

EFFICACY OF BIOPESTICIDES AGAINST MAJOR PESTS OF WINTER WHEAT WHEN APPLIED BY UNMANNED AERIAL VEHICLES IN SOUTH-EASTERN KAZAKHSTAN

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Annotation. In the context of the development of organic agriculture, the introduction of environmentally safe plant protection methods is of particular importance. The aim of this study was to evaluate the effectiveness of biological protection of cereal crops using biopreparations and unmanned aerial vehicles (UAVs) based on phytosanitary monitoring.

The research was conducted on demonstration fields of organic farming in the Almaty region at the demonstration site of the Zhiembayev Kazakh Research Institute of Plant Protection and Quarantine (KazRIPPQ). During the growing season, a total of 16 pest species were identified during surveys of wheat crops.

On winter wheat at the tillering stage, the abundance of the cereal leaf beetle (*Oulema melanopus* L.) reached 9-11 adults per m², while the sunn pest (*Eurygaster integriceps* Put.) reached 0.6-0.7 adults per m², which was close to the economic threshold of harmfulness. At the stem elongation-heading stage, a harmful population density of wheat thrips (*Haplothrips tritici* Kurd.) was recorded, reaching 7-8 adults per stem.

The application of biological preparations using unmanned aerial vehicles (UAVs) provided high biological efficacy: up to 95.3% against the cereal leaf beetle, 91.0% against the sunn pest, and 88.5% against wheat thrips. In addition, an increase in beneficial entomofauna was observed due to the establishment of nectar-producing zones and artificial nesting sites.

The obtained results confirm the prospects of integrated biological plant protection in organic farming, which contributes to reducing pest populations to a safe level while maintaining the ecological balance of agroecosystems.

Keywords: biological plant protection, entomology, cereal leaf beetle, sunn pest, wheat thrips, unmanned aerial vehicle.

Introduction. Global experience demonstrates that economically efficient and environmentally safe crop production is achieved through the integrated application of technological practices within farming systems of a planned level of intensification. These technologies represent a unified system for managing the crop production process through crop rotation systems, soil cultivation practices, fertilizer application, and plant protection measures within the framework of organic farming systems [1].

In the Republic of Kazakhstan, the development of this sector is regulated by the Law of the Republic of Kazakhstan “On the Production and Circulation of Organic Products”, which defines the legal, economic, and organizational foundations for the production of organic products. At the same time, an analysis of the list of registered plant protection products shows that the share of

biological preparations accounts for only about 2%, which is insufficient for the full development of organic farming and indicates the need to expand the range of biopreparations and to improve mechanisms for their introduction into agricultural practice.

Plant protection in organic farming reflects significant progress in the development and application of biological methods for controlling harmful organisms, such as the use of natural bioregulators, beneficial microorganisms, entomophages, and agronomic practices. However, despite the accumulated scientific and practical experience, the number of challenges is increasing, including the growing resistance of pests, the expansion of their species diversity, and changes in their distribution ranges. These factors complicate the adaptation of such approaches to different agroclimatic conditions, reduce their long-term effectiveness, and hinder their optimal implementation in organic farming systems aimed at ensuring environmentally safe agricultural production [2]. Despite the advantages of using biopesticides in intensive and organic agriculture, the number of biological preparations registered for use remains limited: about 300 worldwide, 50 in Russia, and only 19 in Kazakhstan. At the same time, biological plant protection systems have been implemented in practical agriculture on only about 2% of agricultural land in the Russian Federation [3,4]. Biological plant protection has two main directions. The first involves the use of “living organisms against living organisms”, i.e., the application of bacteria, fungi, nematodes, entomophages, acariphages, entomopathogenic viruses, and other biological agents that act as antagonists of phytopathogens. Microorganisms that are antagonists of phytopathogens are commonly used to control plant diseases. In the control of weeds, herbivorous insects are used, for example the ragweed leaf beetle, which feeds on ragweed without damaging cultivated plants. In addition, microorganisms causing diseases and subsequent death of weeds - known as mycoherbicides - are also used. The second direction involves the use of preparations based on biologically active substances of natural origin for regulating biotic environmental factors. These include pheromones that attract pests and disrupt their mating by disorienting them, as well as agents that facilitate the transmission of entomopathogenic organisms. There are also biorational non-toxic pesticides that regulate the population density and development of insect pests. One of the main advantages of the complete or partial rejection of chemical pesticides is the active reproduction of beneficial organisms, which serve as the main regulators of the populations of many harmful species. This process is known as natural biocenotic regulation [5].

