity in fatty intestines and intestines. Under conditions of acute bacteriosis, along with the activation of humoral immune responses, suppression of the cellular immune system was determined. Systemic stimulation of immunity can occur due to the membranotropic action of Bacillus thuringiensis toxins, in which, upon activation, site-specific components are formed that interact directly with the receptors of epithelial cells and trigger their lysis.

Suppression of cellular immune responses in acute infection is probably associated with depletion of the pool of hemocytes, which may be associated indirectly with active participation in the regenerative processes of the intestine, as well as in the isolation of hemolymph-penetrating components of intestinal gut cells and intestinal bacteria. Acute infections are extremely rare in nature, as they can cause rapid elimination of both the host and the pathogen from the environment, accompanied by a reduction in the number of highly virulent microorganisms. However, in nature, insects are constantly exposed to bacteria, including weak and avirulent [Oppert et al., 1994; Forcada et al., 1999; Bravo et al., 2005, Grizanova, 2012].

The ability to produce phytohormones is present in many bacteria. Auxins [Spaepen et al., 2007], Azotobacter vinelandii [Azcon, Barea, 1975] Pantoea agglomerans [Omer et al., 2004] and Bacillus subtilis were found in the culture fluid of Azospirillum and Pseudomonas [Veselov et al., 1998, Arkhipova et al. ., 2006] - cytokinins, Proteus mirabilis, P. vulgaris, Klebsiella pneumoniae - gibberellins [Karadeniz et al., 2006], Azospirillum brasilense - abscisic acid [Cohen et al., 2009], endophytic bacteria Achromobacter xylosoxidans - Bacillus acid [Forchetti et al., 2007], Pseudomonas aeruginosa - salicylic acid [De Meyer et al., 1999]. Existing phytoregulators of growth cause an increase in plant resistance to biotic stresses [Bari, Jones, 2009, Shakirova et al., 2010, Kudoyarova et al., 2011, Yashchuk et al., 2015].

Biochemical defense mechanisms of insects have been studied and described. Some of them are based on the induction of proteolytic cascades, which cause mechanization and coagulation of hemolymph under conditions of injury, as well as the production of active oxygen metabolites and signaling molecules, including those involved in antigen recognition [Marmaras et al., 1996; Theopold et al., 2004; Jiravanichpaisal et al, 2006; Williams, 2007]. There are also systems that produce biological reducing agents and activated glucosides and, agglutinins with different carbohydrate specificity, involved in the recognition processes [Galaktionov, 2004] and a set of antimicrobial peptides that determine the bactericidal and fungicidal properties of hemolymph; Lviv, Nikolenko, 1999; Bulet et al., 2004].

The protective system is mediated by hemolymph cells and together with humoral factors plays a role in phagocytosis, synthesis of antimicrobial peptides, histolysis and histogenesis in the process of metamorphosis [Glupov, 2001; Gayfullina et al., 2004]. Thus, the biochemical systems of insects are involved not only in protective processes, but also in the regulation of ontogenesis, which is due to purely congenital factors [Yamakawa, Tanaka, 1999, Zhang et al., 2004].

Recent studies have refuted the established thesis about the insurmountable boundary between the innate and adaptive defense systems of insects [De Gregorio et al., 2001; Eason et al., 2004]. The main problem is that the biochemical mechanisms of insect resistance to pathogenic microorganisms have been studied without taking into account their metabolic relationship and ontogenetic features of functioning. At the same time, the presence of an adaptive response in insects allows for the possibility of specific and long-term biochemical protective functions. These processes must be related to the ontogenetic characteristics of insects, as the larva is radically different from the adult. They usually occupy different ecological niches, have different nutritional specifics, as well as longevity, which can play a key role in the functioning of biochemical mechanisms and factors,

Based on various strains of Bacillus thuringiensis, a wide range of microbiological drugs has been developed, including bitoxybacillin, which contains viable bacterial spores and the exotoxin they produce [Smirnov et al., 1982; Kandybin, 1989]. The practice of using this drug in the system of protection against insect pests leads to the emergence of resistant individuals with effective mechanisms for recognition and elimination of pathogenic bacteria.

No less important ontogenetically are other conditions for the functioning of biochemical defense mechanisms. In the process of search and practical application against insects BAS often do not take into account the conditions of formation of protective reactions preceding the controlled stage of the experiment. This remark can be attributed to the study of southern subspecies of honey bee. For a similar reason, attempts to develop drugs based on chitosan for beekeeping have not yet been successful [Albulov, 2008].

A significant number of various humoral and indirect cellular factors are involved in the protective reactions of insects. As in many organisms, the penetration of the pathogen in insects is accompanied by phagocytosis and oxidase flare with the formation of activated oxygen metabolites, which induces an antioxidant system, the components of which are the enzyme catalase, peroxidase and superoxide dismutase. Control of the level of formation of TBA-reactive products allows you to reliably assess the effectiveness of the functional system [Saltykova, 2009].

The close interrelation of anti - and phenol oxidant systems in the formation of the initial stage of realization of protective reactions in insects is established. Ontogenetic differences in the formation of biochemical protective reactions and their connection with the cellular structures of insect hemolymph were also revealed. This is manifested in the predominance at the larval stage of nonspecific, and imaginal - specific biochemical mechanisms.

The possibility of preadaptation of insects with non-lethal doses of bacterial drug, which is to stimulate biochemical protective reactions and increase survival, has been proven. The possibility of forming a long-term and ontogenesis-covering reaction of biochemical and cellular systems, which determine their stability, has been revealed. The important role of critical periods of insect ontogenesis associated with the stages of molting under conditions of larval age and developmental stages in the formation of long-term protective reactions is shown. It is proved that the induced activity of biochemical protective reactions in insect larvae is reproduced in the subsequent stages of ontogenesis, as well as two generations at the same stage of insect development without additional influence of the inducing factor [Saltykova, 2009].

Under the conditions of choosing a biocontrol agent for the creation of microbial plant protection products, the selection of source strains for virulence, productivity and the ability to synthesize enzymes or toxins is quite important. As a rule, the result of such selection is a strain that is superior in quality to the reference cultures of the producer of the drug required for production.

It is also important to select the optimal nutrient medium for the cultivation of biological agents. Cultivation in a liquid nutrient medium (deep method) is used, as a rule, to obtain bacterial preparations and partially fungal. Fungal preparations are obtained not only by deep but also by superficial and deep-surface cultivation. This is due to the fact that blastospores of fungi obtained under deep culture conditions are not as viable and active as conidia, which are formed by fungi on the surface of the nutrient medium. In recent years, the method of surface cultivation of fungi on loose substrates is gaining popularity. The main feature of the production of viral entomopathogenic drugs is the accumulation of viral biomass on live insects with the subsequent extraction of baculoviruses from dead individuals, which is a more labor-intensive process,

A detailed study of hormonal regulation of the activity of enzymes of tyrosine metabolism, dehydrogenase, esterase and phosphatase enzyme complexes in various insects was carried out in order to develop modern hormonal methods of pest control of crops. Identification and possibility of using hormones and their analogues to increase the viability, productivity and resistance to diseases of beneficial insect species [Kutuzova, 2006].

Chemical compounds produced by living organisms that participate in information chemical interaction and through which in natural biological systems organisms of one species affect the growth, development and behavior or biology of organisms of other species, are called semiochemists [Whittaker, Feeny, 1971]. They play a significant role in the complex interaction of natural systems, such as "animal-animal", "animal-plant", "plant-plant" and "plant-pathogen" [Harborn, 1985].

Entopomathogens [Wouts, 1981, 1985] based on fungal [Inglis et al., 1995], viral [Regev, 1996], bacterial drugs [Kim, 2006] and entomopathogenic nematodes [To] control phytophagous, including apple fruit fly. Danilov, 1980]. Entomopathogenic drugs to reduce the number of phytophagous (insects and mites) are created on the basis of natural regulators of the number of plant pests - pathogens of insect diseases. The sources of strains of bacterial, viral and fungal diseases of insects, which are the basis of biological drugs for plant protection, are epizootics. The basis of drugs are both live cultures of active strains of entomopathogens and products of their metabolism, in particular, toxins and enzymes [Burtseva et al., 2001].

For comparison with the use of chemical plant protection products, biological products do not cause the rapid development of resistance in phytophages. In addition, the accumulation of synthetic chemical insecticides in food, soil and water bodies along the food chain is transmitted to animals and humans and poses a threat to human health. With a high level of environmental safety of biological drugs, their use does not always give a stable effect, which explains the complexity of the interaction of entomopathogens with the insect and the environment.

The death of insects, as a rule, does not occur immediately, but after a certain period of time, which is necessary for the development of the disease. This latent period is especially long when using viral drugs. In addition, the active substance of the drugs is exposed to the destructive effects of abiotic factors when released into the environment. In order to compete successfully with chemical pesticides, biological products and methods of application must meet certain requirements that ensure their integrity in the environment and the reliability of the insecticidal effect. All this necessitates the development of approaches that underlie the effectiveness of biological products [Sternchis et al., 2011].

A significant number of entomopathogenic microorganisms have been shown to persist in host insect populations and often play a key role in regulating their numbers. Others, despite high aggression, are less closely related to host populations. Based on this, there are two main strategies for the use of entomopathogens in biological plant protection - the introduction of pathogens in the arthropod population and the use of biological drugs for short-term pest reduction. Direct approaches involve the need to analyze the factors that determine the pathogenicity of a group of pathogens and assess the possibilities of their use and the development of preparative forms of bioinsecticides with new properties [Lednev et al., 2013].

Recently, drugs based on various strains of Bacillus thuringiensis Berliner are used, which are effective against phytophagous and belong to the families Lepidoptera, Hymenoptera, Diptera and Coleoptera. They are characterized by intestinal action, the effectiveness of which is manifested by the entry of insects into the intestine and active nutrition [Babchuk, 1983, Feitelson, 1993]. The pathogenic effect of Bacillus thuringiensis Berliner on insects is associated with toxins and other metabolites that are synthesized by these bacteria [Burtseva et al., 2001]. It is recognized that the main factor of insecticidal action of this bacterium is crystalline protein endotoxin, which is formed in cells in the form of a pair of spore inclusions or crystals [Martin et al., 1987, Harborne, 1991; Appel, Schultz, 1992]. Infection of larvae of Galleria mellonella L. Bacillus thuringiensis Berliner bacteria stimulates the intensification of lipid peroxidation processes in the intestine in the first day after infection, followed by a decrease to control values. The development of bacterial infection is accompanied by an increase in the activity of superoxide dismutase, glutathione-β-transferase and oxidation of thiol-containing components in the intestine of larvae of Galleria mellonella L. [Dubovsky, 2004].

One way to solve the problem of creating effective and environmentally friendly drugs to control the Colorado potato beetle is to use recombinant strains based on Bacillus thuringiensis and Pseudomonas putida as producers of entomotoxins [Dobritsa et al., 2001].

The strain Bacillus cereus, two strains of Bacillus thuringiensis ssp.dakota and Bacillus thuringiensis ssp.thuringiensis showed antibacterial activity against both gram-negative and gram-positive microorganisms. The strain Bacillus thuringiensis ssp.thuringiensis inhibited the growth of fungi of the genera Mucor and Fusarium, and some strains of Bacillus thuringiensis ssp.dakota showed antagonistic properties against Alternaria alternate [Kalmykova, Burtseva, 2011].

The peculiarities of the composition and number of phytophages and representatives of beneficial insects and spiders in the agrobiocenosis of black currant have been studied. It was found that spiders of the genera Salticidae and Lycosydae are entomophagous of a number of pests, including blackcurrant phytophages. Along with the protective effect against the black currant crop, the use of biological products ensures the preservation of biodiversity of useful entomo- and araneofauna. The expediency of lepidocide against gooseberry fireweed, phytoverm complex of aphids and fireweed, which damage plants and fruits of black currant, has been scientifically substantiated [Vaskin, 2006].

The presence of two strategies for the implementation of biochemical defense systems in insects at the initial stage of action of bitoxybacillin was revealed. Sublethal concentrations of the drug form protective reactions, which are aimed at eliminating the damaging factor and activating metabolic processes. High concentrations of bitoxybacillin cause the activation of protective reactions, which are aimed at localization and elimination of the pathogen against the background of a general decrease in metabolism.

The ontogenetic differences in the implementation of protective reactions in insects to bitoxybacillin were determined on the example of the Colorado potato beetle. At the larval stage, the development of nonspecific defense mechanisms predominates, the share of enocytoid hemocytes increases, and mechanisms of specialized defense are formed in adults of phagocytic hemocytes. The ability of insects to form long-term protective reactions in ontogenesis has been revealed. Re-treatment with bitoxybacillin in the next phase of insect development causes an outbreak of activity of anti - and phenol oxidant enzymes in hemolymph, an increase in the titer of specific agglutinins and accelerated differentiation of phagocytic cells from prohemocytes [Gayfullina et al., 2007].

The development of reactions of defense systems to bitoxybacillin in dark forest bees and the growth of phagocytic activity of hemolymph cells, the activity of antioxidant enzymes, glucose-6-phosphate dehydrogenase, enzymes of the phenol oxidant system and increased levels of glycosaminoglycans. The ability of insects to form long-term protective reactions in ontogenesis has been revealed. The possibility of using chitosan as an inducer of protective reactions in insects has been shown, which is manifested in the rapid neutralization of toxic agents of bitoxybacillin and their survival [Saltykova, 2009].

Water-soluble compounds that are able to inhibit the activity of cellulosolytic and pectolytic enzymes Leptinotarsa decemlineata Say were isolated from potato tissues. and Trichoderma reesei. Significant differences in the level of anti-cellulase and anti-pectylase activity in potato tubers and leaves are shown [Shevchenko et al., 2009].

The penetration of bacteria into the intestines of insects causes not only the lysis of epithelial cells and disruption of digestive processes, but also changes in the activity of antioxidant enzymes, as well as the ratio of non-enzymatic antioxidants. In addition, there is a decrease in the activity of enzymes of the detoxifying system, and in particular, nonspecific esterases.

Under these conditions, it is possible that the hemolymph releases activators (mediators) of the immune system, the source of which may be intestinal epithelial cells. This process can occur primarily in sluggish infections.

During toxicosis, components of destroyed epithelial cells and representatives of the vulgar microflora can also enter the hemolymph. Under the action of mediators secreted by intestinal epithelial cells, components of the destroyed intestine and infiltrated microorganisms, an increase in phenoloxidase activity, phagocytosis reactions and encapsulation in hemolymph, as well as antibacterial activity in the fatty body and intestine.

Under conditions of acute bacteriosis, along with the activation of humoral immune responses, the cellular part of the immune system is suppressed. Systemic stimulation of immunity can occur due to the membranotropic action of BT toxins, in which activation produces site-specific components that interact directly with the receptors of epithelial cells and trigger their lysis. Suppression of cellular immune responses in acute infection is probably associated with the consumption of a pool of hemocytes, which may be mediated by their participation in the regenerative processes of the intestine, as well as the isolation of hemolymph-penetrating components of destroyed cells, bacteria and concomitant microflora. Barbashova, Vladimirova, 1981, Andrews et al., 1985, Glupov et al., 2001, Grizanova, 2012].

Morphological, physiological, biochemical and insecticidal properties of collection strains and natural isolates of Bacillus thuringiensis ssp.kurstaki were studied. It is shown that strains of one subspecies show a wide variability of these properties. However, such phenotypic diversity could be described by such a term as "metastability of the phenotype", ie "stability by instability" [Golovlev, 1998]. BAR, which are synthesized by strains, during vegetative growth and at the early stage of spore formation make a certain contribution to insecticide, and also cause adaptation of these cultures to life in microbic communities [Kalmykova, 2003].

Screening of Bacillus thuringiensis strains of more than 40 subspecies revealed a number of cultures with multifunctional, antibacterial, fungicidal and growth-promoting properties. This information predicts the possibility of creating new microbiological drugs based on Bacillus thuringiensis for plant health management [Kalmykova, 2016]. The presence in the structure of Bacillus thuringiensis of a spectrum of species with insecticidal and fungicidal activity gives hope for the possibility of finding in nature multifunctional strains of this bacterium for the production of universal means of control not with individual pests but with their complex [Muntian et al., 2016].

The results of long-term experiments on search, isolation and assessment of virulence of natural strains of Bacillus thuringiensis showed their widespread distribution in the habitat of insects of different biocenoses of the Republic of Belarus and the possibility of using collection producer strains to create new biological products [Prischepa, 2015].

Co-infection with Metarhizium anisopliae and Bacillus thuringiensis ssp. morrisoni var tenebrionis of Leptinotarsa decemlineata larvae causes synergistic effect and insect mortality. Under conditions of bacteriosis and mixed infection, the systems involved in protecting insects from fungal infection, in particular the intensity of encapsulation and enzymes of the detoxifying system, are suppressed. Fungal infection caused by Metarhizium anisopliae at 24oC for Gallería mellonella larvae caused later activation of phenol oxidase in the cuticle of insects, as well as a decrease in the intensity of encapsulation compared to the optimal (34oC) temperature for them [Yaroslavtseva, 2012].

The multifunctional properties of Bacillus thuringiensis and Beauveria bassiana were studied and the insecticidal action of bacterial and fungal entomopathogens on Colorado potato beetle larvae, as well as their antifungal activity against the rhizoctonia pathogen Rhizoctonia solani was shown. In the field, the antagonistic effect of entomopathogenic bacteria in the suppression of potato rhizoctonia has been proven. The obtained results are promising in biotechnology for the production of drugs to protect plants and increase their competitiveness with chemical pesticides [Sternchis et al., 2015].

Under the influence of the fungus Beauveria bassiana, the incidence of currant berries of gooseberry and septoria leaves decreased by 1.5-3.5 times compared to the control, and the biological efficiency was 70%. In relation to aphids, the degree of damage was reduced by 2 times, and the biological efficiency was 49%. The obtained results indicate the polyfunctionality of the entomopathogenic fungus Beauveria bassiana against phytophagous insects and currant septoria [Drozdetskaya, 2015].

The effectiveness of the metabolic biological product Fitoverm against pests of different varieties of white cabbage in the Kemerovo and Novosibirsk regions (Russia) was studied. In laboratory experiments with the assessment of insecticidal action revealed different sensitivity of insects belonging to different families to the biological product. In the field, Fitoverm proved to be the most effective against scale insects. Higher concentrations of the drug were required to suppress the cabbage aphid. Against cruciferous fleas, the use of Fitoverm is impractical [Shulgina et al., 2010].

Developed a biological product Batsikol based on Bacillus thuringiensis var. Darmstadiensis with entomocidal and fungicidal properties with a fairly wide range of action on pests, which is used for the treatment of vegetative plants. It has been effective against a number of dangerous pests, including the Colorado potato beetle, cruciferous fleas (a complex of species of the genus Phyllotreta), oriental mustard leafhopper (Colaphellus hofti Men.), Bread striped fleas (P. vittula Redt.), Rapeseed avigetus (Meliget) F.), cabbage leafhopper (Phaedon cochleariae F.), elm leafhopper (Hanthogaleruca luteola Midler), grass leech (Oulema melanopus L.), cruciferous bedbugs (Eurydema), thyme (Diashididae), strawberry-raspberry weevil Hbst.), Buckwheat weevil (Rhinoncus sibiricus Faust.), The fungicidal effect of bacicol on a number of phytopathogenic fungi was detected in the laboratory and confirmed by vegetation and field experiments using different technologies of its application in accordance with the type of parasitism and environmental characteristics of phytopathogenic fungi [Grishechkina, 2015].

