

Biological method of plant protection is one of the green economy development directions

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Abstract. The importance of the biological method of plant protection as one of the prospects for the green economic development in Russia and in the world is discussed in the article. The modern directions of the Russian agricultural science development for the transition to environmentally friendly agricultural production are analyzed. The experience of biological preparations and biological agent's application in Russia and abroad is considered in the historical aspect. A differentiated approach has been proposed for chemical treatments prescribing, carrying them out only in pest proliferation centers, on border land and catching band, which makes it possible to almost halve the pesticides use. The field research results on the study of the spatial distribution of useful entomofauna in irrigated agricultural landscapes are presented, ways of increasing the species diversity and number of beneficial insects (entomophages and parasites) in agrocoenosis due to the redistribution of useful entomocomplex species in agrocoenosis and natural agricultural landscape are shown.

1. Introduction

The loss of the pesticides permitting capabilities and the natural environment pollution have led to increased attention to the search for alternative means and methods that preserve natural regulators of the pests number. The reorientation of plant protection systems should be concretized at the regional level, based on agricultural specialization and climatic characteristics.

Most experts in many countries of the world believe that a sustainable reduction in the pests' number in agrocoenosis can be achieved only with integrated plant protection, which provides for the pests number control. According to various estimates, the lost production from pests annually reaches 20-35% [1]. The integrated plant protection is based on a harmonious combination of all known and developed methods (chemical, organizational and



economic, agro technical, immunological, biological, etc.), while in modern conditions the emphasis is on the maximum use of biological resources.

One of the main goals of integrated plant protection is to create an optimal biocenotic environment for the useful fauna in the fields, which, first of all, is to enhance the role of predators and parasites. This can be achieved with a certain targeted impact on agrobiocoenosis.

2. Materials and methods

The aim of the study is to find ways to increase the effectiveness of the biological method in plant protection in Russia and abroad, which contributes to importance increasing of organic farming and the development of a green economy in rural areas. The research materials are Russian and foreign works in the field of biological plant protection and the application of the biological method in agriculture, as well as statistical data on the development indicators of agriculture in Russia. The system analysis methodology is used in the study.

3. Results and discussion

Currently, more and more emphasis is placed on the development and application of ecological farming technologies in agricultural production. In all countries of the world, the demand for environmentally friendly products is growing. This trend is discernible in Russia with the adoption of the Federal Law on the Production of Organic Products in 2018. The scientific literature notes that the use of genetically modified synthetic growth regulators and the use of pesticides are not allowed in organic farming. All of the above implies the application expansion of biological plant protection products [2, 3, 4].

Russian agricultural science also determines the transition to highly productive and environmentally friendly agricultural production as one of the priority directions of its development, which is undoubtedly associated with the development of new high-quality and safe food products based on the use of environmentally friendly plant protection products. Every year there is an increasing growth of the area occupied by purely organic or combined with biological farming.

The application of new safe biological preparations in agricultural production on farms of various types of property, the effectiveness of which for plant protection is increasing every year due to the introduction of new scientific research results, makes it possible to reduce the pollution of agricultural landscapes with chemical plant protection agents, to solve the problems of insect pest resistance to insecticides. With the expansion of the biological preparations application, it becomes possible to restore and increase the soils suppressiveness, to improve the microbiocoenosis of soils in agricultural landscapes. All this lays the foundations for the development of organic farming and obtaining of environmentally friendly products.

It is especially important in the further development of plant protection biological methods to expand scientific research dealing with the biological agents influence study, among which beneficial arthropods (predators and parasites) play a leading role. The scientific research results of the ecological and biological characteristics study, as well as such biological agents application as arthropods, nematodes, useful microflora in conditions with a complex epiphytotic, invasive and epizootic environment will also have an important effect.

The attraction of biological organisms as predators and parasites, as well as the use of their waste products along with synthetic analogs is one of the leading directions of the biological method of plant protection. The purpose of the biological method is to reduce the population density of phytophages, pathogens of agricultural crops, weeds without the chemicals application. For the first time in the 80s of the 19th century, the mold fungi spores usage against grain beetle (*Anisoplia austriaca* Hbst.) was suggested by I.I. Mechnikov. This *Bacillus thuringiensis*-based preparation was first produced commercially in France. And currently more than 20 similar preparations are produced [5].

Around the same time, the bio-method began to spread in the United States. Since 1872, a cottony cushion scales (*Icerya purchasi* Maskell), accidentally brought to California, and has led to significant damage to citrus plantations. In 1889, *Rodolia cardinalis* (Mulsant), which is an effective predator of this pest in its homeland, was introduced from Australia to protect trees from *Icerya purchasi*. As a result of the active predatory activity of *Rodolia*, the harmfulness of *Icerya purchasi* has significantly decreased. Similarly, in 50 countries of the world, where *Icerya purchasi* was one of the harmful phytophages, this technique was successfully repeated [6, 7]. In the biological control of weeds in the field crops agrocoenosis, mycoherbicides are used, based on the spores of pathogenic fungi [8]. Currently, the direction of useful species cultivation in biological laboratories is widely developing (for example, *Trichogramma species* and *Cryptolaemus montrouzieri* (Mulsant)), which are then released into nature [9]. Also, attractants and repellents are widely used; an interesting and promising technique for insect pests populations disorienting can be release of the sterilized males large number into nature [10].