Materials and methods. The research was conducted at the experimental fields of LLP “Kazakh Research Institute of Agriculture and Plant Growing” located in Zhalpaksai village, Karasai district, Almaty region, and under laboratory conditions at LLP “Kazakh Research Institute of Plant Protection and Quarantine named after Zh. Zhiembayev”. Monitoring of pest infestation on the demonstration plots of organic farming was carried out weekly. To study the biological characteristics of phytophagous insect development, generally accepted methods in agricultural entomology and plant protection were used [6–17].

Insects (the sunn pest, cereal leaf beetle, adults of ground beetles, cereal beetles, as well as caterpillars and eggs of Lepidoptera) were counted on plots measuring 0.25 m². Small and jumping insects (flea beetles), with the same number of samples, were counted using a Petlyuk box covered with gauze, with a base size of 50 × 50 cm, placed on the soil surface.

Small insects and mites in the field were assessed using two indicators: the percentage of infested plants and the infestation score. The level of infestation was characterized using a 3-point scale:

- 1 point – low infestation (individual specimens are found on the plant, not forming colonies and occupying less than 25% of the leaf surface);
- 2 points – moderate infestation (1-2 colonies are found on the plant, occupying 26–50% of the leaf surface);
- 3 points – high infestation (more than 2 colonies are found on the plant, occupying more than 50% of the total leaf surface).

When necessary, small insects and mites were counted in the laboratory using a binocular microscope.

Sampling of concealed stem pests was carried out for damaging stages located inside plant tissues. For this purpose, sample plants or their parts (shoots, stems) were examined, and the number of pests and traces of their damage were recorded. Usually, 10 samples with an area of 0.25 m² each were taken.

To account for pests that live openly but are difficult to count visually due to high mobility, excessive abundance, or dense vegetation cover, sweeping with an entomological net was used. One sample consisted of 10–20 consecutive sweeps with the net without interruption.

Counts of the red-breasted cereal leaf beetle were conducted according to the established methodology. During the full tillering stage, periodic field inspections were carried out, including 1–2 test sweepings with an entomological net (25 sweeps each) to determine the appearance of cereal leaf beetles [18].

Results and Discussion. During the growing season, regular monitoring of pests through soil excavations and population counts on wheat revealed 16 pest species causing damage of varying degrees. These included click beetles: the common wireworm (*Agriotes sputator* L.), the dark click beetle (*Agriotes obscurus* L.), and the broad click beetle (*Selatosomus latus* F.); darkling beetles: the steppe darkling beetle (*Blaps halophila* M.) and the sandy darkling beetle (*Opatrum sabulosum* L.); the striped flea beetle (*Phyllotreta vittula* R.); the red-breasted cereal leaf beetle (*Oulema melanopus* L.); the wheat thrips (*Haplothrips tritici* Kurd.); the Moorish bug (*Eurygaster maura* L.); the sunn pest (*Eurygaster integriceps* Put.); the greenbug aphid (*Schizaphis graminum* Rond.); the English grain aphid (*Sitobion avenae* F.); cereal flies including the frit fly (*Chlorops pumilionis* Bjer.) and the wheat meromyza (*Meromyza nigriventris* Mcq.); as well as the greater cereal flea beetle (*Chaetocnema aridula* Gyll.) and the lesser cereal flea beetle (*Chaetocnema hortensis* Geoffr.) [19,20].