Strain Bacillus amyloliquefaciens VKPM B-11008 is characterized by antagonistic activity against a wide range of plant pathogens, growth stimulating effect, chitinase, phosphatase and nitrogenase activities against pesticides of the 4th class of danger. The technology of obtaining a biological product using wheat bran raw materials for deep cultivation of Bacillus amyloliquefaciens VKPM B-11008 and humic compounds, which ensure the preservation of the viability of the strain and its activity during storage, has been developed. The biological product is compatible with fungicides based on mancoceb,mefenoxam, carbendazim, benomyl, copper chloride, fludioxonil, thiram, triticonazole, insecticides based on thiamethoxam, benzultup, acetamiprid, fipronil, herbicides based on glyphosate, clopyralid.Seed treatment with tank mixtures of bacizulin with fungicides is accompanied by the disappearance of their retardant action [Siraeva, 2012].

The results of many years of research on the detection of entomopathogens in the Black Sea subtropics are summarized. In the populations of 16 species of insects that develop on subtropical and ornamental vegetation, 28 isolates of entomopathogenic fungi were isolated. The most common are imperfect fungi of the genera Lecanicillium Zare Cams., Beauveria Bals and Trichotecium Pers. Entomopathogenic fungi detected in the subtropical zone, to some extent, can regulate the number of pests of ornamental and subtropical crops, which are a resource of natural strains and promising for use in plant protection [Slobodyanyuk et al., 2016].

High heterogeneity of Beauveria bassiana on the basis of virulence against locust pests has been reported. In Kazakhstan, 6 strains of this fungus with high biological activity were found for representatives of this group of pests, for which the optimal titers of the working suspension were selected. Selected cultures have high virulence in insects of other systematic groups. Temperature referendums were determined for these fungal cultures and laboratory methods of deep and solid-phase fermentation were developed [Uspanov, 2013].

Optimal cultivation conditions of Bacillus subtilis strains BZR 336g and Bacillus subtilis BZR 517 were established: pH of the medium, temperature, cultivation terms, as well as sources of carbon and nitrogen nutrition. Original samples of optimized nutrient media were obtained, which provide a liquid culture of drugs with the optimal number of colonies of forming units in combination with high antifungal activity against pathogens Fusarium graminearum and Fusarium oxysporum var. orthoceras [Hamster et al., 2016].

To increase the effectiveness of biological protection of cabbage from pests and diseases, it is necessary to carry out additional pre-sowing treatment of seeds in 0.5% suspension of Trichodermin, and the root system of seedlings treated with a mixture of 0.2% Planriz and 0.4% Fitoverm [Kuznetsova, 2003].

The main hyperparasites of powdery mildew fungi are pycnidia of the genus Ampelomyces Ces. ex Schlecht. Their high natural biotic potential has been established - hyperparasites of the genus Ampelomyces develop on 137 species of plants affected by powdery mildew, and on 54 - to the maximum extent. These hyperparasites are more significantly inhabited by the genera Erysiphe, Golovinomyces, Sphaerotheca, Microsphaera and Phyllactinia. In addition to the theory of related evolution of phytopathogenic fungi, the regularities of development of powdery mildew fungi and their hyperparasites for the triotrophic system, which is characterized by group selection, increasing reproduction rate, parasitic activity and the emergence of new species [Puzanova, 2003].

In the field, pre-planting treatment of three varieties of potato tubers and spraying of raspberry and currant plants with a suspension of entomopathogenic fungus Beauveria bassiana was used to protect against diseases. A decrease in the prevalence and development of rhizoctonia on stems and stolons with a decrease in the number of sclerotia on tubers of the new crop is shown. The growth-stimulating effect with increasing yield of potato tubers depending on varietal characteristics was observed.

Spraying berry crops with a suspension of the fungus caused a decrease in the infestation of raspberries with purple spot, and currants - septoria with increasing productivity of these crops. In Siberia, the antifungal effect of Beauveria bassiana was demonstrated for the first time [Tsvetkova et al., 2016]. The use of biologicals Phytocid and Planriz caused an increase in the total number of bacteria in the soil compared to the control by 13.0–36.1% under the conditions of growing potatoes of the Skarbnytsia variety and by 4.5–24.6% - Amulet, a decrease in the soil of 1.2 -1.8 times the number of fungi of the genera Fusarium and Alternaria. With the use of the fungicide Rovral aquoflo, the ecological index of Shannon's species diversity was lower compared to the options for the use of biological products. Under these conditions, there was a decrease in the species composition of microorganisms, the dominance of dark-colored micromycetes - Alternaria sp.,

The effectiveness of biological preparations based on strains of local microorganisms (Lepidotsid and Boverin) and Bacillus thuringirensis with a prolonged effect has been experimentally proven. The highest biological efficiency was determined in Lepidocide and strain 4793 - 55-84%, and the lowest - Boverin and strain 2909 - 63-73%. A balanced system of apple tree protection against winter moth has been developed and tested [Polivoda, 2007].

An important aspect in the development of mycoinsecticides may be the creation of highly specialized strains of entomophytic fungi. Thus, most species of the genus Beauveria do not show selectivity under the conditions of insect infestation, which can adversely affect pollinators and predators that kill pests. Some species of anamophore fungi are highly virulent only for certain families of insects, due to the composition of epicuticular compounds, G-proteins and enzymes of fungi that hydrolyze the cuticle, as well as the level of toxin formation.

The development of mycoinsecticides is aimed at obtaining transgenic strains-overproducers of insectotoxin-blockers of insect-specific ion channels, which from the beginning are components of spider venoms. The combination of properties of highly virulent and transgenic entomopathogens that produce insect venoms of spider venoms will significantly reduce the dose of the biological product, which is necessary for effective defeat of hosts, increase the speed and effectiveness of mycoinsecticides [Schukina et al., 2015].

Currently promising areas of further research of entomopathogenic fungi, as the basis of biological plant protection products, are the study of the ability of strains to produce enzymes and toxins, optimization of technologies for the production and use of mycoinsecticides, improvement of forms of biological products, expansion of fungal bioagents (subfamily Coccoidea) [Yankovskaya, Voitka, 2015].

Spore-forming strains were isolated from natural sources and identified as Bacillus amyloliquefaciens by 16S rRNA analysis. They are characterized by pronounced fungicidal activity against fungi of different genera, including several species of the most phytopathogenic genus Fusarium (F.graminearum, F. solani, F.culmorum, F. avenaceum, F. sporotrichioides, F. nivale - Microdochium, F.oxysporum) , as well as Rhizoctonia solani, Sclerotonia sclerotiorum, Phomopsis helianthi, Phoma solanicola, Alternaria tenuis, Botrytis cinerea, Cercospora zeae-maydis, Magnaporthe grisea and Phytophtora infestans. Existing fungi are the causative agents of diseases such as fusarium wilt, fusarium wilt, Alternaria, phomosis, root rot, fomopsis, cercosporosis and late blight, which often affect plants in greenhouses.

The antagonistic potential of natural Siberian strains of bacteria of the genus Bacillus has been revealed. The studied strains of bacterial antagonists of

B. subtilis, B. amyloliquefaciens and B. licheniformis showed bactericidal and fungistatic action in vitro on pure cultures of pathogenic bacteria and phytopathogenic fungi. Inhibition by strains-antagonists of growth of pathogens that cause diseases of agricultural plants is promising for the creation of environmentally friendly crop products [Lelyak, Shtershnis, 2014].

The complex effect of Bacillus thuringiensis and Batsikol is revealed, which includes antagonistic action against phytopathogenic fungi - pathogens of dangerous plant diseases and harmful insects [Smirnov, 2000]. The Far Eastern species of coccinellide Harmonía âxyridis Pallas was introduced into the culture and tested in closed soil. In the conditions of industrial biolaboratory on the example of species of Far Eastern origin new information on the processes of adaptation of natural insects in the process of their introduction into the culture was obtained. An original method of mass breeding of harmony and a new method of colonization of the predatory mite Amblyseius mckenziei Sch are proposed. Technologies of joint application of microbiological plant protection products and entomophagous have been developed. Scientific and technical documentation of biological products based on Verticillium lecanii (Zimm.) Viegas-producing strains has been developed, Beauveria bassiana (Bals.) Vuill. of Far Eastern origin [Yarkulov, 2002].

Methodical approaches and features of interrelations in the system "entomopathogenic nematodes - insects" and some regularities of development of micropopulation of nematodes in an insect body are published. The invasive activity and behavior of nematodes in the habitat of the host insect depending on abio- and biotic factors have been studied. Original models of comparative assessment of nematode pathogenicity based on mathematical modeling of dependence of infestation intensity and mortality of host insects on infection conditions (temperature, dose of infectious load, duration of free contact period and intensity of host parasite infestation) have been developed. Models have been created that allow to identify the optimal temperature, dose and timing of infection for the species or strain of nematodes, as well as to achieve the required level of biological efficiency [Danilov, 2001].

In some countries, industrial productions have been set up to develop biological preparations based on entomopathogenic nematodes and are being commercially sold. Nematodes can infect more than 1,000 species of insects from different families at all stages of development, except for eggs, which are adapted to long-term existence in the soil without food, and are compatible with many plant protection products. They can be applied to soil and plants by any type of sprayer that is safe for humans, warm-blooded animals and plants [Downes, Griffin, 1966, Dolmans, 1983].

The effectiveness of the use of entomopathogenic nematodes of the families Steinernematidae and Heterorhabditidae against target objects is largely determined by knowledge of the patterns of behavior of the invasive stage of nematodes in changing ambient temperatures. Biological drugs based on entomopathogenic nematodes are mainly used to control the developmental stages of insects living in the soil. The results of tests of such nematode drugs indicate significant limitations in the possibilities of their use under conditions of lowering the soil temperature below 150C. Intensive genetic research on the growth of tolerance and activity of entomopathogenic nematodes in changing temperature conditions in their locations, especially in the direction of low temperatures, is carried out in world research centers [Griffin, Downes, 1991, 1994; Grewal et al. , 1996; Schirocki, The Hague, 1997; Ehlers et al., 2005].

Under experimental conditions, screening at a certain stage of selection achieves some corrections in the cold reaction of individual strains of nematodes, but for unknown reasons, in the future this figure is restored to baseline. Studies on the search and selection of natural cold-adapted strains of entomopathogenic nematodes are more successful [Hazir et al., 2001]. The strains selected in this way form the basis of new biological drugs.

The prospects of using entomopathogenic nematodes of Steinernema feltiae against larval stages of onion fly have been demonstrated. The maximum percentage of larval death at doses of 120, 240 and 480 invasive larvae / ml caused the death of 91.6-100% of larvae of the 3rd age after 72 hours. It was found that 1 and 5-day-old pupae were poorly susceptible to infection by entomopathogenic nematodes Steinernema feltiae [Mahmoud Farag Mahmoud Farag Musa, 2005].

Entomopathogenic nematodes Steinernema carpocapsae reduce the number of adult bugs by 43%, Steinernema feltie - 63%. In combination with sublethal doses of pyrethroids, the effectiveness of treatments increased by 20-30%, ie it is possible to recommend the use of entomopathogenic nematodes in combination with insecticides to control the number of this pest [Marus, 2003].

Undoubted interest in the fight against American thrips (Echinothrips americanus Morgan) is a drug based on the entomopathogenic nematode Steinernema feltie Entonem-F (Nemabakt), which was highly effective on roses against the nymphs of Western flower thrips under conditions of introduction into the greenhouse soil.].

Laboratory experiments revealed significant differences in the behavioral reactions of Steinernematidae carpocapsae and Steinernematidae feltiae depending on the temperature and mechanical composition of the soil. Invasive larvae of S. carpocapsae at a temperature of 25 ° C on loamy and sandy soils were mainly localized in the surface layer, and at 200 ° C were evenly distributed in the soil profile. The larvae of S. feltiae were concentrated in the surface layer only on sandy soil at a temperature of 200 ° C, and on loamy soil at 25 ° C. Thus, the accepted in world practice division of nematode species into cruises and bases is realized only in a certain range of gradation of edaphic factors.

In the field, a similar effect of edaphic factors on the behavior of nematodes. Most larvae of S. feltiae (70-80%) on sandy and loamy soils at a temperature of 13-20 ° C infect insects in the surface layer. On heavy loam, nematodes of this species are evenly distributed over the soil horizon. The intensity of insect infestation with S. carpocapsae under these temperature conditions was insignificant. In the case of the combined presence in the soil of S. carpocapsae and S. feltiae in laboratory and field experiments, the first species mainly penetrated the larvae of the flour beetle, and the second - infected the caterpillars of the wax moth.

The obtained results confirm the influence of insect species on the intensity of invasion by different species of entomopathogenic nematodes. Under conditions of colonization into the soil of a new biotype of S. carpocapsae, there was an increase in invasive activity of populations of local species of these parasites in the upper soil layer, among which S. feltiae predominated [Turitsyn, 2010].

Biological regulation of the development of phytoparasitic nematodes Globodera rostochiensis and Meloidogyne incognita was demonstrated under the conditions of application of the drug Nematophagin MF and its composition with strains of soil antagonist bacteria and entomopathogenic strain of the fungus Paecilomyces lilacinus. This approach is based on the ability of the predatory fungus Arthrobotrys oligospora IG to significantly or completely eliminate the invasive larvae of Globodera rostochiensis and Meloidogyne incognita in the soil and prevent their penetration into the root system of plants. The antagonistic bacteria obtained as a result of screening, introduced into the soil together with Nematophagin MF, at the stage when phytohelminthiasis passes into the stage of bacteriosis and mycosis, causes inhibition of the development of pathogenic microorganisms for plants.

Substances secreted by Bacillus subtilis, Serratia plymuthica, Pseudomonas chlororaphis and Pseudomonas putida also have a phytostimulant effect, which increases the resistance of plants against diseases caused by phytohelminths. The complex application of the parasitic fungus Paecilomyces lilacinus and Nematophagin MF reduces the development of meloidoginosis by 2.4 and 1.9 times increases the biomass of the root system of cucumber plants. The fungus Paecilomyces lilacinus, which infects females and eggs of meloidogine, causes a decrease in the development of plant diseases after the penetration of pesticide nematodes into the root system [Migunova, 2011].

Bacillus thuringiensis, a bactericide of the group Bacillus thuringiensis, was used to control scale insects on blackcurrant plantations. In the control of American powdery mildew, anthracnose and septoria, the drug Albit was used, which contains a purified active substance from the soil bacteria Bacillus megaterium and Pseudomonas aureofaciens. Against spider mite used the drug Fitoverm, the active substance of which is an extract from the biomass of bacteria Streptomyces avermitilis strain VNIISHM-54 or VNIISHM-51. The effectiveness of protective measures against pests and diseases of currants is consistently high. All these drugs do not pollute the environment [Smirnov et al., 2009].

The mechanism of hormonal regulation of the activity of enzymes of tyrosine metabolism, dehydrogenase, esterase and phosphatase enzyme complexes in various insects is revealed in order to develop modern hormonal methods of pest control, as well as the possibility of using hormones and their analogues to increase viability and disease resistance. insects. On the basis of formulated ideas about the effectiveness of hormones and hormone-like substances as regulators of insect growth, the use of which largely depends on the correct dose of the drug, phase of development, sensitivity of a particular type of test objects to their action. .

The study of hormonal regulation of enzyme activity in insect pests at different stages of their development allowed to establish general patterns in the regulation of metabolism, which must be taken into account when developing new control methods in plant protection practice to reduce crop pests. Undoubtedly, theoretical and practical interest is the study of enzymatic mechanisms of resistance to various insecticides in insects and the comparison of the obtained information with the biological level of resistance. Biochemical mechanisms of resistance must be considered under the conditions of rotation of pesticides, as well as the selection of inhibitors of enzymes responsible for their development [Kutuzova, 2006].

CHAPTER 10. EFFICACY AND MECHANISM OF ACTION OF RESISTANCE INDUCERS TO INCREASE PLANT RESISTANCE SYSTEMS AGAINST HARMFUL MICROBIOTA

Agricultural plants are constantly under environmental stress, suffering from diseases and pests, and in the years of epiphytosis, crop losses reach 80%. In this state, plants are immunodeficient. No pesticide can replace the immune system, and in some cases can even suppress it. Thus, the chemical and infectious pressure on plants often exceeds the threshold of their possible adaptation. The immune system, which protects plants from disease and stress, currently needs protection itself. Therefore, it is important to develop phytoimmunocorrection in order to effectively control the immune status of plants to overcome its deficiency [Ozeretskovskaya, 1999].

One of the most effective ways to protect plants is to induce their resistance, which is not based on direct suppression of pathogens, but on enhancing the natural potential of plant tissue in the same way as it occurs in nature. Even more important is the cultivation of unstable and medium-resistant varieties, strengthening the resistance of which against pests and diseases is crucial from an economic and environmental point of view [Kovalev, Yanina, 1999, Burov et al., 2012].

From the set of obtained results it follows that one of the key ways to increase the stress resistance of the photosynthetic apparatus under the action of inducers of plant protection systems is to increase the activity of antioxidant enzymes or the content of low molecular weight antioxidants. Common signal intermediates in the induction of protective systems under the action of the studied inducers are reactive oxygen species (ROS). As a result of the action of inducers, the photosynthetic apparatus and the plant as a whole switch from the usual development program to the adaptive one, which provides an increase in the stress resistance of the photosynthetic apparatus. It is hypothesized that resistance inducers may act by altering the level of hydrogen peroxide, abscisic acid (ABA) and/or directly through signaling intermediates such as Ca2 + and transcription factors,

Gene networks that control plant resistance to phytopathogens are extremely complex, involving hundreds of genes. Infection causes significant changes at the molecular genetic, biochemical, physiological and morphological levels both locally, at the site of invasion and systemically. Reconstruction of gene networks responsible for protecting plants from pathogenic bacteria, fungi and viruses is necessary to identify the involved molecular mechanisms, as well as to develop new ways to increase the resilience of agricultural plants.

The transcriptional activity of genes involved in protecting against pathogens usually increases in response to infection, and therefore the characteristics of their promoters are an important source of information for identifying transcription factors that control their work and finding new genes responsible for response to infection. Indicators of promoters are needed to create plants resistant to phytopathogens by genetic engineering [Smirnova, Kochetov, 2014].

Methods of increasing plant resistance have been proposed: inoculation with pathogens, avirulent races, nonpathogenic strains, inactivated pathogens, treatment with microbial metabolites (biogenic elicitors) and chemical compounds (abiotic elicitors), which are signals of induced resistance.

The interaction of the pathogen with the plant initiates a significant number of successive processes, the main point of which is its attachment to the plant and the process of recognition, which must take place at the molecular level with a fairly high specificity. Under the conditions of studying the interaction of pathogens with plants, special attention is paid to elicitors - metabolites that cause protective reactions in plant tissues - the formation of phytoalexins. It is assumed that elicitors are recognized by the plant, resulting in a phytoimmune effect. The various stages of the immune response may be enhanced or inhibited by pathogen metabolites or environmental conditions. The action of elicitor negatively affects the process of formation of pathogen spores, as well as the growth of the mycelium of the pathogenic fungus [Osokina, 2016].

Mechanisms for stimulating the natural immune responses of plants are based on the expression of genes that trigger a cascade of sequential biochemical reactions that stimulate the synthesis of natural substances of abiotic action - phytoalexins and activation of hormonal and enzyme systems that rearrange cellular structures, causing changes in physiological status et al., 1984, Dong, 1998, Goroviy et al. 2002, 2004, Koshevsky and others. 2002, 2004, Teslyuk et al., 2004, 2008, 2010 a, 2010 b, Kovbasenko et al., 2008, Ryabushkina, 2005, Dmitriev et al., 2010, Dulnev et al., 2010, Kovbasenko et al., 2010 , 2013 a. 2013 b, 2013 c, 2014 a, 2014 b, Hryhoriuk et al., 2012, 2013, Kaminsky et al., 2015, Yashchuk et al., 2017].

Inducers of resistance can be described as compounds that induce signaling pathways, stimulate gene activation, defense responses and the formation of resistance in plants against pathogens. This resistance is manifested in the localization of the pathogen in the process of defeat, blocking its subsequent penetration, spread and reproduction in plants. Such compounds induce biochemical reactions in plants, including signaling cascades of natural induced resistance, as well as signal-specific signaling pathways and defense reactions specific to each compound [Dmitriev et al., 2015, Tyuterev, 2015].