The scientific literature provides information on the control of the harmful stubborn weed *Orobanche spp.* by *Fusarium species* and *Phytomyza orobanchiae* Kalt utilizing. [11]. It should be noted that when using the biological method, one of its features is the strict interaction of biological agents and their enemies, i.e. a specific type of biological agent or biological product is aimed at suppressing a specific type of weeds, insects or pathogenic organisms. Only recently, entomophages with significant polyphagia, which are capable to reduce the population size of not one but several phytophage species, have become more widely used.

In recent years, the role of the biological method in agricultural production abroad has been constantly growing. On 8% of the cultivated areas of agricultural crops in the United States, plant protection is carried out using biological agents, and in China on cotton plantations, the use of pesticides has decreased by 90% due to the biological method [12, 13]. The areas of the biological method application are also growing in Russia, in particular, the protection of forest plantations in the country is carried out mainly using the biological method [14, 15]. Thus, the bacteria strains of the *Bacillus thuringiensis* group began to be widely used in the control of the most dangerous forests pest - the siberian silkworm (*Dendrolimus sibiricus* Tschetv.) [5].

The success of the biological method in plant protection can be attributed to the control of invasive phytophage species. It is known that the butterfly *Cactoblastis cactorum* (Berg) [11, 16] was used in Australia to restrict the reproduction of *Opuntia species* and to suppress *Salvinia molesta* L. weevil *Cyrtobagous salviniae* Calder and Sands were utilized [17].

The expansion of biological methods application in plant protection allows to reduce the chemical load on agricultural landscapes, to improve the quality of agricultural products and the stability of agricultural producers in the competitive market struggle.

Another direction of reducing the pesticide load in agricultural landscapes is a differentiated approach when prescribing chemical treatments and carrying them out only in pest proliferation centers, on border land and catching band, which, according to a number of authors, makes it possible to almost halve the pesticides use. The pesticides consumption in the implementation of integrated crop protection systems is reduced by 50-70%. In addition to significant cost savings, all of this is essential to environmental safety.

More than forty years of research carried out at the All-Russian Research Institute of Irrigated Agriculture have revealed the possibilities of increasing the biological method effectiveness by expanding the biological diversity and the number of useful species in entomocomplexes of field crops during irrigation. The predators and parasites number control is possible through the spatial redistribution of beneficial insects between agrocoenosis and natural biotopes of agricultural landscapes. It has been established that areas of natural and anthropogenic origin (border land and forest edge) can contribute to an increase in the biodiversity of beneficial insects. Our investigations are consistent with the data of O G Guseva, A M Shpanev, A G Koval [18].

We have obtained results on the influence of plant phenology and microclimate that develops inside herbage on the formation of the composition and structure of entomocomplexes in agrocoenosis of field crops. A much richer entomocomplex is formed under irrigation conditions. Also, the entomofauna is significantly influenced by the degree of anthropogenic impact during the cultivation of agricultural crops. It was found that in crop rotations with the presence of up to 60% of perennial grasses in the structure, more comfortable conditions for the vital activity of useful insect species are created. The optimal microclimate created in the standing grass crop, a soil cultivation minimum, a long-term permanent growth in one place for several years allow insects to find favorable living conditions on crops of perennial grasses (mainly alfalfa and legume-bluegrass herbal mixtures). In our studies, we obtained data on the polydominant entomocomplexes formation in crop rotations with the perennial grasses participation of 40-60%, while their species diversity is significantly higher than in tilled crop rotations. Such polydominant complexes have increased stability, which is important in ecological balance maintaining in agricultural landscapes.

The research results show that, on average, during the vegetative season, the number of useful insect species in crop rotations with the presence of perennial grasses is 2.4-2.7 times higher than the abundance of entomophages and parasites in rotations with tilled crops. The number ratio of entomophages and pests is here 1: 4.7 - 1: 6.7. It is known that with such a ratio, self-regulation of the entomocomplex, the creation of stable entomological communities is possible.

4. Conclusion

In recent years, biological preparations, attractants and repellents have been increasingly used in Russia and in the world, and also the predators and parasites release has been increasing. The biological preparations and biological agents application is one of the promising trend for the organic farming promotion and the green economy development in rural areas.

A differentiated approach at chemical treatments prescribing and carrying them out only in pest proliferation centers, on border land and catching band, can almost halve the pesticides application. The pesticides consumption during the integrated crop protection systems implementation is reduced by 50-70%. In addition to significant cost savings, all of this is essential for environmental safety.

The increasing source of biological diversity, numeric abundance and regularly spaced distribution of beneficial insects in the irrigated crop rotations are perennial grasses crops, which should be located near areas with the most intense anthropogenic load. At the same time, a horizontal migration of entomophages and parasites to neighboring tilled crops was noted, which allows to increase biodiversity and the number of useful species. Thus it will result in a stability augmentation in the phytosanitary state of the agricultural landscape and a decrease in pesticide load.

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