During the monitoring period, 15 species belonging to 11 families and 3 insect orders were identified. Three species of entomophagous insects listed in the Red Book of the Republic of Kazakhstan and the Almaty Region were also recorded: the tree mantis (*Hierodula tenuidentata*), the short-winged Coranus (*Coranus subapterus*), and the punctate lady beetle (*Stethorus punctillum*).

Before the start of field trials evaluating the effectiveness of various crop protection schemes against pests, preliminary measures were organized to ensure the timely implementation of protective treatments at optimal periods.

At the demonstration field of organic farming, observations were carried out to monitor the population dynamics of the main pests (the red-breasted cereal leaf beetle, the sunn pest, wheat thrips, etc.). During these observations, the timing of development of individual stages of their life cycle was determined. The results of phytosanitary monitoring showed that during the tillering stage of winter wheat, the abundance of adult cereal leaf beetle (*Oulema melanopus*) reached 9–10 individuals per m², while the sun pest (*Eurygaster integriceps*) reached 0.6–0.7 individuals per m².

For the adult cereal leaf beetle, this indicator approached the economic threshold of harmfulness (ETH), which, according to literature data, is 10 individuals per m² during the tillering stage. Reaching this level serves as a signal for implementing protective measures, since exceeding the ETH may lead to massive leaf damage, disruption of plant photosynthetic activity, and a decrease in crop yield.

In April, field experiments were established on winter wheat against the cereal leaf beetle and the sun pest using biological preparations. The treatments were carried out with the use of unmanned aerial vehicles (UAVs) (Figures 1, 2,3). The data presented in Figure 1 indicate the high biological efficacy of the applied protection schemes. Thus, with two applications of biological preparations, the effectiveness reached 93.5–95.3% compared with the control. The use of unmanned aerial vehicles (UAVs) ensured uniform and precise distribution of the working solution, reduced consumption of biological preparations, and lower anthropogenic impact on the fields (Figure 2).

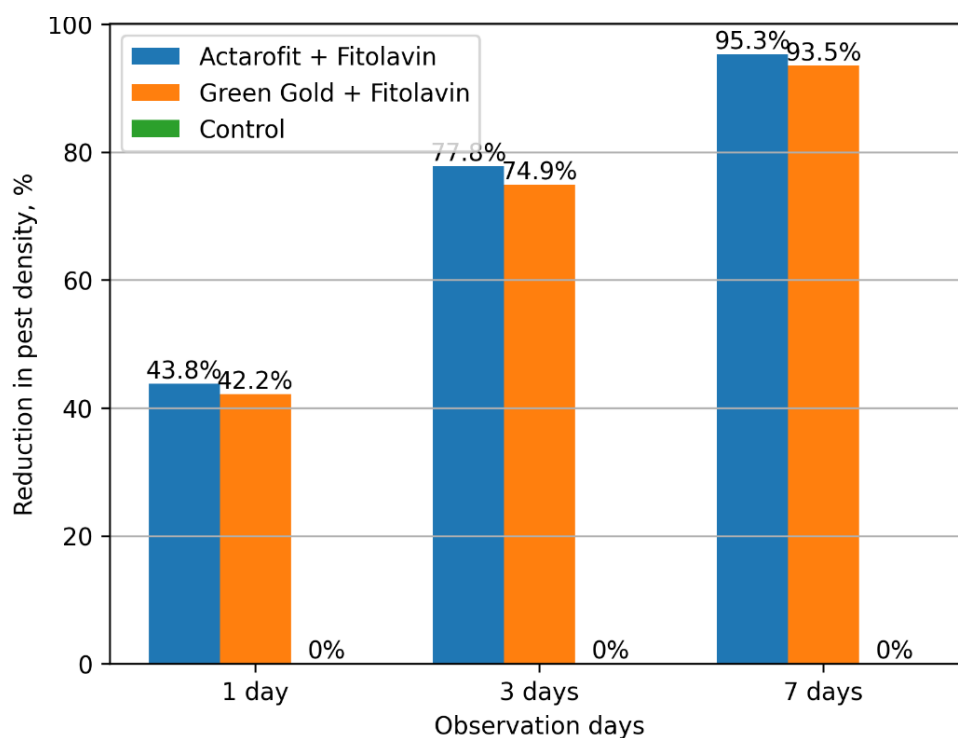


Figure 1 – Biological efficacy of biopreparations against the red-breasted cereal leaf beetle on winter wheat crops, 2025