The essence of induced resistance is to increase the synthesis of enzymes that counteract infection and switch some metabolic reactions from the biosynthesis of constitutive metabolic compounds to the synthesis of phytoalexins and other antipathogenic substances [Bousqet et al., 1990]. One of the fastest reactions of plants to stress is the activation of redox processes, which is accompanied by the accumulation of highly toxic substances that disrupt the permeability of membranes due to lipid peroxidation [Lukatkin, 2003]. The plant cell is characterized by a tiered system of protection against oxidative stress, in which enzymes, especially peroxidase, play an important role [Savich, 1989, Kovbasenko, 1999].

It is involved in the process of strengthening the cell wall of plants under normal conditions and the penetration of phytopathogenic microorganisms, which channels the synthesis of phenolic polymers of lignin and suberin [Gross, 1977; Kolattukudy, 1981; Kolattukudy et al., 1995]. Among other isoenzymes, acidic or anionic peroxidases are able to secrete into the space between the plasmolemma and the cell wall of plants and, thus, are among the first to come into contact with infectious structures of pathogens [Fry, 1987; Reimers et al., 1992]. Increased lignification of plant cell walls and the formation of lignin-like material is observed at the site of localization of fungal pathogens in the tissues of resistant plants [Aist, Israel, 1976]. The ability of anionic peroxidase (AP) from wheat roots to bind to chitin, a polymer of TCH-acetyl-O-glucosamine, was revealed, widespread in the cell walls of phytopathogenic fungi [Feofilova, 1983, Maximov et al., 1995]. Plants have effective mechanisms of antiviral protection in response to infection. In particular, they activate genes encoding PR-proteins (pathogenesis-related proteins). The synthesis of PR proteins is caused by fungi, viruses, bacteria and toxins. PR-proteins of plants are combined into 18 families. PR-9 proteins are peroxidases [Sharipova et al., 2013].

Activation of AP in wheat leaves under the conditions of its defeat by septoria is shown [Maksimov, 1994]. Under similar conditions, the anionic isoform of wheat root peroxidase (ph 3.5) binds directly to chitin, but does not interact with its deacetylated derivative - chitosan, which indicates the participation of cetamide groups in the interaction with AP. The ability of chitin-specific AP to directly bind to spores of the fungus Tilletia caries (DC.) Tul., Which causes durum wheat, has also been established. The localization of the activity of soluble wheat AP is tissue-specific. A significant number of their isoforms are in the roots. In the zone of root differentiation of resistant wheat plants, the activity of AP, including chitin-specific lysoforms, is much higher than in susceptible. The clearest differences between varieties in the activity of AP are manifested under conditions of pathogen infection. So, in the process of inoculation with the pathogen of hard smut, a stable variety of wheat responds with a cardinal increase in the activity of AP in the roots, aboveground part of the seedling and mainly in their basal zone. Under such conditions, there is mainly inactivation of chitin-containing peroxidases and the ratio of AP activities between the apexes of the root and coleoptile is preserved, which is characteristic of unaffected plants [Yusupova, 2000]. The obtained results demonstrate the active participation of chitin-specific AP in the protective reactions of plants under the conditions of their defeat by phytopathogenic fungi. The change in the activity of the same anionic peroxidase isoenzymes under conditions of pathogenesis indicates the presence of common metabolic pathways in response to biotic stress. aboveground part of the seedling and mainly in their basal zone. Under such conditions, there is mainly inactivation of chitin-containing peroxidases and the ratio of AP activities between the apexes of the root and coleoptile is preserved, which is characteristic of unaffected plants [Yusupova, 2000]. The obtained results demonstrate the active participation of chitin-specific AP in the protective reactions of plants under the conditions of their defeat by phytopathogenic fungi. The change in the activity of the same anionic peroxidase isoenzymes under conditions of pathogenesis indicates the presence of common metabolic pathways in response to biotic stress. aboveground part of the seedling and mainly in their basal zone. Under such conditions, there is mainly inactivation of chitin-containing peroxidases and the ratio of AP activities between the apexes of the root and coleoptile is preserved, which is characteristic of unaffected plants [Yusupova, 2000]. The obtained results demonstrate the active participation of chitin-specific AP in the protective reactions of plants under the conditions of their defeat by phytopathogenic fungi. The change in the activity of the same anionic peroxidase isoenzymes under conditions of pathogenesis indicates the presence of common metabolic pathways in response to biotic stress. The obtained results demonstrate the active participation of chitin-specific AP in the protective reactions of plants under the conditions of their defeat by phytopathogenic fungi. The change in the activity of the same anionic peroxidase isoenzymes under conditions of pathogenesis indicates the presence of common metabolic pathways in response to biotic stress. The obtained results demonstrate the active participation of chitin-specific AP in the protective reactions of plants under the conditions of their defeat by phytopathogenic fungi. The change in the activity of the same anionic peroxidase isoenzymes under conditions of pathogenesis indicates the presence of common metabolic pathways in response to biotic stress.

In plants, some peroxidases are localized in the apoplastic space of cells, where they are bound by ionic and covalent bonds with cell wall polymers [Graskova, 2008]. Previously, it was believed that cell wall peroxidases are involved only in the biosynthesis of lignin and the formation of crosslinks in cell walls. Later, peroxidase secretion was shown in the cell walls of tobacco leaves under conditions of fungal infection [Bestwick et al., 1997]. Cytochemical methods have shown the localization of peroxidase activity in cell walls and uninoculated tissues of lettuce leaves and tissues infected with a bacterial pathogen [Bestwick et al., 1998]. It has been found that cell wall peroxidases are responsible for the formation of peroxide during the oxidative flash in response to the action of an elicitor from a pathogenic fungus in bean cells [Bohvell et al., 2002].

Recently, there has been information that peroxidases are weakly bound to the cell wall on the cell surface of plant cells, which are able to be easily separated from the cell wall, circulate in the apoplast and initiate an "immune response" at the site of contact with the pathogen. It is likely that peroxidases are the first to face the "attack" of the pathogen, fight it and "send" a signal about its appearance in the genome of the plant cell and thus initiate their protective reaction. The obtained results allow to consider peroxidase as a stress enzyme that can be used to detect plant defense mechanisms under the action of BAS of natural origin and abiotic stress that affects plants in agroecosystems due to their pollution by industrial emissions [Graskova, 2008].

The reactions of plants at the initial stages of interaction with the endophyte Bacillus subtilis 26D are similar to those under conditions of pathogenesis. In the first hours of contact, an increase in the level of ABA is observed, which is probably due to the attachment of bacterial cells to surface tissues and their rooting into plants. After establishing primary contact, there is a consistent increase in the level of auxins, in particular IOC in the balance of phytohormones, and together with the cytokinin-like activity of endophytic cells may be one of the mechanisms of stimulating plant growth by bacteria [Mubinov, 2007].

Biopreparations based on Bacillus Cohn and their metabolites increase the yield and quality of sugar beet roots by adjusting the composition of the microflora in the root zone. Available biologics cause a reduction in the number and species diversity of pathogenic myxomycetes, which, in turn, reduces the likelihood of infection with pathogens of the root system and leaves of plants. In addition, an important contribution to the formation of productivity and resistance of plants against adverse environmental factors (pathogenic and herbicidal pressure) is likely to increase enzymatic activity in both the rhizosphere and sugar beet leaves due to exposure to biologicals. It can be concluded that the use of biologicals Fitosporin-M, Albit and Vitoplan causes a decrease in morbidity, increase in productivity and quality of sugar beet roots under conditions of pathogenic myxomycetes and herbicide pressure. The stimulating effect was most pronounced under the conditions of application of Fitosporin-M, which allows to recommend it in the technologies of intensive cultivation of sugar beet [Pusenkova et al., 2015].

Bacteria of the genus Bacillus inhibit the development of an infectious process caused by Clavibacter michiganensis subsp. michiganensis on tomatoes. Pre-sowing treatment of seeds with suspensions of Bacillus subtilis IIB B-7023 and Bacillus pumilus 3 causes an increase in plant resistance against bacterial cancer, probably due to their synthesis of BAS with antimicrobial properties. Of the two strains of bacilli that differ in antagonistic properties against C. michiganensis subsp. michiganensis, a significant stimulating effect on the growth and development of tomatoes showed a strain of B. subtilis IMV B-7023, which is part of bacterial drugs [Roy et al., 2012]. Comparative evaluation of the antagonistic activity of endophytic strains of Bacillus subtilis 11B, Bacillus subtilis 26D and Bacillus subtilis 49PH against phytopathogenic fungi showed that the manifestation of bacterial antagonism is not associated with the production of hydrolytic enzymes - chitinases and glucanases, but with the synthesis of antibiotics, including surfactin. It was found that the fraction of metabolites of the studied strains, which contains antibiotics at a concentration of 0.01 mg / l shows high inhibitory activity on plant growth. Thus, the increase in the concentration of endophyte cells in biological products for seed treatment enhances their fungicidal activity and inhibits plant growth [Lukyantsev, 2010].

A regional strain of the bacterium Bacillus amyloliquefaciens has been isolated, which simultaneously has antagonistic activity against a wide range of plant pathogens, stimulating effect on plant growth and development, ability to fix molecular nitrogen in pure culture, regenerative activity by soil fertility and coenocytosis. , and does not show a toxic effect on flora and fauna [Siraeva, 2012].

The ecological impact of Acholeplasma laidlawii var. granulum pc 118 on the activity of phenylalanine amiacliase (FAL, CF 4.3.1.5) in the callus of sugar beets. The optimal conditions for the enzymatic reaction was the use as a substrate of L-phenylalanine, pH 8.4-8.8, temperature optimum 38-40o C. maximum value and gradually decreases after 24 h reaches the initial level.

Increased FAL activity of plants is considered as a protective reaction in response to the pathogen [Panchenko, Korobkova, 2012].

The strategy of rooting endophytic bacteria, which is characterized by increasing auxin levels and stimulating the growth of inoculated plants, is similar to the "strategy" of colonization of tissues of a susceptible host plant by the fungus Tilletia caries, which requires live plant cells. Increasing the level of indolyl-3-acetic acid (IOC) should probably lead to loosening of the cell wall, facilitating the process of rooting and spread of endophytic bacteria in plant tissues [Lindow, Brandl, 2003]. However, the same factor is "useful" for biotrophic fungi [Dyakov, 1994]. And perhaps because, under the conditions of treatment of plants with the drug Phytosporin is not observed a significant reduction in the damage of wheat plants by hard smut. In ternary plant-endophyte-phytopathogenic systems, the effect of the biotrophic fungus on plant metabolism was probably stronger than that of bacteria.

Preparations with polyfunctional action were obtained by the method of hydrolytic destruction of upper sphagnum peat of low degree of decomposition in the presence of cobalt or Neolithic salt. In the variants of the field experiment, which used preparations for growing wheat, there was a decrease in the infection of the grain of the crop, compared with the control. In addition, their use in low concentrations (0.005%) provided a significant increase in yield and improved wheat grain quality [Sysoeva et al., 2008].

Protective reactions of plants, which are induced by cytokinins and synthetic compounds and mimic the properties of starvation, drought and fungal pathogenesis in a number of test systems, include maintaining the activity of the translation apparatus at a high level. The general regularities of changes in the endogenous hormonal system under the action of chemically different anti-stress drugs that increase the resistance of plants to adverse environmental conditions are revealed. Treatment of wheat plants with bisol-2, baitan and salicylic acid (SC) induces an increase in ABA levels, which against the background of maintaining a high content of IOC acid can lead to pre-adaptation of plants to possible stress interactions and reduce their damaging effect. Induced by SC, Bisol-2 and Baitan resistance of plants against salinity, moisture deficiency and fungal diseases are associated with the prevention of a sharp shift in the balance of IOC = ABA, caused by stressors. Wheat plants have been shown to induce resistance under the influence of SC not only against fungal diseases, but also salinization of the environment and moisture deficiency, which allows to attribute this endogenous PPP to drugs with a broad spectrum of protective action [Shakirova, 1999, 2001].

Cytokinins in low concentrations and in combination with auxins are a necessary regulator of peroxidase synthesis. Cytokinins regulate the saturation of the cell wall with xylanases, polyphenol oxidases, peroxidases and chitinases, which are involved in protection against pathogens [Hu, Rijkenberg, 1998, Talieva et al., 1999]. It has been established that cytokinins increase the resistance of cells against fever and dehydration, dehydration, fungal and viral infections, mechanical action and exposure to various chemical agents [Sorokin et al., 1962, Kulaeva, 1979, Tom, 1984]. However, it cannot be ruled out that the accumulation of cytokinins in infected tissues may also be the plant's hormonal response to pathogen penetration. It has been shown that cytokinins are involved in signal transduction under the action of various stresses [D'Agostino, Kieber, 1999], expression of some protective genes [Harding, Smigocki, 1994] and synthesis of alkaloids [Yahia et al., 1998]. The increase in the content of cytokinins in wheat plants occurred under conditions of infection with rust [Popova, Tyuterev, 1988, Muzykantov et al., 1991, Fursova et al., 1991], powdery mildew [Talieva et al., 2001], smut mushrooms [Maximov et al. , 2002] and viruses [Sziraki, Gaborjanyi, 1974]. Cytokinins play an important role in the development of hernias on cruciferous crops caused by the fungus Plasmodiophora brassicae [Siemens et al., 2006]. Under these conditions, there is a decrease in the level of expression of genes encoding degradation enzymes and an increase in the level of gene expression of cytokinin receptors. In addition, overexpression of the enzyme cytokinin oxidase causes resistance of Pseudomonas aeruginosa to Plasmodiophora brassicae [Siemens et al., 2006]. 1994] and the synthesis of alkaloids [Yahia et al., 1998]. The increase in the content of cytokinins in wheat plants occurred under conditions of infection with rust [Popova, Tyuterev, 1988, Muzykantov et al., 1991, Fursova et al., 1991], powdery mildew [Talieva et al., 2001], smut mushrooms [Maximov et al., 2002] and viruses [Sziraki, Gaborjanyi, 1974]. Cytokinins play an important role in the development of hernias on cruciferous crops caused by the fungus Plasmodiophora brassicae [Siemens et al., 2006]. Under these conditions, there is a decrease in the level of expression of genes encoding degradation enzymes and an increase in the level of gene expression of cytokinin receptors. In addition, overexpression of the enzyme cytokinin oxidase causes resistance of Pseudomonas aeruginosa to Plasmodiophora brassicae [Siemens et al., 2006]. 1994] and the synthesis of alkaloids [Yahia et al., 1998]. The increase in the content of cytokinins in wheat plants occurred under conditions of infection with rust [Popova, Tyuterev, 1988, Muzykantov et al., 1991, Fursova et al., 1991], powdery mildew [Talieva et al., 2001], smut mushrooms [Maximov et al. , 2002] and viruses [Sziraki, Gaborjanyi, 1974]. Cytokinins play an important role in the development of hernias on cruciferous crops caused by the fungus Plasmodiophora brassicae [Siemens et al., 2006]. Under these conditions, there is a decrease in the level of expression of genes encoding degradation enzymes and an increase in the level of gene expression of cytokinin receptors. In addition, overexpression of the enzyme cytokinin oxidase causes resistance of Pseudomonas aeruginosa to Plasmodiophora brassicae [Siemens et al., 2006]. The increase in the content of cytokinins in wheat plants occurred under conditions of infection with rust [Popova, Tyuterev, 1988, Muzykantov et al., 1991, Fursova et al., 1991], powdery mildew [Talieva et al., 2001], smut mushrooms [Maximov et al., 2002] and viruses [Sziraki, Gaborjanyi, 1974].

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One of the important achievements of the world biotechnological process in the search for new promising substances in recent years has been the production, study and implementation of biopolymers of chitosan, chitin and their derivatives. Chitosan induces a range of reactions in plants that protect them from pathogens. One of the primary protective reactions - oxidative flash - the formation of ROS: superoxide (O2-) and hydrogen peroxide (H2O2). There is evidence that oxidative flare and associated signals may play a central role in integrating a diverse set of plant protective responses. The mechanism of ROS formation under the action of chitosan includes activation of:

1) NADP oxidase of cell walls;

2) apoplastic peroxidase (NADP-oxidase), which generates hydrogen peroxide;

3) apoplastic amine, diamine and polyamine oxidases [Szajdak, Maryganova, 2007, Almagro et al., 2009].

Activation of NADP oxidase is shown in rice plants under the action of N-acetylchitosanoligosaccharides, and peroxidase - chitosan in tomatoes.

Peroxidase isoforms produce hydrogen peroxide at alkaline pH, which is characteristic of the apoplast after induction of resistance. In tomato plants, one of the first reactions induced by chitosan is alkalization of the extracellular environment (apoplast). Chitosan can activate amine, diamine and polyamine oxidases, which are their substrate, resulting in the formation of ROS [Cauchie, 2002].

Chitosan has gained popularity in protecting plants from pathogenic fungi, nematodes and other pests. It is practically harmless to humans, animals, useful fauna and environmental objects. Chitosan is easily broken down by plant enzymes and microorganisms to the safe sugar glucosamine, so its use does not require hygienic rationing in food and the environment [Bochkarev, 2000].

It is used to improve the quality of soils in compositions with natural or industrial preparations, as well as as a binder in the manufacture of granular forms of fertilizers. However, the most promising use of chitosan as an environmentally friendly chemical immunomodulator (inducer of disease resistance) of plants, ie a substance that increases non-specific resistance to disease due to altered metabolism of plant tissue. Chitosan can be used at any time during the growing season. Under the influence of chitosan, in response to contact with the parasite, the plant synthesizes protective substances phytoalexins or accumulates phenols, which are oxidized to toxic to nematode compounds. Adverse conditions are created for the development of female nematodes, which as a result lay several times fewer eggs.

Currently, a number of unique compositions have been created, which are the basis for the development and application of cost-effective and effective technologies of preventive action [Bochkarev, 2000].

Chitin, chitosan and other glucans are not toxic against fungi and bacteria that have an indirect mechanism of action. Suppression of root rot of plants is due to the fact that glucans stimulate the development of soil fungi and actinomycetes, which are antagonists of fusarium and other parasitic fungi. As a result, the lysis of conidia and spores of phytopathogens begins and their population decreases sharply. This treatment of the soil with glucans allows for a long time (up to 3 years) to dramatically reduce the incidence of plant root rot [Adachi et al., 1987].

Under the influence of chitosan, the activity of the enzyme phospholipase A, which participates in the regulation of NADP oxidase activity, increases, resulting in increased Ca2 + fluxes in plant cells. The accumulation of calcium in the cytoplasm regulates the activity of NADP oxidase [Keller et al., 1998, Ak et al., 1998].

Chitosan is effective in cross-linking cell wall polysaccharides, which binds it and makes it the first barrier to pathogen penetration. Cross-linking of cell wall polysaccharides under the action of chitosan can be carried out with the participation of ROS and feruroyl-side chains. ROS as signaling molecules are mobile carriers of an unpaired electron. There are direct and indirect mechanisms of regulation of gene expression in response to changes in the oxidative status of the cell. Cysteine residues in protein transcription factors can be oxidized, which alters the transcription of genes responsible for oxidative stress. Chitosan activates the MAP kinase cascade. The cytosolic MAP kinase moves to the nucleus, where it phosphoryl is a transcription factor that regulates the activity of defense genes [Hastie et al., 1997, 1998, Ligterink et al., 1997, Easton et al., 2005].

Among the inducers of oat phytoalexins (chitosan, chitin, glycolchitin, glucan, oligogalacturonic acid), water-soluble chitosan has been shown to be the most effective elicitor of avenalumines in leaves [Bordin et al., 1991]. Chitosan causes the formation of phytoalexins in the seedlings of cowpea (Vigna umbellate L.). Induction is not inhibited even at high temperatures [Anuradha-Maity et al., 1994]. Chitosan induces the formation of pisatin and PR proteins in pea tissues and inhibits the growth of some fungal pathogens, such as Fusarium oxysporum f. sp. phases. Octamer showed the highest activity in the induction of pisatin and increased resistance [Hadwiger et al., 1994].

Biochemical changes in plants correlate with the high efficiency of chitosan against pityotic root rot (pathogen - Pythium aphanidermatum). A study of the induction of disease protection genes in tobacco and tomato plants after chitosan treatment showed that the transcription of chitinase and β-1,3-glucanase genes was increased to a greater extent and FAL, anionic peroxidase and 3-oxy-3-methylglutasyl OhA reducta [FAL]. -Sang Keun et al., 1998].

Chitosan increases the activity of β-1,3-glucanase in plants. In pea endocarp tissues, β-1,3-glucanase is one of the major proteins involved in the protective response to fungal infection. A similar enzyme is also present in the leaves of pea plants, which is 78% identical in amino acid sequences of β-1,3-glucanase from bean plants, and 62 and 60% to two β-1,3-glucanases from tobacco, 57% - β-1,3-glucanase from soybean plants and 51% - β-1,3-glucanase from barley [Chang et al., 1992]. The analysis of the genome of Southern pea plants was performed. It has been shown that the pea genome contains only one β-1,3-glucanase gene. The accumulation of β-1,3-glucanase mRNA in the endocarp of pea beans under conditions of infection with incompatible fungus Fusarium solani f was compared. sp. phaseoli, compatible Fusarium solani f. sp. pisi and after treatment with chitosan.

The mechanism of activation of the plant genome by chitosan is as follows. It has been suggested that chitosan, as a polycation containing NH2 + groups, interacts directly with negatively charged nuclear proteins or with DNA, which can alter the location of heterochromatin in structural genes. This hypothesis was based on the fact that 20% of all 3H-labeled chitosan applied to pea beans, after 5 h are localized in the cell nuclei, causing their structural changes [Hadwider, Losckie, 1982, Tada et al., 2001] , as well as the direct interaction of this polymer with DNA [Hadwider, Beckman, 1980]. The SELEX method was able to obtain single-stranded DNA with a size of about 20 triplets, which interacts not with chitosan and α-chitin, but with β-chitin [Fukusaki et al., 2000].

Highly effective elicitors are polysaccharide components of cell walls of phytopathogens - chitin derivatives [Silipo et al., 2010, Kovbasenko et al., 2013]. Water-soluble low-molecular chitooligosaccharides are especially relevant in the study of the mechanism of induced action on the immune potential of plant cells. One of the mechanisms of their protective action is the activation of genes that regulate the synthesis of pathogen-induced proteins, specifically oxalate oxidase and peroxidase [Davoine et al., 2001]. It is shown that the degree of acetylation of the biopolymer plays a role in the specificity of the manifestation of the biological activity of chitosan derivatives [Santos et al., 2008]. Given that the strategy of protective response of plants is determined by the type of food specialization of the pathogen,

Mikosan biological product, which is made of wood-destroying and higher basidiomycetes, which is a complex of 1,6-β-glucan and oligomers of 1,3-β-glucan, oligochitin, melanin, oligochitosan [Gorovy et al., 2001, 2002, 2004, Koshevsky et al., 2001, 2002, 2004, Teslyuk et al., 2001, 2004, Sabluk et al., 2002, Bondar et al., 2004, etc.]. Higher fungi are a unique producer of raw materials for the production of protective drugs, because their cell walls contain glucans and chitin in the form of chitin-glucan complex. Inhibition of root rot of plants is due to the fact that glucans stimulate the development of soil fungi and actinomycetes, which are antagonists of fusarium and other parasitic fungi. As a result, the lysis of conidia and phytopathogenic spores begins and their population decreases sharply. This treatment of the soil with glucans can dramatically reduce the incidence of plant root rot for up to three years. Another mechanism of plant protection against phytopathogenic fungi is that due to glucan treatment plants are immunized.

Glucan oligosaccharides induce increased synthesis of β-glucanase chitinase and phytoalexins in treated plants. The level of enzymes that cause the lysis of hyphae and haustoria of parasites can increase 10 times or more. During germination in the callus of treated seeds, an increased content of lytic enzymes is induced, which provide resistance against phytopathogenic fungi. In addition to preventing fungal and bacterial infestation of seedlings, such treatment accelerates seed germination [Koshevsky, 2004, et al., Gorovy, 2004]. Studies by Ukrainian scientists have confirmed the high efficiency of Mikosan application on various crops [Borodai et al., 2004, Koshevsky et al., 2004, Teslyuk et al., 2015, etc.].

Mycobiopreparation Mikosan-B is a very effective means of protecting grapes from powdery mildew and vegetable crops from a complex of diseases that can reduce the pesticide load and get environmentally friendly products [Dubrovin et al., 2011, Fedelesh-Gladynets et al., 2014, Teslyuk et al. , 2015].

The influence of the mycobiopreparation Mikosan on the vital activity of soil microorganisms was studied [Teslyuk, Gvozdyak and others. 2010]. It is established that the mycobiopreparation is complexї eiї Mikosan is a product of biotechnology for obtaining the active substance from the fruiting bodies of higher basidiomycetes.iin-coot ordinary (Fomes fomentarius (L. Fr.), Gill.). The active substance of the mycobiopreparation "Biofungicide Mikosan" includes a chitin-glucan complex (β-glucans and melaniNic) and low molecular weight polysaccharide chitosan obtained by enzymatic degradation of high molecular weight chitin. The active substances of the mycobiopreparation of natural origin are part of (in tiand or other number) of almost all animal and plant organisms.

The main active ingredient of the biofungicide is Mikosan єalkaline extract of aphilophoral fungi. According to the literature, the constituent components of the cell wall of the aphilophoral fungusiin there are glucans, melanins i xifence. Glucans are organic compounds likeibelong to the class of polysaccharides. Genderisaccharides - chains of monosaccharides that connect mithe same glycosidic bonds. These are linear or branched chains of natural monosaccharides with a chain length of more than 10 monosaccharide units.

Monosaccharides are associated with mia glycosidic bond i therefore, polysaccharides have a common name - glucans.

Melanins in the soil are subject to complete biostructureїto humic acids by microorganisms. Theyєthe main component of microorganisms and chernozems, which determine soil productivity. Toxic manifestations of fungal melanins iїtheir components are not detected.

It is established that pid exposure to Mikosan does not reduce the density is usefulї fauna isoil microflora. We did not detect species impoverishmentї diversity of microflora in the soil, as well as significant changes in їratio.

The number of agronomically useful groups of microorganisms asi involved in the transformation and immobilization of the elementiin the nutrition of plants - ammonifiers, oligonitrophils and bacteria that use nitrogen mineral compounds, as well as phosphorus-mobilizing bacteria and fungiiin. We found that in the soil there is a decrease in the titers of ammonifying bacteria on control samplesi variant, where the seeds were treated with Mikosan. Reducing the titer of ciєї group microorganismiin passes faster at a temperature of 200C (10-2) than 50C (10-3). Soi the results were obtained under the conditions of the study of nitrifying bacteria in the control i experimental varianti. A slight sensitivity of this drug was found to phosphorus-mobilizing bacteria, the number of which in relation to the control decreased by 0.6%.

Thus, based on the results of studies to study the effect of the biofungicide Mikosan on the viability of microorganisms, we can conclude that nid its effect does not reduce the density is usefulї fauna i soil microflora, and species depletion has not been establishedї diversity of microflora in the soili and significant changes in їhim ratio.

We investigated the toxicological evaluation of the biofungicide Mikosan on the sensitivity of the animal body [Teslyuk, Svitly and others, 2010]. An integral part of the mycobiopreparation are carbon-ammonium salts, which are a mixture of ammonium carbonate and bicarbonate. These are unstable compounds that decompose into components above 12oC - ammonia and carbon dioxide. The decomposition of carbon-ammonium salts in model experiments showed that 5% of salts decompose within 48 h [Sergeev, 1995; Zhminko and others, 1995]. Mycobiopreparation Mikosan is recommended for use in agriculture biofungicide: Mikosan-H - for seed treatment and Mikosan-B - spraying plants during the growing season.

Under the conditions of the oral route of administration of Mikosan to the body was determined by the lethal dose (LD50) of the drug. When administered to the stomach, the technique of administration was followed and data on the amount of substance that can enter the animal's body depending on its species and body weight were taken into account. In order to establish the species sensitivity to the action of the fungicide, studies were performed on white rats and mice. The peculiarity of the toxic effect of the drug depending on the sex of the animals was also studied. The experimental and control groups contained 6 females and males of white rats (weighing 160-170 g) and 10 male white mice (weighing 24-26 years), which were previously quarantined for 2 weeks in the vivarium on a diet established for laboratory animals.

Biofungicides (Mikosan-H and Mikosan-B) according to the study method were administered on an empty stomach in the native form in the stomach of animals using a metal probe in a wide range of doses: 1000, 3000 and 5000 mg / kg. 2 hours after administration of the animals received food and water.

Observation of animals showed that the behavior, consumption of food and water in the experimental group of rats (males and females) did not differ from control animals: the response to external stimuli (light, noise) did not change. Sensitivity to the drug in both male and female rats was the same (Table 4).

Table 4

Survival of white male and female rats under one-time conditions intragastric intake of the biofungicide Mikosan

[Teslyuk, Light and others, 2010]

Dose, mg / kg	Males		Females	
	Mikosan-N	Mikosan-B	Mikosan-N	Mikosan-B
	Live,%	Deaths,%	Live,%	Deaths,%
1000	100	0	100	0
3000	100	0	100	0
5000	100	0	100	0

The intake of Mikosan into mice at doses of 1000 and 3000 mg / kg did not cause symptoms of intoxication and death of animals. Under the conditions of Mikosan-H at a dose of 5000 mg / kg in animals there was a decrease in motor activity and respiratory disorders. The death of mice was observed during the first day, which was 30% (table. 5).

Table 5

Survival of white male mice under a single intragastric intake of the biofungicide Mikosan

[Teslyuk, Light and others, 2010]

Dose, mg / kg	Mikosan-N		Mikosan V	
	Live,%	Deaths,%	Live,%	Deaths,%
1000	100	0	100	0
3000	100	0	100	0
5000	70	30	100	0

It is shown that the LD50 for rats (males and females) and male mice for both Mikosan-H and Mikosan-B is set at> 5000 mg / kg, which allows to classify the biofungicide under the conditions of a single gastric intake to low-risk substances (hazard class 4). in accordance with GOST 12.1.007-76).

Under conditions of contact with the substance in the production and use for its toxicological characteristics, the ability of the latter to pass through intact skin is important. The study of skin-resorptive action of the fungicide was carried out in accordance with the guidelines "Assessment of the impact of harmful chemical compounds on the skin and justification of maximum permissible levels of skin contamination" in white rats and rabbits, which were applied drugs - Mikosan-H and Mikosan-B in specially prepared area of skin (size 2 x 2 cm2 for rats and 4 x 6 cm2 for rabbits).

Under repeated exposure, Mikosan-H was applied to the skin of white rats for 2 weeks (4 hours, 5 times a week). The criterion of effect, as well as at single drawing, served time and degree of display of signs of intoxication, lethality of animals. In addition, under conditions of repeated application of biofungicide on the skin, weekly noted the dynamics of changes in body weight of animals. At the end of the experiment, we studied the indicators that characterize the state of the nervous system, the functional state of the kidneys and liver, hematological parameters, calculated the absolute and relative mass of internal organs.

It was found that a single application of Mikosan-H and Mikosan-B on the skin of rats and rabbits at a dose of 3000 mg / kg did not cause clinical manifestations of poisoning and fatalities in animals. LD50 Mikosanu-H and Mikosanu-B for both species of animals more than 3000 mg / kg (hazard class 4 according to GOST 12.1.007-76).

Under the conditions of repeated application of the drug on the skin of rats during the experiment, no clinical symptoms of intoxication and death of animals were detected. Weight gain in experimental animals did not differ significantly from weight gain in animals of the control group (Table 6).

Table 6

Dynamics of body weight of white rats under conditions of repeated application Mikosanu-H on the skin of animals

[Teslyuk, Light and others, 2010]

Dose, mg/kg	Initial table, g	Term of researches, week		Weight gain after 2 weeks in relation to the initial weight,%
		1	2	
Control	228.4 + 19.3	232.0+ 21.0	244.0 + 17.2	7.0
Experiment	193.0 + 31.7	198.0+ 17.5	210.0 + 20.0	8.0

Notes: no probable differences

No changes in the indicators characterizing the state of the nervous system (approximate reaction and mink reflex) of animals were detected (Table 7).

Table 7

The state of the nervous system of white rats under repeated conditions applying Mikosan-H to the skin

[Teslyuk, Light and others, 2010]

Dose, mg/kg	Approximate reaction (number of squares, min.)	Mink reflex (number of glances, min.)
Control	7.00 + 0.83	1.80 + 0.29
Experiment	8.33 + 2.22	2.67 + 1.21

Notes: no probable differences have been established

Thus, based on the results of studies to study the toxicological properties of biofungicides (Mikosan-H and Mikosan-B), we can conclude that the drug under conditions of oral and dermal effects on the body of warm-blooded animals is low-risk (4 hazard class according to GOST 12.1.007- 76), does not irritate the skin and mucous membranes of the eyes, has no sensitizing properties, low accumulation.

Pre-sowing treatment of seeds with mycobiopreparation biofungicide Mikosan-H caused an increase in productivity of pea plants. Thus, the weight of 1000 grains from plants without seed treatment was 216.7 g, in the variants with the standard it was 10.6 g, and when using the biological drug Mikosan-H - 7.8 g more. The yield of peas in the variant with Mikosan (7 l / t) was higher compared to the control by 5.5 c / ha.

Analysis of results for 1999-2008 [Gorovy, Koshevsky, Teslyuk, Redko]. showed that the treatment of pea seeds with biofungicide Mikosan-H provides reliable protection against fungal diseases. The biological effectiveness of this drug did not differ from the best foreign biocidal chemicals.

The program of our research included the study of the effectiveness of the mycobiopreparation biofungicide Mikosan-H and its compositions on other crops, including barley. Its treatment was carried out two weeks before sowing at the rate of 7 liters of composition based on alkaline mushroom extract per ton of seeds. The compositions had an elicitor content of 7.2, 30.0 and 71.4 g/l and 100 g/l of ammonium carbonate and bicarbonate. The control were experimental plots of barley without treatment. Vitavax 200 FF chemical disinfectant with a consumption rate of 2.5 l / t and chitosan biological elicitor (200 g/t) with the appropriate addition of ammonium carbonate and bicarbonate were used as standards. The effectiveness of different methods of processing plant seeds was determined by the strength of growth - 3 days after sowing, germination - 7 days; plant height - at the 13th stage of the EC; damage to plants by root rot - tillering phase (stage 23 EC) and milk ripeness of grain (stage 73 EC) in accordance with the "Guidelines for state testing of fungicides, antibiotics and pesticides". The results of the influence of different methods on seed sowing quality, disease resistance and biometric parameters of barley plants are given in table 8 - 10.

Table 8

Influence of methods of presowing processing of seeds on sowing qualities and biometric indicators of spring barley

[Koshevsky, Teslyuk 2010]

Version		Energy germination,%	Field similarity,%	Length plants, see
Control		45.3	78.2	62.0
Vitavax 200 FF, 2.5 l / t		56.9	83.9	70.0
Chitosan + salt, 200 g/t		49.2	81.4	68.6
Composition, which is studied	50 g/t	49.2	81.4	68.6
	210 g/t	60.9	89.5	78.8
	500 g/t	60.9	89.5	78.8
NSR 05		4.73	4.65	5.21

Table 9

The influence of methods of pre-sowing seed treatment on the development of diseases spring barley plants,%

Version	Ustilago nuda	Fusarium spp. (EU stage 23)		Fusarium spp. (73 stage EC)	
		Affected plants	Development of the disease	Affected plants	Development of the disease
Control	1.6	60.9	7.2	94.4	11.0
Vitavax 200 FF, 2,5l / t	0	24.4	2.6	52.6	3.0
Chitosan + salts, 200 g / t	0.2	36.5	3.4	68.8	5.2

Continuation of the table. 9

Composition, which is studied	50 g / t	0.1	36.0	3.4	68.5	5.1
	210 g / t	0	23.7	2.6	63.0	3.1
	500 g / t	0	23.5	2.5	63.0	3.0
NSR 05		0.14	3.47	0.36	4.48	0.59

Table 10

The effectiveness of pesticides on the seeds of spring barley

Version		Technical efficiency,%			Mass of 1000 grains, g	Yield, c/ha
		Fusarium spp. (Stage 23)	Fusarium spp. (Stage 73)	Ustilago nuda,		
Control		-	-	-	47.1	30.6
Vitavax 200 FF, 2.5 l/t		63.8	72.7	100	50.6	36.2
Chitosan + salt, 200 g/t		52.7	52.6	87.5	48.2	31.4
Composition, being studied	50 g/t	52.9	55.8	90.4	48.6	34.1
	210 g/t	61.1	71.9	100	51.6	37.7
	500 g/t	61.2	71.8	100	51.8	37.8
NSR 05		4.5	4.4	4.8	3.1	0.9

The analysis of experimental researches confirmed high efficiency of application of fungal glucans for increase of resistance of spring barley against diseases.

At the same time, the research was conducted in 2001-2003 in SFG "Condor" Ulyanovsk district of Kirovograd region (Steppe). Barley seeds were treated two weeks before sowing with PS-10 disinfectants with a consumption rate of the working solution of 1 liter per 100 kg of grain. The sowing rate is 4.5 - 5 million similar grains per hectare.

The biological effectiveness of the drug Mikosan-N was studied on barley of the Eden variety of the second reproduction according to generally accepted methods [Tribel, 2001]. Sowing qualities of seeds treated with disinfectants were determined according to the method [DSTU 4138-2002.]. Spring barley was grown in accordance with the technologies adopted for the steppe zone of Ukraine.

Under the conditions of treatment of spring barley seeds with mycobiopreparation biofungicide Mikosan-N with a consumption rate of 3.5 and 7 l / t, it was found that it stimulates the sowing quality of seeds and biometric indicators of plants.

Analysis of the biological effectiveness of the biofungicide Mikosan-N showed that at a dose of 7 l / t mycobiopreparation provides plant protection 78.8 (23 stage EU) and 67.9% (73 stage EU) spring barley from fusarium root rot, ie at the level of the standard (vitavax 200 FF). Under the conditions of using the mycobiopreparation at a dose of 3.5 l / t, the biological effectiveness against fusarium root rot was 62.6% (EU stage 23) and 59.0% (EU stage 73). Biological efficacy against solid smut at the site. where the seeds were treated with the biofungicide Mikosan-H with a dose of 7 l / t was 96.1%, and in the variant with a rate of 3.5 l / t - 92.3%.

When treated with mycobiopreparation Mikosan-H at the rate of 7 l / t, the weight of 1000 grains of barley compared to the control was 2.66 g higher, and at a concentration of mycobiopreparation 3.5 l / t - 1.01 g. (7 l / t) was higher than in the control by 0.72 t / ha, compared with Vitavax 200 FF by 0.26 t / ha, and at the rate of 3.5 l / t - by 0.32 t / ha that is within the error.

It becomes obvious that the use of the mycobiopreparation Mikosan-H for the treatment of barley seeds at the rate of 7 l / t is an effective and promising way to protect against the most harmful diseases. It increases the intensity of growth, field germination of seeds, plant development, phytosanitary condition of sowing and efficiency of barley cultivation.

The program of our research was to study the effectiveness of Mikosan-N for the protection of vegetable crops from disease [Teslyuk, Kovbasenko, Dmitriev, etc., 2010]. The research was carried out in laboratory, field and vegetation conditions on the following crops: cucumber - hybrid F1 variety Rodnychok, melon variety Tavrychanka, potatoes - variety Luhovska, tomatoes of the Lagidny grade in DGP Borova, the Kiev region. during 1999–2002 [Koshevsky, Kovbasenko, Kovbasenko, Teslyuk, 2004].

Phytopathological records of plant infestation were performed according to generally accepted methods. The racial composition of the fungus Phytophthora infestans (Mont.) De Bary was identified on differentiating plants. Biochemical parameters of peroxidase activity were determined by Michlin and Bronevitskaya, titratable acidity - by titration, dry matter - by refractometer, vitamin C - by Moore's method.

The work was performed on an artificially created infectious medium. The results of the study are presented in table. 11 - 14 [Koshevsky, Kovbasenko, Kovbasenko, Teslyuk, 2004].

Table 11

Biological efficiency of pre-sowing treatment of seeds with Mikosan-N in protection of plants against root rot (DGP, Borova, 2000 - 2002)

Version	Development of the disease, %	Technical efficiency,%
Cucumber, hybrid F1 Spring		
Control without processing	9.5	0
Mikosan - H, 6 ml / kg	0.6	93.7

Continuation of the table. 11

Apron XL, 2.5 ml / kg	0	100
Melon variety Tavrichanka		
Control without processing	9.5	0
Mikosan - H, 6 ml / kg	0.9	90.5
Apron XL, 2.5 ml / kg	0	100

Table 12

Biological efficiency of drugs in plant protection against downy mildew

(DGP Borova, 1999 - 2002)

Version	Disease development,%	Technical efficiency,%	Commodity harvest, c / ha
Cucumber, hybrid F1 Spring			
Control without processing	47.2	0	94
Mikosan - B, 10 l / ha	6.8	85.6	164
Efal, 3.0 l / ha	6.4	86.4	168
Efal, 1.5 l / ha + Mikosan - B, 5 l / ha	6.2	86.9	171
NIR 05, c / ha	-	-	7.1
Melon variety Tavrichanka			
Control without processing	26.2	0	390
Mikosan - B, 10 l / ha	2.6	90.1	500
Efal, 3.0 l / ha	1.9	92.4	500
Efal, 1.5 l / ha + Mikosan - B, 5 l / ha	1.8	93.1	506
NIR 05, c / ha	-	-	8.3

Table 13

Biological efficacy of drugs against late blight on potato and tomato plants (DGP Borova, 2001–2002)

Version	Disease development,%	Technical efficiency,%	Commodity harvest, c / ha
Potatoes, Lugovskaya variety			
Control without processing	41.3	0	173
Mikosan - B, 10 l / ha	9.7	76.5	238
Efal, 3.0 l / ha	9.0	78.2	240
Efal, 1.5 l / ha + Mikosan - B, 5 l / ha	8.6	79.3	243
NIR 05, c / ha	-	-	5.4
Tomato variety Gentle			
Control without processing	37.7	0	12
Mikosan - B, 10 l / ha	10.6	71.9	490
Efal, 3.0 l / ha	9.3	73.4	493
Efal, 1.5 l / ha + Mikosan - B, 5 l / ha	9.0	76.2	495
NIR 05, c / ha	-	-	5.8

Table 14

Dynamics of peroxidase activity in the leaves of tomato plants, 0.01 ml of N iodine per 1 g of crude substance (plants are not affected)

Version	Before processing	After processing, days		
		2	5	8
Control-without processing	11.48	11.48	11.48	11.48
Efal, 3.0 l/ha	11.48	17.00	15.02	13.18
Mikosan-B, 10 l/ha	11.48	21.34	18.04	15.02
Efal, 1.5 l / ha + Mikosan - B, 5 l/ha	11.48	19.00	16.80	14.64

Table 15

The dynamics of acidity of cell sap in the leaves of tomato plants, % on raw weight (plants are not affected)

Version	Before processing	After processing, days		
		2	5	8
Control-without processing	0.47	0.47	0.47	0.47
Efal, 3.0 l/ha	0.47	0.72	0.59	0.51
Mikosan-B, 10 l/ha				
Efal, 1.5 l / ha + Mikosan - B, 5 l/ha	15.0	82.0	495	

Table 16

Influence of drugs on suppression of fungal parasitism *Phytophthora infestans (Mont.) de Bary* (vegetation experiment, 2003)

Version	Disease suppression,%		
	Physiological races		
	4 and 1.4	XYZ	5.6.7.8.9.10
Control-without processing	0	0	0
Efal, 3.0 l/ha	98.4	85.0	85.2
Mikosan-B, 10 l/ha	80.3	74.2	74.3
Efal, 1.5 l / ha + Mikosan - B, 5 l/ha	94.2	80.6	79.0

Studies have shown that Mikosan-H, as an inducer of plant resistance, has almost the same effectiveness as the fungicide Apron, which inhibits the parasitic activity of pathogens. In addition, the mycobiopreparation biofungicide Mikosan-B is quite effective in the treatment of plants during the growing season and is practically not inferior to classical fungicides.

Similar results were obtained and published for other cultures. Therefore, the active substance of the mycobiopreparation Mikosan has practically no effect on the pathogen, at the same time it induces protective mechanisms in plants. This is confirmed by our results on changes in redox activity and acidity of cell juice, as well as data on the suppression of rasospecific parasitism Phytophthora infestans (Mont.) De Bary.

Given the high environmental safety of the non-pesticide drug Mikosan, it should be used more intensively to increase plant resistance, especially in conditions of weak and moderate disease development, as well as the pre-infection stage. In the seasons of epiphytic development of diseases it is necessary to use the drug in tank mixtures with classical fungicides to simultaneously suppress the parasitism of harmful objects and the induction of plant defense mechanisms.

The biological effectiveness of the application of the mycobiopreparation biofungicide Mikosan on the basis of fungal biopolymers was studied by us during 2003–2005 in laboratory, field and vegetation experiments on cabbage varieties Dymerska 7, Ditmarsher Fruyer, Amager 611, Bilosnivazhka, Kharkiv, Kharkiv. [Yarovy, Onishchenko Teslyuk, Kovbasenko, Kovbasenko, 2008]. The synthetic drug Apron XL and the inducer of arachidonic acid resistance were used for comparative evaluation. Phytopathological observations of white cabbage plants were performed according to generally accepted methods. Biochemical parameters of peroxidase activity were determined by Michlis and Bronovitskaya.

In cold and humid springs, cabbage seedlings are often damaged by root rot, which causes liquefaction of crops in the nursery. Mycobiopreparation biofungicide Mikosan-H was used for pre-sowing treatment of white cabbage seeds. The work was carried out on an artificially created infectious environment (Tables 17 - 19)

Studies have shown that Mikosan - H, as an inducer of plant resistance, has almost the same effectiveness as the classic fungicide - a pesticide (Dr. metalaxyl), which inhibits the parasitism of pathogens.

In addition, the formulation of the drug Mikosan - B, as well as arachidonic acid were quite effective in the treatment of plants of white cabbage in the growing season (2nd year) (table 18).

Studies conducted in VIZR found that under the influence of chitosan in potato tubers sharply increases the synthesis of phytoalexins [Tyuterev, 2002]. Similar results were also obtained for the drug Mikosan, which had virtually no effect on the growth of the pathogen, but induced protective mechanisms in plants.

Table 17

Biological efficiency of pre-sowing treatment seeds Mikosan-H in protection of white cabbage from root rot (2003 - 2005)

[Yarovy, Onishchenko, Teslyuk, Kovbasenko, Kovbasenko, 2008].

Version	Disease development,%	Technical efficiency,%
Variety Dimerskaya 7		
Control, without processing	10.4	0
Mikosan - H, 6 ml/kg	0.7	93.3
Apron XL, 2.5 ml/kg	0	100
Variety Dietmarscher Früyer		
Control, without processing	10.8	0
Mikosan - H, 6 ml/kg	0.8	92.6
Apron XL, 2.5 ml/kg	0	100
Variety Amager 611		
Control, without processing	9.3	0
Mikosan - H, 6 ml/kg	0.6	93.5
Apron XL, 2.5 ml/kg	0	100

Table 18

Biological effectiveness of drugs in the protection of white cabbage from diseases [Kovbasenko and others. 2003-2005]

Version	Peronosporosis,%		Alternaria,%	
	Development of the disease	Technical efficiency	Development of the disease	Technical efficiency
Variety Amager 611				
Control, without processing	19.6	0	21.4	0
Mikosan - B, 10 l/ha	4.3	78.1	4.4	79.4
Arachidonic acid), 0.002 l/ha	4.5	77.0	4.7	78.0
Grade Snow White				
Control, without processing	17.4	0	20.1	0
Mikosan - B, 10 l/ha	3.8	78.2	4.1	79.6
Arachidonic acid, 0.002 l/ha	4.0	77.0	4.4	78.1
Grade Kharkiv winter				
Control, without processing	16.2	0	19.7	0
Mikosan - B, 10 l/ha	3.4	79.0	3.9	80.2
Arachidonic acid, 0.002 l/ha	3.6	77.8	4.3	78.2

In support of this conclusion, we obtained positive results regarding the change in the activity of the oxidoreductase enzyme peroxidase (Table 19).

Table 19

Dynamics of change of peroxidase enzyme activity in healthy tissues of white cabbage of Kharkiv winter variety, MP 0.01N iodine per 1 g of crude substance

Version	Before processing	After processing, days		
		2	5	8
Control, without processing	12.65	12.69	12.72	12.75
Mikosan-B, 10 l/ha	12.65	23.78	19.51	16.77
Arachidonic acid, 0.002 l/ha	12.65	21.45	17.98	15.83

It was found that the biological effectiveness of Mikosan - H as an inducer of resistance against downy mildew on different varieties of cabbage is from 71.8 to 79%, and Alternaria from 79.4 to 80.2%, which corresponds to the action of the classical fungicide - pesticide (d.r. metalaxyl), which inhibits the parasitism of pathogens. In addition, the mycobiopreparation biofungicide Mikosan - B, as well as arachidonic acid are quite effective in the treatment of white cabbage plants during the growing season.

Ecologically safe and biologically active drugs Mikosan and arachidonic acid are quite effective inducers of protective mechanisms in white cabbage plants. Therefore, it is especially advisable to use them at the pre-infection stage, as well as weak and moderate development of diseases.

To increase the effectiveness of induced plant protection against diseases and to study the synergistic action of organic inducers of resistance with their inclusion in compositions based on fungal glucans, studies were conducted on other vegetable crops. [Teslyuk, Kovbasenko, Dmitriev, Dubrovin, 2010].

It is established that exogenous and endogenous phenolic organic acids (salicylic, cinnamic, ferulic, gallic, benzoic, etc.) are quite effective inducers of the acquired resistance of plants to diseases [Tyuterev, 2002, Klessig, 1994, Tarchevsky, 2002, Zaprometov 2004, etc. .]. Based on the axiom that plants have resistance genes and are able to respond to their defeat by pathogens, it is assumed that there are substances that stimulate phytoimmune reactions. Oligosaccharides of microbial and plant origin are signaling molecules involved in the expression of plant resistance genes against pathogens.

Mikosan, as a derivative of chitin, actively induces the formation of antipathogenic substances in plant cells and tissues. In addition, one of the first reactions of the plant to contact with the pathogen is the alkalinization of the environment in the intercellular space, and organic acids play an important role in immune responses at later stages of the pathological process [Koshevsky, 2004, Kovbasenko, 2008, Kovbasenko, 2008]. Thus, the use of a synergistic mixture of two inducers of resistance of plants of different chemical nature strengthens the defense mechanisms over time.

We studied the biological effectiveness of the inducer of protective mechanisms of the biofungicide Mikosan on vegetable crops, including tomatoes, potatoes, cucumbers, melons, onions and watermelons in laboratory, field and vegetation experiments. Phytopathological records of plant damage were performed according to the generally accepted method [Bondarenko, 2001].

Biochemical parameters of peroxidase activity were determined by Michlis and Bronevitskaya, titratable acidity - by titration, dry matter - by refractometer, and vitamin C - by the Moore method [Yarosh, 1987]. The content of amino acids, nitrates and potassium in plants was determined on an infrared quality analyzer model 4500 of Indo-American production (supplier "Interagrotech", Moscow) using a computer program of the American company "NIR System".

Processing of vegetative plants of vegetable crops in the field was carried out before the onset of the first symptoms of their diseases, and then 2-3 times, depending on the development of diseases. Accounting for plant lesions was carried out in accordance with approved methods. The conducted researches established rather high biological efficiency of the mycobiopreparation biofungicide Mikosan (tab. 20).

Table 20

Biological efficiency of resistance inducers in vegetable crops (2007-2009)

[Teslyuk, Kovbasenko, Dmitriev, Dubrovin, 2010].

Disease	Version							
	Control (without processing)		Mikosan, 10 l/ha		Cinnamic acid, 0.2 kg/ha		Mikosan, 5 l/ha + Cinnamic acid, 0.1 kg/ha	
	RH	BE	RH	BE	RH	BE	RH	BE
Potatoes, Luhivska variety								
Phytophthora	21.6	0	9.4	55.6	10.0	53.7	8.9	57.8
Early dry spot	12.0	0	5.8	51.7	6.1	49.2	5.5	54.2
Potatoes, Zarevo variety								
Phytophthora	22.8	0	9.6	57.9	10.2	55.3	9.1	60.1
Early dry spot	13.4	0	6.0	55.2	6.4	52.2	5.6	58.2
Tomato, variety Gentle								
Phytophthora	20.0	0	9.2	50.4	9.8	51.0	9.0	55.0
Early dry spot	10.0	0	5.7	43.0	6.3	37.0	5.4	46.0
Tomato, variety Flora								
Phytophthora	21.4	0	9.6	55.1	10.1	52.8	9.3	56.5
Early dry spot	11.4	0	6.4	43.9	6.6	42.1	6.2	45.6

Continuation of the table. 20

Tomato, Bobrytsky variety								
Phytophthora	19.2	0	8.8	54.2	9.7	49.5	8.6	55.2
Early dry spot	9.0	0	5.0	44.4	5.8	35.6	4.8	46.7
Tomato, variety Chorus								
Phytophthora	19.6	0	9.0	54.1	9.8	50.0	8.8	55.1
Early dry spot	10.0	0	5.6	44.0	6.4	36.0	5.3	47.0
Tomato, Borivsky variety								
Phytophthora	19.8	0	9.2	53.5	9.8	50.5	8.9	55.1
Early dry spot	10.2	0	5.8	43.1	6.6	35.3	5.4	47.1
Cucumber, hybrid F1 Spring								
Peronosporosis	12.4	0	7.0	43.5	7.8	37.1	6.7	46.0
Cucumber, grade Source								
Peronosporosis	11.8	0	6.8	42.4	7.7	34.7	6.5	44.9
Onion of the 1st year variety Skvyrska								
Peronosporosis	22.0	0	11.0	50.0	12.1	45.0	10.7	51.4
Onion of the 2nd year Skvyrska variety								
Peronosporosis	32.0	0	17.3	45.9	18.9	40.9	16.8	47.5
Watermelon, variety Tavrichanka								
Peronosporosis	15.0	0	7.8	48.0	8.3	44.7	7.6	49.3
Watermelon, Stokes grade Kiev								
Peronosporosis	11.6	0	5.4	53.4	5.9	49.1	5.2	55.1

Notes: RH - development of the disease; BE - biological efficiency.

We studied the change in the activity of the redox enzyme peroxidase, the dry matter content, vitamin C and the titrated acidity of cell juice. As a result of the analysis, no significant changes in dry matter and vitamin C content were detected in uncontrolled variants, but differences in peroxidase enzyme activity and titrated acidity of cell juice were found, the general trend of which is similar in its dynamic manifestation (Tables 21 and 22).

Table 21

Dynamics of peroxidase enzyme activity in leaves plants of the tomato variety Gentle, mg-eq / min

Consumption of the preparation, kg/ha	Before processing	After processing, days		
		2	5	8
Control, without processing	11.5	11.5	11.5	11.5
Mikosan, 10 l/ha	11.5	19.7	17.9	14.8
Cinnamic acid, 0.2 kg/ha	11.5	18.4	16.9	15.7
Mikosan, 5 l / ha + Cinnamic acid, 0.1 kg/ha	11.45	20.0	18.8	16.7

Our results showed that Mikosan and cinnamic acid induce protective mechanisms in plants and help reduce their disease incidence, and the tank mixture of half the rate of consumption of these inducers shows even higher efficiency.

Table 22

Dynamics of acidity of cell sap of plant tissues tomato variety Gentle,% on crude matter

Consumption rate of the drug, kg / ha	Before processing	After processing, days		
		2	5	8
Control, without processing	0.45	0.45	0.45	0.45
Mikosan, 10 l/ha	0.45	0.94	0.73	0.61
Cinnamic acid, 0.2 kg/ha	0.45	0.79	0.57	0.49
Mikosan, 5 l / ha + Cinnamic acid, 0.1 kg/ha	0.45	0.99	0.89	0.65

We determined the effect of Mikosan and cinnamic acid and their tank mixture on the composition of amino acids, nitrates and potassium in plants of the tomato variety Gentle (Table 23)

Table 23

The effect of cinnamic acid, Mikosan and their tank mixture on potassium content, nitrates and amino acids in the leaves of tomato variety Gentle.

After processing, days	Version	Nitra, mg / kg	Lei Qing, %	Tyrosine,%	Arginin,%	Glutmin,%	Potassium,%
2	Control	191.4	2.23	2.12	3.31	1.81	30.8
	Cinnamic acid, 0.2 kg/ha	254.3	2.03	2.00	3.07	2.37	20.0
	Mikosan, 10 l/ha	268.3	2.00	1.96	3.04	2.42	19.8
	Mikosan, 5 l / ha + Cinnamic acid, 0.1 kg/ha	272.7	1.98	1.95	3.03	2.44	19.8
5	Control	235.0	2.28	2.15	3.40	2.19	32.4
	Cinnamic acid, 0.2 kg/ha	272.3	2.15	2.01	3.10	2.95	21.4
	Mikosan, 10 l/ha	274.5	2.13	2.00	3.08	2.98	21.0
	Mikosan, 5 l / ha + Cinnamic acid, 0.1 kg/ha	275.6	2.15	2.01	3.09	2.99	21.00

Continuation of the table 23

8	Control	181.6	2.30	2.21	3.38	2.22	33.4
	Cinnamic acid, 0.2 kg/ha	215.6	2.18	2.07	3.24	2.91	22.3
	Mikosan, 10 l/ha	218.0	2.17	2.05	3.22	2.93	22.1
	Mikosan, 5 l / ha + Cinnamic acid, 0.1 kg/ha	218.1	2.17	2.04	3.22	2.93	22.2

Therefore, our proposed inducers of plant resistance and their tank mixture have a stimulating effect on the protective mechanisms of plants in the pathological process.

The biological effectiveness of protecting vegetable crops from diseases by increasing their resistance to phytopathogens, rather than by suppressing their parasitism.

The biofungicide Mikosan, which is based on chitin, fungal glucans and melanins, actively induces the formation of antipathogenic substances in plant cells and tissues. One of the primary reactions of the plant to contact with the pathogen is the alkalinization of the environment in the intercellular space, and organic acids play a very important role in immune responses in the later stages of the pathological process. Hence the need to study the effectiveness of the combined action of Mikosan and organic acids - a synergistic mixture of two inducers of resistance of plants of different chemical nature, which strengthen the defense mechanisms over time.

The research was performed in laboratory, field and vegetation conditions of BPH Borova, Kyiv region. during 2007-2009, phytopathological observations of plant disease were carried out according to generally accepted methods. Peroxidase activity was determined by Michlis and Bronevitskaya, acidity - by titration, dry matter - by refractometer, vitamin C - by the Moore method.

Processing of vegetative plants of potatoes, tomatoes, cucumbers, onions, melons and watermelons with a mixture of Mikosan and cinnamic acid was carried out in the field before the first symptoms of their diseases, and then 2-3 times, depending on the development of diseases, which showed a high enough biological efficiency - from 44.9 to 60.1%

Thus, Mikosan and cinnamic acid induce protective mechanisms in plants, reducing their disease incidence, and the tank mixture of half the rate of consumption of these inducers leads to even higher efficiency.

Spraying of vegetable crops during the growing season according to the prognosis of pathogens Mikosan-B and cinnamic acid and their composite mixture showed positive biological effectiveness in protecting plants from diseases by increasing resistance to phytopathogens, rather than by suppressing their parasitism.

The use of Mikosan and lunularic acid and their compositions to induce protective mechanisms reduced the incidence of plant diseases, and the tank mixture of half the rate of consumption of these inducers increased efficiency [Teslyuk, Kovbasenko, Dubrovin, 2010].

High biological efficiency of the use of the mycobiopreparation Mikosan to increase the resistance of plants against diseases was obtained as a result of experimental studies on sugar beets [Bondar, Kyryk, Koshevsky, Teslyuk, 2005], winter wheat [Koshevsky, Gorovy, Koretsky, Teslyuk, Teslyuk, 2005] , Gorovy, Redko, Teslyuk, 2004], as well as rape [Bondar, Kyryk, Koshevsky, Teslyuk, 2005].

Pre-sowing treatment of seeds with mycobiopreparation Mikosan-H reduced plant damage by bacterial diseases during the growing season under natural and artificial infection, stimulated growth and development, creation and development of bacterial nodules on plant roots, increasing chlorophyll, nitrogen, phosphorus and potassium, quality of soybean grain [Teslyuk, Kaminsky, Dubrovin, Polishchuk, 2010]. The impact of harmful objects causes a decrease in crop yields by 30% or more, which involves the protection of plants.

A new direction in the development and use of drugs for disease protection is the stimulation of plant defense mechanisms through the use of mycobiopreparations based on chitin-glucan complexes of fungal origin.

Mycobiopreparation of new generation biofungicide Mikosan has high efficiency for protection of plants against diseases and stimulation of plants. It is a promising product of modern scientific knowledge about plant immunity and science-intensive biotechnology of fungal glucans.

The use of mycobiopreparation is recommended for the treatment of seeds and plants during the growing season of spring and winter wheat, barley, corn, peas, soybeans, sugar beets, sunflowers, fruits and vegetables. High efficiency, safety for humans and the environment, as well as the low cost of the mycobiopreparation biofungicide Mikosan (brands H and B) opens wide opportunities for the transition of crop production in Ukraine to fundamentally new environmental and economic levels. The use of BAR fungal polysaccharides chitin-glucan-melanin complex confirmed our idea of using as an inducer of immune responses of plants to protect them from stress. This opens up modern areas of scientific and practical creation and application of environmentally friendly drugs in the agricultural sector.

The effect of resistance inducers Krezacin, Silk, Chitosan, Sodium Humate, Ambiola, Potassium Humate, El-1 and Eracond against late blight and scabies was revealed. The mechanism of protective and stimulating action of inducers of disease resistance is manifested in the responses of plants through the synthesis of phytoalexins, pigments and carbohydrates. Of the potato varieties, mainly ryegrass was identified. Treatment of tubers and potato leaves with an inductor causes active synthesis of reshitin with a maximum at the end of the first day, which continues throughout the period of action of the inductor [Porsev, 2000].

Treatment of cucumber plants with Zircon stimulates its effect on arthropod phytophages. The dependence of the nature of the manifestation of zircon-induced chemical reactions on the species of phytophages, morphological condition of plants, as well as the concentration of the working solution of the drug was revealed. The necessity of conducting research under the conditions of development of a scientifically substantiated strategy of using immunomodulators as an element of integrated plant protection is shown [Kirillova, Selitskaya, 2015].

The biological product Rizoplan, applied to vegetative potato plants, showed activity against Pytophthora infestans (Mont.) De Bary for 5-7 days, most intensively during the period of conidia germination and lesions. Under favorable conditions for the development of the disease in the conditions and four times of use, this drug did not differ in effectiveness from the contact fungicide polycarbacin. The drug agate 25K also reduced the germination of conidia Pytophthora infestans (Mont.) De Bary [Kuznetsova, 2000].

Isolated strains of bacteria of the genus Bacillus, in particular Bacillus subtilis strains 1-3, Bacillus weihenstephanensis and Bacillus pumilis inhibit the growth and development of phytopathogenic myxomycetes of the genus Fusarium. These strains of bacteria can be considered as potential biological products for inhibiting the growth of phytopathogens - pathogens of dry rot of potatoes [Asaka, Shoda, 1996; Backman et al., 1997; Brannen, Kenney, 1997; Chen, Wu, 1999, Mardanova et al. 2015].

Bacteria Bacillus amyloliguefaciens UKM 5137, on the basis of which a new biological drug sporophyte was created, showed antagonistic properties against pathogenic bacteria of the genus Xanthomonas [Lapa et al., 2005]. It was found that a mixture of Bacillus amyloliguefaciens UKM 5137 and Bacillus subtilis UKM 5009 causes a complex effect on bacteria of the genera

Xanthomonas and Pseudomonas, which cause damage to soybean plants, which confirms the possibility of creating a biological product to more effectively protect crops from bacterial infections.]. In the interactions between pathogens and biological control agents, when pathogens are suppressed, the genotype of the host plant plays an important role [Smith, Goodman, 1999].

Strain Bacillus amyloliquefaciens subsp. plantarum BIM B-439D, which is the basis of the biopesticide betaprotectin, has a high antagonistic activity against a wide range of phytopathogens, which significantly expands its scope for protection of agricultural plants from anthracnose, fusarium wilt, gray rot, helminthiasis, helminthiasis etc. The high level of antagonism of the strain is due not only to the production of antibiotics, but also the enzymatic activity of bacteria (protease, amylolytic, β-glucanase, chitinase and xylanase). It was also found that the supernatant of the culture fluid of the studied strain contains compounds that belong to the group of low molecular weight cyclic lipopeptides [Berezhnaya et al., 2014].

Isolated from the soil spore-forming strain, which was identified by analysis of 16S rRNA as Bacillus amyloliquefaciens, was marked by pronounced antagonistic activity against the fungi Fusarium graminearum, Fusarium nivalae, Fusarium solani, Phhizoctonia solianiolianois, Sclerotiotio, Scleroistio. These fungi are the causative agents of diseases such as ear fusarium wilt and wheat fusarium wilt, fusarium wilt, Alternaria and phomosis of potatoes, root rot and sunflower fomopsis.

The fungicidal factor of the Bacillus amyloliquefaciens strain causes lysis of Fusarium solani conidia. Zoospores of Phytophthora infestans (Mont.) De Bary do not germinate in the presence of a fungicidal factor. In all cases, there is no formation of growth tubes and mycelium. The inhibitory effect of bacteria on pathogenic fungi can be due to the formation of a complex of enzymes that lyse the cell walls of fungi, the synthesis of antibiotics and competition in the consumption of nutrients. It can also be predicted that the inhibitory effect of the fungicidal factor of the strain Bacillus amyloliquefaciens is associated with the formation of antibiotic substances that secrete cells into the environment [Kuzin et al., 2012].

The fungicidal effect of the bacterium Bacillus aureofaciens, bacterial suspension and centrifugate of culture fluid on the development of phytopathogens Fusarium culmorum, Botrytis cinerea, Alternaria alternata, Alternaria infectoria, Alternaria solani, Alternaria tenuissima, Pythiliga titiissia. The presence of an inhibitory effect that depends on the type of fungus is shown [Burova, 2013].

New methodological approaches have been developed to control the number of leaf-eating insects. One of them is the creation of insecticides based on nucleic acids, involving short single-stranded DNA fragments of antiapoptotic genes of nuclear polyhedrosis viruses, homologous to antiapoptotic host genes [Oberemok, Skorokhod, 2014], as well as long double-stranded RNA fragments [2013, Kni, Kni.

The development and application of such drugs are based on methods of blocking the expression of genes important for the life of insect pests using the mechanisms of RNA interference, as well as antisense technologies. DNA insecticides based on the anti-apoptotic gene IAP-3 of the nuclear polyhedrosis virus of the odd silkworm can be used to create safe, relatively affordable and fast-acting DNA insecticides to control the number of populations of the odd silkworm [Oberemok, Skorokhod, 2014].

The idea of DNA insecticides is unique and has its own features, including small oligonucleotides, the use of single-stranded DNA molecules and viral antiapoptotic genes, which distinguishes them from other known post-genomic approaches to plant protection currently being developed [Oberemok, Gninenko, 2015].

Metabolites that are prescribed by the FS-94 isolate of the fungus Fusarium sambucinum inhibit the development of phytopathogenic fungi. Their protective effect against wheat septoria and carrot alternariosis is based on the ability to inhibit the germination of phytopathogenic spores and induce plant resistance against them. It has been shown that the studied metabolites are elicitors of systemic acquired stability, which activate the signal systems of wheat plants, including salicylate-dependent. Exometabolites of isolate FS-94 are characterized by properties of sensitizers that increase the sensitivity of the causative agent of wheat septoria to azole fungicides and prolong the action of the latter. It has been shown that the fraction of extracellular metabolites with maximum antiseptorial activity has a protein nature [Semina et al., 2012, Semina, 2013].

In the zone of penetration of the fungus Tilletia caries into wheat germ in the surface cells of the coleoptile, the production of hydrogen peroxide was detected. Pathogen-resistant plants are characterized by a higher level of its generation and early deposition of lignin in the cell walls. The generation of hydrogen peroxide in the surface cells of wheat rhizomes of wheat callus ensures their resistance to fungal infection. In infected with the fungus Septoria nodorum Berk. in the cells of wheat leaves is the generation of hydrogen peroxide. In Tilletia caries-infected wheat calluses, it is traced in parenchymal cells in contact with the mycelium. SC and chitooligosaccharides increase the generation of hydrogen peroxide in the cells of leaves and calluses of wheat, which stimulates the attenuation of the symptoms of septoria on the leaves and slows the growth of the pathogen in the calluses. Inducers of plant resistance cause abnormalities in the development cycle of fungi in plants and callus of wheat. Under the conditions of cultivation of calluses of susceptible samples of wheat in the presence of inducers of resistance, the formation of dense areas and rhizoids not affected by Tilletia caries and Ustilago tritici fungi is observed. Under the conditions of calluses cultivation in the conditions of inhibition of hydrogen peroxide generation, calluses loosen and their dry weight growth decreases. Some single facts confirm the key regulatory role of hydrogen peroxide in the growth of plant cells [Troshina, 2007]. Under the conditions of calluses cultivation in the conditions of inhibition of hydrogen peroxide generation, calluses loosen and their dry weight growth decreases. Some single facts confirm the key regulatory role of hydrogen peroxide in the growth of plant cells [Troshina, 2007]. Under the conditions of calluses cultivation in the conditions of inhibition of hydrogen peroxide generation, calluses loosen and their dry weight growth decreases. Some single facts confirm the key regulatory role of hydrogen peroxide in the growth of plant cells [Troshina, 2007].

The biological efficiency of the fungicide betaprotectin (DR - spores and metabolic products of Bacillus subtilis BIM B-439 D) 2% in relation to the pathogens of gray rot, fusarium wilt and penicillosis lily [Linnyk, Sverchkova, 2012].

Rhizosphere bacteria Pseudomonas putida and Pseudomonas aurantiaca colonize the rapeseed root system. The studied bacteria are not displaced by the aboriginal microflora of non-sterile soil even 3 months after inoculation. One of the mechanisms of phytoprotective activity of the bacteria Pseudomonas putida and Pseudomonas aurantiaca is their ability to synthesize metabolites that induce systemic resistance of rape against pathogens of Alternaria. It has been shown that pioverdines, phenazine antibiotics, gibberellins, a complex of gaseous compounds, extracellular metabolites (culture fluid released from cells), and a complex of intracellular substances (disintegrated cells) can induce plant resistance to pathogens and reduce lesions of Alternative rape -42%, depending on the inducer of resistance [Kuleshova et al., 2011].

The microbiological drugs Extrasol, Fitocid-R and Planriz have been shown to be effective in delaying the development of dry fusarium rot. Biological efficiency for 2 days in relatively susceptible varieties Kalynivska and Povin fluctuated between 32.2-77.1%, and the rest - 13.3-39.4%. The effectiveness of biological products against Fusarium wilt for two weeks decreased slightly, which on the 15th day averaged 25.5%. The studied biological products were slightly inferior to chemical control [Borodai et al., 2014]. The microbiological preparation Extrasol based on a consortium of associative bacteria showed a wide range of antibiotic action against Fusarium solani, F.oxysporum, F.sambucinum, Alternaria solani and Pectobacterium carotovorum. Under the conditions of Extrasol application, the growth inhibition of phytopathogens was 1.4–1.9 times greater in comparison with Phytocid-P and 1.7–2,

The endophytic method of existence of bacteria of the Bacillus subtilis 26D strain in the tissues of wheat and potato plants has been proved. Its participation in the launch of molecular mechanisms of induced resistance against septoria and late blight has been revealed. Transcriptional modulation of peroxidase genes in wheat and potato plants has been substantiated, which causes an early immune response and suppression of the protective response during pre-sowing treatment of plants with a complex of bacterial suspension with salicylic or jasmonic acid (LC). Comparative analysis of the transcriptional status of genes of wheat peroxidases M21334 and TC 151917 in response to Bacillus subtilis 26D and LCD in normal and under conditions of infection with pathogens confirmed their participation in endophyte-induced plant resistance [Abizgildina, 2012].

The strain with the most pronounced fungicidal activity in the genera Fusarium and Alternaría was characterized by phytostimulant activity and the ability to colonize plants, which was identified as Bacillus atrophaeus B-9918 [Koryazhkina, 2012]. The advantage in the manifestation of antagonistic properties to the isolate of Bipolaris sorokiniana isolated from wheat seeds belongs to the strain Bacillus subtilis 113. The results of the studies can be used to develop probiotic drugs in crop production to control phytopathogenic fungi, in particular Bipolaris sorokiniana]. New endophytic strains of Bacillus subtilis have been isolated, which predominate the antagonistic activity of the reference strain Bacillus subtilis 26D, which is the basis of the drug phytosporin-M.

The active ingredients of Stimunol are a mixture of natural amino acids, proteins, enzymes, vitamins and BAS, the combined effect of which on the plant is complex. The effective effect of the drug was manifested under conditions of treatment of plants at low rates of consumption, from 0.1 to 5 ml / t of seeds and 10 ml / ha (according to DR). Fungistatic effects are observed under conditions of seed treatment with homeopathic dosages up to 10-5 ml / t. This suggests that the effect of Stimunol on plants involves the inclusion of individual components in the signaling systems of plants, which ensures the multifunctionality of the drug. The peculiarity of the action of Stimunol, largely depends on the dose [Bobreshova, 2011].

A wide range of substances from a large group of structurally dissimilar compounds of organic and inorganic nature can act as inducers of stability of tomato plants: secondary metabolites of microorganisms (Bacillus bacteria, fungi of the genus Fusarium, symbiotrophic endophytic fungi, wood-destroying fungi, etc.) and plants. , steroid glycosides, terpene and hydroxycinnamic acids, etc.), heteropolysaccharides of the cell wall of fungi, peat humates, trace elements, phenols, systemic fungicides, etc. [Poliksenova, 2015].

Antimicrobial peptides are natural antibiotics that are synthesized in the cells of living organisms to fight pathogens and are important effector molecules of the immune system. Antimicrobial peptides are diverse in structure and mechanisms of action. Based on the homology of amino acid sequences and spatial structure, they are divided into several families: defensive, thionine, lipid-transferring proteins, heavy and notin-like peptides, as well as cyclotides of antimicrobial activity. Antimicrobial peptides are of undoubted interest for increasing the resistance of agricultural plants by genetic engineering [Egorov, Odintsova, 2012].

In the laboratory, an increase in the resistance of transgenic plants against pathogens constitutively expressing the genes of a number of antimicrobial plant peptides has been shown [Lay, Anderson, 2005]. It was found that peptides have high inhibitory activity against phytopathogens, which are synthesized in the form of precursors and consist of signal and mature peptides and C-terminal prodomain. HAM homologous peptide genes have been found in related plant species of the genera Triticum and Aegilops. They encode highly homologous precursors that differ at position 34 in the polypeptide chain of the mature peptide. This substitution has been shown to affect the antifungal activity of peptides.

The expression of WAMP genes in response to pathogen damage and abiotic stress, as well as its regulation by phytohormones have been studied [Odintsova, Egorov, 2013]. Currently, about two dozen α-harpins have been isolated from various sources found in flowering plants. Functionally, α-harpins are heterogeneous, including antimicrobial peptides and protease inhibitors. They are considered as effector molecules of plants to counteract biotic stress, ie as protective peptides. Thus, in some plants the peptides are encoded in the form of long tandem repeats, and in others - in the composition of common genes with spare proteins [Vasilevsky et al., 2013].

Synthesis of antimicrobial peptides is one of the most common defense mechanisms of innate immunity of living organisms, which are produced by bacteria, fungi, micromycetes, plants and animals. The protective effect of many microbial bioagents, including strains of Tricoderma, Bacillus, Pseudomonas, Agrobacterium, Streptomyces and Gliocladium is most often used for biocontrol of phytopathogens. Antimicrobial peptides cause vital links in the metabolism of pathogens, such as inhibition of nucleic acid and protein biosynthesis, inhibition of enzyme activity, or disintegration of the cell membrane. Antimicrobial peptides are formed in the body by ribosomal and non-ribosomal synthesis. Biocontrol fungi and bacteria implement both pathways and produce a wide range of linear and cyclic peptides. Depending on the structural features,

Defensin of barley and other cereals inhibits translation in the cell-free system [Mendez et al., 1990]. Some defenses have the property of inhibitors of the enzymes α-amylase and proteases, involved in protection against insect pests [Wijaya et al., 2000, Melo et al., 2002]. Most of the studied defensins have antimicrobial activity. The first defensins for which antifungal activity was shown were Rs-AFP1 and Rs-AFP2 radish seed peptides [Terras et al., 1995]. Studies of the interaction of plant defensin NaD1 of Nicotiana alata flowers with Fusarium oxysporum using fluorescent methods have shown that defensin penetrates fungal hyphae, accumulates in the cytoplasm and causes cell death [Van der Weerden et al., 2010].

The main functional characteristic of thionines is a wide range of antifungal and antibacterial activity in vitro [Bohlmann et al., 1988]. The spectrum of antimicrobial activity of thionines includes various phytopathogenic fungi, as well as bacteria, although some of them, including Pseudomonas and Erwinia, were insensitive to the action of peptides of this family. In addition, thionines act in synergy with other cysteine-rich proteins or peptides [Terras et al., 1993].

The mechanism of action of thionines was first studied in the yeast Saccharomyces cerevisiae. It has been shown that thionine from wheat seeds stimulates an increase in the permeability of cell membranes, as evidenced by the release into the environment of potassium ions and the acid residue of orthophosphoric acid [Hernandez-Lucas et al., 1974]. Studies with the fungus Neurospora crassa have shown that thionine from barley seeds causes the outflow of isoaminobutyric acid from the hyphae of the fungus. In addition, this peptide stimulates the entry of calcium and hydrogen ions into the hyphae of the fungus and the outflow of potassium ions, which leads to alkalinization of the environment [Thevissen et al., 1996].

The change in the permeability of fungal cells to ions and other solutes may be the result of a direct interaction between membrane phospholipids and thionines. The study of the interaction of thionines with cell membranes, both artificial and natural, showed that the action of thionines is directed directly at the membrane and not at any receptors on the cell surface. Experiments with thionine from Pyrularia pubera show that negatively charged phospholipids are the preferred target for this species [Osorio et Castro, Vernon, 1989]. At the same time, it also lyses membranes consisting mainly of neutral or cationic phospholipids [Wang et al., 1993, Richard et al., 2005]. Physico-chemical analysis of the interaction of this thionine with phospholipid membranes of different composition showed that the structural disorders caused by it increase under the presence of phosphatidylserine in the membranes. Binding of Pyrularia pubera thionine to lipid bilayer phosphatidylserine appears to occur without thionine incorporation into the membrane [Wall et al., 1995]. 2S albumins, which are able to increase the antimicrobial activity of thionines, also interact with negatively charged phospholipid membranes and cause an increase in their permeability [Onaderra et al., 1994].

Three possible mechanisms of action of thionines on the cell membrane have been proposed. In the first case, it is assumed that they are embedded in the membrane with the formation of selective ion channels [Hughes et al., 2000, Lianos et al., 2004]. The second mechanism assumes that thionines cover the membrane with the formation of peculiar layers on its surface and stimulate the growth of its stiffness and fluidity at the edges of the areas covered with peptides. Mass binding of the peptide to the cell surface thus causes membrane destabilization and cell destruction [Thevissen et al., 1999, Richard et al., 2002]. In the third case, the primary lining of the membrane with peptides is also provided, which stimulates an increase in the stiffness of the covered areas of the membrane. At the same time there is a pulling of phospholipids from edges of these sites to the center, which causes destabilization and violation of the integrity of the bilayer [Stec et al., 2004]. Despite the available experimental information in favor of these predictions, none of them is fully confirmed.

The antipathogenic effect of some microbial metabolites is not related to their biocidal activity, but to the ability to induce protective reactions in plants that are attacked by the pathogen. This strategy of biocontrol deserves special attention because the lack of direct action on phytopathogens minimizes the likelihood of their development of resistance to pesticides. Activation of the earliest defense mechanisms in plants is induced by the recognition by their cells of molecular features inherent in microorganisms, including phytopathogens. This set of structural and chemical characteristics of microorganisms that interact in nature with plants was united by MAMP (microbe-associated molecular pattern), and in relation to phytopathogens - by the term PAMP (pathogen-associated molecular pattern).

Metabolites of various chemical nature, which are components of MAMP or RAMP, are non-specific (general) elicitors (inducers). They induce in plant tissue a cascade of interconnected protective reactions, including ROS formation, callose deposition, protein phosphorylation, and enhanced transcription of genes responsible for the primary response. Thus, RAMP serves as a trigger that includes the basic mechanisms of phytoimmunity that stimulate the development of resistance [Shcherbakova, Javahiya, 2013].

LCD regulates gene expression during plant development, as well as the activation of protective reactions against bio- and abiotic stresses [Stumpe, Feussner, 2006; Creelman, Mullet, 1997; Wasternack, Parthier, 1997; Ziegler et al., 2000; Delker et al., 2006]. Its most significant effects include the effect on the expression of genes of proteinase inhibitors [Farmer, Ryan, 1990], defensins [Thorma et al., 1998] and thionines [Bohlmann et al., 1998], as well as genes involved in the synthesis of phytoalexins [Blechert et al., 1995], alkaloids [Baldwin et al., 1997], phenols [Gundlach et al., 1992; Mueller et al., 1993; Baldwin et al., 1994] and essential oils, such as terpenoids (Ketchum et al., 1999; Koch et al., 1999; Yukimune et al., 2000; Wang et al., 2004].

Regulation of transcription embodies the activation of some genes in the presence of jasmonate and in the formation of significant amounts of the corresponding mRNA. Most likely, transcription activation involves interaction with a protein (activator or repressor) that is capable of forming a complex with jasmonate, which is essentially an inducer. A fragment containing the regulatory region of the p.pinII gene was isolated from potato DNA by polymerase chain reaction (PCR) [Gurevich et al., 1996]. This region of DNA determines the activation of gene transcription in the presence of jasmonate. The DNA fragment isolated by the researchers was cloned into plasmid pTE2pb. Based on it, an affinity sorbent was obtained, with the help of which four proteins were isolated and characterized from the sum of potato proteins, which were able to be desorbed from the affinity sorbent in the presence of physiological concentration of jasmonate. It is likely that these proteins are subunits of two transcriptional repressor proteins for which jasmonate serves as an inducer. The authors believe that the binding of receptor proteins to the regulatory region of the gene involves three sites (boxes G, I and III), the similarity of which can be traced in the analysis of plant gene structures regulated by jasmonate.

The effect of treatment of wheat plants with phytohormones, in particular 24-epibrasinoid, 6-benzylaminopurine (BAP) and SC, marked by growth-stimulating and anti-stress effects, on the transcriptional activity of the TADHN gene of dehydrin was analyzed. The sensitivity of the studied gene to each of the three phytohormones was revealed, which confirms its possible involvement in the spectrum of protective action against stress interactions. Using the inhibitor of fluoridone ABA biosynthesis, it has been shown that the regulation of TADHN transcription of the dehydrin gene in wheat plants is realized through both dependent and independent of endogenous ABA signaling pathways [Klyuchnikova et al., 2012].

The molecular mechanisms of action of jasmonates on the effector systems of cells are similar to auxins [Wasternack, 2007]. Jasmonates are thought to interact with the F-box protein SO1, which is part of the SCF complex and structurally close to the TIR1 protein [Xie et al., 1998]. Through the mediation of SOI1-protein, the activity of numerous transcription factors that regulate the expression of jasmonate-dependent genes is controlled [Lorenzo, Solano, 2005].

Jasmonates induce the formation in plants of such stress compounds as thionines, induced by pathogens and divalent metal ions, phenylpropanoid pathway enzymes. They inhibit the synthesis of some proteins that were present in plants before the treatment or action of stressors, as well as carry out the general regulation of protein synthesis. Jasmonate-induced genes have a domain in the promoters that corresponds to jasmonate, which includes G-box - a known site of binding of transcription factors with ZIP-structure. It is believed that jasmonate can directly interact with these or other constantly synthesized transcription factors [Tarchevsky, 2000].

Bracinosteroids interact with plant hormones, change the qualitative composition and quantitative ratio of auxins, cytokinins and ethylene, increase the level of gibberellins and reduce the content of endogenous ABA [Vizarova, 1980; Hamburg, 1986; Kuralov et al., 1995; Sakurai et al., 1999]. The rate of absorption and movement of epibrasinolide in plants is an important indicator of the mechanism of its action [Deeva, 2008].

The regulatory effect of brassinosteroids on the plant cell is realized through a two-component system, which includes serine-threonine protein kinase located in the plasma membrane, which is similar in structure to Toll receptors of animals and Toll receptors Drosophila melanogaster [Belkhadir, Chory; Gendron, Wang, 2007]. This BRI1-labeled receptor protein kinase contains an extracellular domain comprising 24 LLR repeats, a transmembrane region, and a large cytoplasmic domain with kinase activity and is represented in the active state by a homodimer. The site that binds brassinosteroids is formed by two LLR repeats (LLR21 and LLR22) and a region of 70 amino acid residues located between them [Kinoshita et al., 2005].

The interaction of the ligand with the extracellular domain of BRI1 causes a change in the conformation of the kinase domain located in the cytoplasm and stimulates its autophosphorylation at serine and threonine residues, which are localized in the activation loop of the kinase domain [Wang et al., 2005]. One of the mechanisms of activation of the kinase domain is the removal of the inhibitory effect of the C-terminal portion of this domain on the activation loop. Separation of the C-terminal region 41 of the amino acid residue stimulates the autophosphorylation of the BRI1 receptor kinase even in the absence of brassinosteroids [Wang et al., 2005b].

Another inhibitor of BRI1 kinase activity is BKI1 (BRI1 kinase inhibitor 1), a membrane-associated protein that interacts directly with the kinase domain activation loop. Binding of brassinosteroid to receptor kinase causes dissociation of the BRI1-BKI1 complex and converts BKI1 into a cytosolic form [Wang, Chory, 2006]. Brassinosteroids are also one of the main regulators of apoptosis in plant cells [Sakurai et al., 1999]. It has been shown that 24-epibrasinolide causes a decrease in the permeability of cell membranes and an increase in the content of bound water [Voronina, 2008].

The total physiological reactions that cause brassinosteroids include stimulation of photosynthetic activity of cells, increasing the level of soluble proteins and carbohydrates [Braun, Wild, 1984; Kovalev, 1998; Vardhini, Rao, 1999; Prusakova et al., 2000, Borzykh et al., 2014], induction of systemin in tomato [Holton et al., 2007] and modulation of the enzymatic system of plants. Thus, the action of brassinosteroids showed an increase in the activity of soluble invertase in isolated cotyledons of rice [Beinhauer et al., 1990] and cell wall invertase in a suspension culture of tomato cells [Goetz et al., 2000], carboxylase in wheat leaves [Bajguz, Czerpak, 1998] and cotyledons of arabidopsis seedlings grown in the dark [Nagata et al., 2000], nitrate reductase and glutamine synthetase [Sairam, 1994], ATPase and other enzymes [Prusakova, Chizhova, 1996; Sasse, 1997; Altmann, 1999; Prusakova et al., 2000].

In recent years, information has been obtained that the SC is able to reduce the incidence of plant diseases through the development of systemic acquired resistance. Recently, there have been publications to study the mechanism of action of the IC. The discovery of the fact that the SC-binding protein is a catalase, the activity of which is blocked by the SC, gave reason to believe that one of the mechanisms of action of the SC is the inhibition of H2O2, ie the degrading enzyme. By blocking catalase activity, SC causes the accumulation of hydrogen peroxide, which either alone or through other types of active oxygen activates the expression of protective genes and possibly acts as an intracellular messenger [Durner, Klessig, 1996].

The inhibitory effect of SC on the synthesis of ethylene has been announced, which is most likely due to the inhibition of the enzyme involved in the conversion of 1-amino-cyclopropane-1-carboxylic acid into ethylene, and the efficiency of the process depends on the pH level. This allowed us to characterize SC in concentrations comparable to those found in the tissues of some plants as an effective, non-toxic and reversible inhibitor of ethylene biosynthesis [Romani et al., 1989, Medvedkov, Markov, 1991]. One of the mechanisms of SC action on plant cells is a change in the proton conductivity of membranes (primarily plasmolema), which leads to acidification of the cytoplasm and a sharp increase in energy expenditure (due to ATPase) to remove protons from cells and absorb potassium ions [Gordon et al., 2003].

Experimental confirmation of the participation of SC in the signal regulation of gene expression under conditions of aging of Arabidopsis leaves, preceding cell death, was also obtained [Morris et al., 2000]. CC can also serve as a regulator of the transport of organic matter in the phloem [Burmistrova, Krasavina, 1999], gravitropism [Medvedev, Markov, 1991], as well as other physiological processes [Raskin, 1992, Alvares, 2000, etc.]. Experimental information on the stimulation of the synthesis and accumulation of free SC and benzoic acid in unaffected tobacco leaves under the influence of treatment with hydrogen peroxide is available in the literature [Leon et al., 1995].

The mechanism of action of SC may be related to its ability to primarily protect the affected plant organism by increasing the levels of various compounds involved in protective metabolic processes. The authors believe that SC is able to induce NADP oxidase and simultaneously inhibit alternative oxidase and, thus, regulate the redox status of plant cells. Therefore, the role in the regulation of this status is associated with the hypersensitivity reaction [Dat et al., 2007].

Biogenic elicitors are thought to be recognized by glycoprotein receptors on the surface of the host plant's plasmolemma, followed by a cascade of reactions that stimulate phytoalexin accumulation, cell wall lignification, and other protective responses [Ryan, Farmer, 1991, Renelt et al.

Coordinated activation of several phospholipases under the conditions of extracellular signal transduction across the plant cell membrane is necessary for the release of lysophosphatidylic acid, which, in turn, acts as a secondary mediator in the activation of the signaling cascade [Tarchevsky, 2002, Dmitriev et al., 2015].

Synthetic analogues of phytohormones and other compounds that are actively involved in the processes of growth and passage of developmental stages can significantly increase plant productivity. Phenolic compounds, especially derivatives of oxycinnamic acids, play a special role; in particular chicory, caffeine, chlorogenic and others. They are found in a wide range of fruits, vegetables, grains and other crops, which is an integral part of people's diet. In this regard, the use of drugs based on them is quite safe for human health and the environment.

One such drug is Zircon, the active substance of which is isolated from the medicinal plant Echinacea purpurea (L.) Moench (Asteraceae), which is a mixture of hydroxycinnamic acids and their derivatives [Malevannaya, 2010]. in the world of medicinal plants [Wills, Stuart, 1999], due to immunostimulatory properties and other beneficial effects, which are realized due to the active action of derivatives of caffeic, chlorogenic and chicory acids, as well as lipophilic alkylamides and polysaccharides [Bauer, Wagner, 1991].

Plants respond to phytopathogens by additional synthesis of endogenous soluble phenolic compounds, mainly hydroxycinnamic acids. Along with this, the activity of the corresponding enzymes of phenolic biosynthesis increases: FAL and transcoric acid hydroxylase. This explains the inhibitory effect of hydroxycinnamic acids on pathogens, which were found in model experiments with pure cultures of pathogens [Ruelas, Other., 2006].

Our studies also confirmed the effectiveness of zircon (20 ml / ha) on crops (Table 24).

Table 24

The effectiveness of zircon on the development of diseases and technical efficiency of crops

Disease	Control (without processing),%		Processing,%	
	RH	THAT	RH	THAT
Cucumber, grade Source				
Peronosporosis	7.6	0	4.0	47.4
Anthracnose	6.4	0	3.6	43.8
Tomato, variety Flora				
Alternaria	12.0	0	8.0	33.3
Phytophthora	8.4	0	4.8	42.9
Tomato, variety Gentle				
Alternaria	10.8	0	6.4	40.7
Phytophthora	7.2	0	4.0	45.7

Continuation of the table 24

Potatoes, Luhivska variety				
Alternaria	10.2	0	7.2	29.4
Phytophthora	12.4	0	8.4	32.3
Onions, variety Stuttgart				
Peronosporosis	14.8	0	10.2	45.1
Cabbage of the 2nd year, Snow White variety				
Peronosporosis	17.6	0	12.0	31.8
Anthracnose	16.0	0	11.2	30.0

Notes: RH - development of the disease; TE - technical efficiency

From a practical point of view, metabolites with the properties of nonspecific elicitors have significant scientific value as possible plant protection products, as the resistance induced by them is also nonspecific. This means that under the action of the owl inducer can develop resistance to several diseases. However, the successful use of inductors in agriculture is impossible without understanding the mechanism of their action. Moreover, the study of the mechanisms of induced plant resistance often leads to the discovery of potential elicitors.

The advantages of associations of rhizosphere microorganisms (Bacillus firmus - Klebsiella terrigena, Pseudomonas aureofaciens - Bacillus megaterium and others) as a basis for creating biologicals over pure cultures of individual components by the sum of the main indicators are shown: The stimulating effect of the association Pseudomonas aureofaciens - Bacillus megaterium on plants is due to the microbial metabolite of poly-β-hydroxybutyric acid (PGT), which is a new class of active substances-phytoactivators.

Based on PGT, a new biological product Albit was created, which combines the advantages of biological (environmental friendliness and low price) and chemical drugs (high efficiency, stability, long shelf life), which has a clear versatility (growth regulator, fungicide, antidote, microfertilizer) and versatility. effects on a wide range of plants and pathogens. The dependence of the efficiency of Albit on plant species, variety, terms and methods of application, consumption rates, combinations with other pesticides, infectious and agrochemical background, region, seasonal weather and climatic conditions and other practically important factors was established, which significantly increased the effectiveness of biopreparation in phytosanitary technologies.

A complex system of interconnected mechanisms of albite influence on the system "plant - pathogens - soil microbial community", the structure of development and yield of crops, as well as the supply of plants with basic nutrients and bioremediation of soils is described. For the first time, a comprehensive study of the anti-stress activity of Albit on plants has been carried out. A universal broad-spectrum antidote that protects plants from nonspecific phytotoxic effects of herbicides has been proposed and described in detail. The fundamental difference between the regulatory and antidote action of the biological product, as well as the effect of the active substance of herbicides, the type of agricultural plant and the method of application on the protective properties of Albit [Zlotnikov, 2011].

Immunoregulators of plants Albite, Immunocytophyte, Silk and its analogues increase the resistance of cereal plants against pathogens of smut, helminthosporiosis spots, septoria, rhinhosporiosis, powdery mildew, root rot and abiotic products. Bioimmunizers Planriz, Agate, Albit, El-1 and Novosil showed a higher percentage of reduction in the incidence of flax, especially bacteriosis [Kudryavtsev, 2007].

To protect potatoes from late blight, it is necessary to use biological products based on bacteria of the genus Pseudomonas, in particular Rhizoplan and Agate 25K. It was found that they are more effective to use during the growing season of plants, compared with pre-planting treatment of tubers. In this case, the drugs in combination with pre-planting treatment of tubers with a low-frequency electric field can be components of potato growing technologies with limited use of chemical plant protection products [Kuznetsova, 2000].

Under the influence of inducers of disease resistance, certain protective systems of tomato plants are activated; in particular the activity of RNase, FAL-lyase, chitinase. Inducers are effective against fungal and viral pathogens (WUA, Monifolin, Fuzaxin, Fumar, PAK), cause in relatively resistant varieties and hybrids increase the activity of RNase by 1.3-2.0 times, chitinase 10-30 times, FAL-lyase 1, 3-5.0 times. A sharp increase in enzyme activity occurs after 24-48 hours. and lasts for 10-14 days and depends on the nature of the inducer, plant genotype and environmental conditions. The increase in the functional activity of RNase, chitinase and FAL-lyase can be used as a biochemical criterion under the conditions of selection of inducers of disease resistance of tomato plants [Dorofeeva, 1994].

For the first time, three new strains of Azotobacter vinelandii IB 1, Azotobacter vinelandii IB 3 and Azotobacter vinelandii IB 4 have been identified, which have a wide range of antagonistic activity against phytopathogenic myxomycetes. Genetic certification of selected strains of Azotobacter, which produce phytohormones, was performed. The antagonistic effect of these strains on phytopathogenic myxomycetes is associated with the production of substances of antibiotic nature. The isolated metabolites are polythiophosphates and tetraaminosucrose and belong to the group of antibiotics not previously described in the literature. Introduced antagonistic bacteria take root in the root zone of treated plants and retain high levels of antagonistic and nitrogenase activity, without inhibiting the aboriginal microflora [Pugacheva, 2004].

Tests of antagonistic bacteria under conditions of protection of tomatoes from Botrytis cinerea and Fusarium oxysporum f. sp. lycopersici showed that in almost all variants, growth inhibition of Botrytis cinerea and members of the genus Fusarium was observed. Of particular note are isolates of Bacillus thuringiensis, Bacillus subtilis B1A2, Bacillus subtilis Yc B1-02, Bacillus polymyxa A2 and Enterobacter agglomerans, which, despite the small radius of the colonies, for a long time retained a significant size of the sterile zone. In addition, the bacteria Bacillus subtilis Yc B1-02, Bacillus polymyxa A2 and Enterobacter agglomerans equally inhibited the growth of pathogens of fusarium wilt and gray rot of tomato [Vinogradova, 2011].

The method of step screening of the collection of myxomycetes of the genera Pénicillium Gliocladium and Trichoderma in in vitro and in vivo systems using the collection of phytopathogenic microorganisms selected strain 16 T.asperellum Samuels, Lieckfeit et Nirenberg, as a promising producer of plant protection products. Under in vitro testing, strain 16 T.asperellum showed hyperparasitic activity against phytopathogens of the genera Fusarium, Altemaria, Pyrenophora, Bipolaris, Pleospora (Phoma betae), Phytophthora, Botrytis, Glomerella (Colletotrichum), Thaizoperus, Thanatephorus and Thactophorus . The cultural-morphological and biochemical properties of the strain, features of conidiogenesis under the conditions of cultivation in deep culture and fyaloconidia of different origin have been studied.

In vitro, guanine-containing biocidal products completely inhibit the germination of spores and vegetative growth of pathogens of fusarium wilt, botrythiosis and Alternaria. The effect of pre-sowing treatment of tomato seeds is manifested during the ontogenesis of plants. The stimulated influence on growth processes, morphogenesis and reproductive ability of this vegetable culture is revealed. In addition, the share of fruits affected by late blight decreased by 10-14% in the structure of the crop. As a result of artificial infection of the separated leaves with the pathogen Phytophthora infestans (Mont.) De Bary, inhibition of its growth in the tissues of the disc, reduction of the intensity of spore formation of the pathogen by 70-87%. Thus, it can be predicted that treatment of seeds with a solution of polyhexamethylene guanidine increases the nonspecific resistance of plants against biotic stresses [Sakharchuk et al., 2012].

Humic acids activate energy, nucleic and protein metabolism, plant pollination and fertilization, have anti-stress and antimutagenic properties and form a full crop. Under stressful conditions, they activate DNA repair processes, normalize metabolic processes, reduce the frequency of genetic disorders and stabilize the mitotic cycle, which adapts plants to the undirected action of pesticides and environmental factors [Gorovaya et al., 1992]. It has been proved that humates are characterized by the fundamental property of synergism under the conditions of their joint use with mineral fertilizers, microelements and pesticides. They are characterized by a universal ability to enhance the beneficial effects of other substances [Nemchenko et al., 2006].

The possibility of colonization of plants by the yeast strain Pseudosyma fusiformata VKM Y-2821 and its influence on plant growth and resistance against the phytopathogenic fungus Sclerotinium sclerotiorum was investigated. The ability of yeast to effectively colonize plants and show a stimulating effect on resistance against the phytopathogenic fungus Sclerotinium sclerotiorum by synthesizing antifungal glycolipid was revealed [Zakharchenko et al., 2007].

An integral biochemical indicator of plant resistance to infections is the sum of organic acids. Under conditions of increasing concentration of boric acid applied to the leaves by foliar treatment, this figure increased by 2-3 times compared to the control variant. This trend is consistent with Comes' theory of immunity, according to which an increase in the acidity of cell sap indicates the consolidation of passive immunity of plants.

One of the adaptive reactions of plants to iron deficiency is the reduction of Fe3 + to Fe2 + under the action of phenolic compounds prescribed by the plant, which form complex compounds with the metal and enhance its transport. The same distribution of the number of trace elements is characteristic of copper and zinc, which are part of the enzymes of the electron transport chain. Under the conditions of foliar treatment of plants with boron, the accumulation of this element occurs in the leaf blade, but in the stems and roots, its content in the corresponding variants also increases, compared with the control.

The zinc content in the roots in the variant with treatment with a high concentration of boric acid was 5 times higher than in the control. As a result, there is an active metabolism of phenolic compounds, which involves polyphenol oxidase, for the functioning of which, in addition to boron, zinc is also required. Foliar treatment of plants with microelements of boron, iron, copper and zinc causes an increase in the content of biochemical components in their composition, which characterize the resistance of plants against infection due to the influence on physiological and biochemical processes responsible for plant immunity [Suvorova, 2012].

The regulatory role of cytokinins in the formation of the protective response of wheat plants against fungal pathogens with different types of nutrition (necro-, bio- and hemibiotrophs) is described. Oxalate oxidase, which is associated with the cell wall, makes a significant contribution to the production of hydrogen peroxide in plant tissues under conditions of infection with fungal pathogens.

The protective mechanism of chemical and natural inducers of resistance is associated with their participation in the generation of hydrogen peroxide in the early stages of pathogenesis. Ways to regulate the protective reaction of plants with chitooligosaccharides and SC, which, along with oxalate oxidase activation, induce anionic peroxidase gene expression, which causes increased lignin synthesis in the immediate vicinity of infectious structures of the pathogen, are described.

Information on the ability of chemical resistance inducers to enhance the activity of free protein inhibitors in the tissues of vegetative wheat plants and, thus, to increase their resistance to infection by fungal pathogens.

The protective function of oxidation of phenols by wheat plants with the participation of oxalate oxidase and peroxidase in the process of infection with fungal pathogens with different types of nutrition was observed. One of the mechanisms of suppression of the protective reaction of plants under the conditions of fungal pathogenesis is the inhibition of peroxidase activity in this reaction under the action of β-IOC [Yarullina, 2006].

For the first time, a new systematic approach to protect barley crops from pests has been proposed, which provides for the integrated use of growth regulators, BAS, immunostimulants and low rates of consumption of chemicals at all critical stages of plant development. From exudates of barley roots the preparation Sayam-M is obtained, which is a complex multicomponent system that is able to inhibit the development of root rot and increase the productivity of barley. Based on a systematic approach and multifaceted studies of chlorophyll-protein complexes for the first time in constant droughts, the possibility of reducing the toxic effects of herbicides as protectors of new immunomodulators and biofungicides of nonspecific anti-stress action, which activate lectin biosynthesis in plants.

The results of biochemical analysis of protein polymorphism of gordeins, optical properties of chlorophyll-protein complexes and hemagglutinating activity of lectins can be used to identify mechanisms of induced stability and develop technology for protective and stimulating compositions and modification of pesticide formulations to increase the effectiveness of their biological boomerang ”[Sakaeva, 2004].

Resistance of wheat plants to brown rust increases with age, while the lines of resistance mechanisms are strengthened. Extracellular ROS generation by closing stomatal cells under the conditions of contact with a part of apressoriums was revealed, which stimulates the cessation of fungal penetration into tissues. The accumulation of the protective polysaccharide callose (β-1,3-glucan) on the cell walls occurred in the late stages of pathogenesis and was one of the mechanisms limiting the development of colonies and pustules of the fungus. Callose synthesis increased with age of plants, and phenolic substances in the cytoplasm and lignification of cell walls were observed in the final periods of pathogenesis. Thus, phenolic compounds enriched in syringine acquired a green color of autofluorescence, different from that observed in plants with a hypersensitivity reaction.

The synergistic interaction of molecules of hydrogen peroxide and nitric oxide provides lignification of the cell wall and induces a hypersensitivity reaction [Hong et al., 2008]. In addition, nitric oxide increases the content of SC, which is also a component of signaling pathways under the action of biotic stresses [Klessig et al., 2000]. SC, in turn, can enhance nitric oxide synthesis in Arabidopsis with the participation of an enzyme that exhibits nitric oxide synthetase activity [Zottini et al., 2007]. Dose-dependent accumulation of nitric oxide in tomato after inoculation of xylanase elicitor stimulates increased synthesis of phosphatidic acid due to activation of phospholipase and diacylglycerol kinase. Phosphatidic acid is a necessary link in protecting plants from biotic stresses through hypersensitivity reactions [Laxalt et al., 2007].

Phytoparasitic nematodes, insects and oomycetes are not capable of self-synthesis of sterols. But sterol derivatives are necessary for them to ensure the processes of growth and development. Therefore, the only source of sterols for these parasites are host plants. In this regard, reducing the level of phytosterols in plants should adversely affect the development of sterol-dependent pathogens and insects, ie inhibitors of phytosterol biosynthesis can be considered as potential means of protecting plants from sterol-dependent parasites [Inge-Vechtomov, 1997, Khodjaeva et al., 2000]. One of the key enzymes involved in sterol biosynthesis is considered to be 3-oxy-3-methylglutarate-CoA reductase, which catalyzes the formation of mevalonate from 3-oxy-3-methylglutarate-coenzyme A (OMG-CoA).

Substances belonging to the group of statins are specific inhibitors of this enzyme. This suggested that statins, which inhibit OMG-CoA reductase and reduce phytosterol levels in plant tissues, would prevent their damage by sterol-dependent pathogens and pests. The validity of this prediction is confirmed by one of the representatives of statins - compactin, which has fungicidal activity against a number of phytopathogenic fungi under conditions of testing on a solid nutrient medium [Ukraintseva et al., 2008]. Experiments on plants have also revealed the protective properties of compactin against fungal and viral pathogens. Pravastin is a derivative of compactin, which is widely used in medicine to lower blood cholesterol. Pravastin is able to inhibit the growth of mycelium of phytopathogenic fungi Stagonospora nodorum (E. Castell. Germano), Bipolaris sorokiniana (Sacc. And Sorokin) Shoem., Colletotrichum atramentarium (Berk., Broome) Taubenh., Alternaria tenuissima (Nees, T. Nees: Fr.) Wiltshire. Its ability to inhibit melanin pigmentation in these fungi has also been shown. It is proved that normal pigmentation of a phytopathogenic fungus is a necessary but insufficient condition for the realization of its pathogenic properties [Javahiya et al., 1990]. In this regard, the protective antifungal effect of pravastin may be due to a direct fungicidal effect on the growth of the mycelium of the fungus and blocking melaninogenesis, which stimulates a decrease in its pathogenicity. It was concluded that pravastin can be considered a potential biopesticide that has activity against viruses and fungi, aimed not only at inhibiting their growth by the type of nonspecific fungicidal action, but also by inhibiting melaninogenesis,

The method of regulation of semiochemical interactions for the protection of cultivated plants from pests is gaining more and more recognition in world science and practice. Accumulated knowledge about the protective reactions of plants to pests opens up new opportunities to create fundamentally new, environmentally friendly and with a new mechanism of action of chemical plant protection products and their use in integrated plant protection systems. These can be drugs based on natural elicitors or their analogues for the induction of protective reactions, including the attraction of entomophages, as well as using structural analogues of compounds (repellents, detergents) that provide direct plant protection [Kirillova, 2015].

Under conditions of treatment with LC or methyl jasmonate in plants, the synthesis of volatile compounds, attractive to a number of entomophages, increase lipoxygenase activity and induce the synthesis of protease inhibitors, which reduce the susceptibility of plants to nutrition and phytophagous development [Avdiushko et al., 1995; Thaler, 1999; Rodrigues-Saona et al., 2001; Yarovyi et al., 2006; Feng et al., 2012; Lesley et al., 2013]. In the field, the technical efficiency and impact on the yield of LCD at different consumption rates were studied. It has been shown that winter wheat and spring barley, as well as winter rye, show a significant reduction in the development of powdery mildew and septoria, as well as a stimulating effect on the yield of these crops [Borzykh et al., 2014].

The decrease in the number of western flower thrips Frankliniella occidentalis, quadriceps spodoptera exigua, leafhopper Epitrix hirtipennis, large potato aphid Macrosiphus euphorbiae and peach aphid Myzus persicae was demonstrated by the example of experiments in Thaler et al., 2001]. Three weeks after treatment, the percentage of Spodoptera exigua pupae infected with the Hyposoter exigua endoparasite in the study area was twice as high as in the control [Thaler, 1999]. The use of LCD on cotton showed a decrease in plant population by cotton aphid Aphis gossypii and spider mite Tetranychus urticae by more than 60, and 90% - California thrips Frankliniella occidentalis [Omer et al., 2001].

The results of research on the possible use of SC as an exogenous inducer of protective chemical reactions of plants against herbivorous arthropods are extremely contradictory. A number of studies suggest that SC, the value of which is mainly associated with induced resistance to pathogens, may have an inhibitory and stimulating effect against protective chemical reactions directed against phytophages [Petterson et al., 1994; Bi et al., 1997; Engelberth et al., 2011].

The use of the phenomenon of induced plant resistance against phytophagous has been demonstrated in Michigan (USA). It was found that the activity of one species of phytophage can induce immunity against another, ie more harmful. Scientists have abandoned the treatment of apple plantations from the apple red-brown mite, thus avoiding an outbreak of reproduction of European red [Dietrich et al., 1999]. An example of the antagonism of two phytophages is the situation in vineyards in California, when the Williams mite (Eotetranychus willametei Ewing) was not specifically suppressed to induce resistance against the other, the harmfulness of the Pacific mite (Tetranychus pacificus McGregor). The use of the Williams mite helped to avoid chronic outbreaks of the Pacific mite, while refusing to apply pesticides. However, this method has not been widely used,

Currently, the direction of possible use of induced plant resistance with the involvement of genetic engineering and biotechnology is intensively developing. Due to significant advances in these fields of science, not only genes responsible for carrying out certain protective reactions in response to pests have been identified, but also opportunities to create transgenic lines, which are marked by a certain set of protective genes and enhanced self-defense [Arimura, 2000 ; Liu, 2011; Suzuki et al., 2012]. Currently, a strategy for the development of resistant varieties is proposed, which is based on the concept of the feasibility of constructing varieties with low levels of compounds that provide their constitutional protection, with increased ability to produce compounds responsible for induced protection. It is assumed

The reaction of induced plant resistance to pests is an immunogenetic mechanism that arose during the coevolution of phytophages with plants, which manifests itself under conditions of damage by phytophages as a response to the violation of integrity. Induction of protective reactions of plants to the damaging effect is by its nature one of the forms of general semiochemical interaction in ecosystems, which is developed in the process of combined evolution at interspecific and biocoenotic levels. The resistance of plants against phytophages can be increased not only by selection methods, but also by synthetic immunomodulators that activate the immune system. This requires the maximum expansion of experimental work on the impact of immunomodulators not only on target objects, but also related types of consumers of the first and second order and the general environmental situation in agrocenoses.

The immune system plays a very important role for plants, the ways of implementation and components of which can be varied. One of the components is the receptors, the first sensors of danger. They are represented by membrane and specific cytoplasmic proteins that trigger an immune response. The main indicators of the response are changes in the level of calcium ions, nitric oxide, ROS and the synthesis of signaling hormones [Kopytina et al., 2012].

Thus, the concept of nonspecific induced plant immunity is fully developed, which includes the action of bioregulators of phytopathogens on plant cell membrane receptors, information transfer to the intracellular signaling system, induction of resistance genes activating protective mechanisms (hypersensitivity reaction, synthesis of key molecules and enzymes). The content of salicylic and jasmonic acids, phytoalexins, peroxidase and catalase activity in plant tissues should be taken into account when assessing the response to biogenic stress. Optimization of protective measures with the use of drugs of elicitor action allows to increase the immune status of crops and ensure the ecological functioning of agrocenoses [Karpuk et al., 2015].

CONCLUSIONS

In modern conditions of significant anthropogenic impact on the environment, ecological monitoring is important, the successful conduct of which allows to predict changes in the characteristics of individual parts of the ecological system and to predict the further evolution of the ecosystem over time. Of fundamental importance in this regard is the receipt of express information about the state of organisms as a result of external actions. This means information that would allow in the early stages to diagnose changes in cellular metabolism under the influence of external factors. It is fundamentally important to obtain this information long before the result of external action on organisms manifests itself in visible signs, such as changes in the shape and inhibition of cell growth, declining cell population and biomass [Tsukanova, 2007].

The current situation confirms the common opinion on the need to create environmentally sound plant protection systems based on the abandonment of intensive technologies based on the chemicalization of agriculture. The available set of drugs has a number of positive aspects. A significant number of plant protection products have been developed, which differ in their spectrum and mechanism of action. Enrichment of the arsenal of entomocidal and selective prophylactic drugs provides a prerequisite for the organization of new plant protection systems. Their main feature should be the fluctuations of biological agents of compounds of natural origin or the timely introduction of a system of alternative measures. Such a set can significantly slow down,

In the 80s of the last century, the development of integrated programs to control the harmful microbiota was significantly developed. In the plant protection strategy, the basic concept has been replaced by a more modern one - regulation of pest numbers and its support at an economically intangible level based on phytosanitary monitoring with the integration of available methods and tools. The purpose of such plant protection systems is based on achieving a high effect with the minimum possible loss to the environment. The development and implementation of economic thresholds for harmfulness have streamlined the use of the chemical method and, to some extent, mitigated its negative effects and the general pesticide press on crops. Considerable attention has been paid to the biological method, which is the most effective in integrated systems.

In the last decade, new groups and classes of pesticides with high selectivity of action and relative safety for the environment have been created. A significant number of ecologically safe means of biogenic origin have been developed on the basis of new types of bioproducers and products of their vital activity. Expanding the range of selective and economical means allows to strengthen the greening of integrated plant protection systems, ie to increase their role in biological regulation of pests [Ryabchinskaya, 2002].

The concept of phytosanitary optimization of agroecosystems is based on the principles of maximum activation of biocoenotic methods of regulating the number of pest populations with extensive use of natural resources of antagonists, entomopathogens and entomophagous [Novikova, 2005]. A distinctive feature of aboveground ecosystems is a close dependence on the spatio-temporal dynamics of the set of properties and functions of soils. This statement is currently quite trivial for researchers who deal directly with environmental issues, and is far from obvious to those working in the field of plant protection from harmful microbiota, including microbiological [Dobrovolsky, Nikitin, 1990].

The problems of ecology that face humanity, over time, do not lose their significance, the range of which is expanding. The growing use of pesticides in agriculture and in everyday life requires further progress in the development of new and improvement of existing methods for their rapid and sensitive detection. The most commercially available pesticides are considered dangerous to human health, blocking metabolic pathways. Pesticide residues can be stored in the topsoil and groundwater and transferred by water to the food chain. To improve the phytosanitary situation, appropriate agricultural techniques, the potential of biological and other means of pest control are needed. Only through the introduction of the concept of integrated protection of plants, soils and water can achieve the desired result [Goister et al.,

Improving methodological principles for studying behavior, control, predicting behavior and accumulation of pesticides in agrophytocenoses and implementing these developments in practice will prevent their harmful effects on the environment and humans [Lunev, 2004].

One of the methods of large-scale pest control on plants is the method of complete sterilization. This is the most common variant of the genetic method of control, which involves a significant reduction in the reproductive potential of the pest by introducing into its gene pool a population of cargo-induced dominant lethal mutations. The effectiveness of this method on cabbage mousse was limited due to the low somatic resistance of the species to radiation, as well as inherited sterility, under conditions of using lower doses of radiation [Anisimov, 1997; Belyakova, 1996; Belyakova, Anisimov, 1998].

The discovery of new molecules of microorganisms with the properties of elicitors has significantly changed in recent years the perception of the functioning of the immune system of plants. The most active elicitors can be created by biotechnological methods and after isolation and purification, which are the basis of commercial drugs of non-biocidal action for plant protection. They can also serve as a basis for the creation of new structural derivatives with higher activity and lower sensitivity to destruction. Even if induced systemic resistance does not become the only way to protect plants from harmful microbiota, many researchers believe that it will be integrated into the plant protection system. Of particular interest in this regard are drugs that induce resistance in plants against pests and diseases and physiological stress [Tyuterev, 2015].

One of the important achievements of the world biotechnological process in the search for new promising substances in recent years has been the production, study and implementation of biopolymers of chitosan, chitin and their derivatives.

Higher fungi are unique producers of raw materials for the production of protective drugs, as their cell walls contain glucans and chitin in the form of chitin-glucan complex. One of these drugs, which is based on this raw material and BAS, is the mycobiopreparation Mikosan, which is made from wood-destroying higher basidiomycetes, which is a complex of 1,6-β-glucan and oligomers of 1,3-β-glucan, oligochitin, melanin, olanin [Gorovy et al., 2001, 2002, 2004, Koshevsky et al., 2001, 2002, 2004, Teslyuk et al., 2001, 2004, Sabluk et al., 2002, Bondar et al., 2004, et al.,].

The biofungicide Mikosan, which is based on chitin, fungal glucans and melanins, actively induces the formation of antipathogenic substances in plant cells and tissues. One of the primary reactions of the plant to contact with the pathogen is the alkalinization of the environment in the intercellular space, and organic acids play an important role in immune responses in later stages of the pathological process, so there is a need to study the effectiveness of combined action of Mikosan and organic acids. of different chemical nature, which strengthen the protective mechanisms over time.

Given the results of microbiological studies, as well as the fact that the biofungicide Mikosan is produced on the basis of natural products that are widely used in various sectors of the economy, including medicine, its intended use from the standpoint of impact on the viability of microorganisms is beyond doubt.

Due to significant advances in these fields of science, not only genes responsible for carrying out certain protective reactions in response to pests have been identified, but also opportunities to create transgenic lines, which are characterized by a certain set of protective genes and enhanced self-defense [Arimura, 2000; Liu, 2011; Suzuki et al., 2012].

The reaction of induced plant resistance against pests is an immunogenetic mechanism that arose during the coevolution of phytophages with plants and manifests itself under conditions of damage by phytophages as a response to the violation of integrity.

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