Figure 2 – Implementation of protective measures using UAVs at the demonstration site of Kazakh Research Institute of Agriculture and Crop Production, 2025

In order to evaluate the effectiveness of biological preparations against the sun pest (*Eurygaster integriceps*), field experiments were established. The trials were conducted under conditions of natural pest infestation. As shown in Table 3, high biological efficiency was observed with the application of the preparation Aktorofit 1.8 (*Streptomyces avermitilis*), whose effectiveness reached 91.0%, indicating the high activity of this biological product against the sun pest.

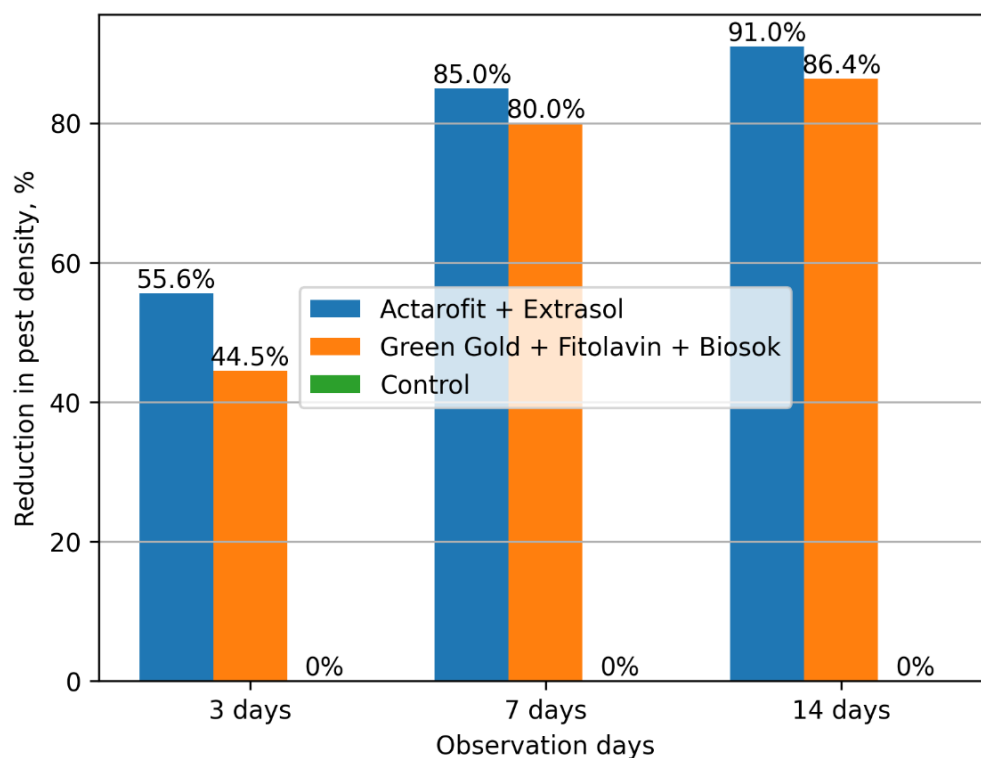


Figure 3 - Biological efficacy of biopreparations against the sunn pest on winter wheat crops, 2025

On winter wheat, at the booting–heading stage, a visual inspection recorded 7–8 adult thrips per stem (economic threshold of harmfulness – 8-10 individuals per stem). These indicators were already considered an important reason for carrying out treatment (Figure 4).

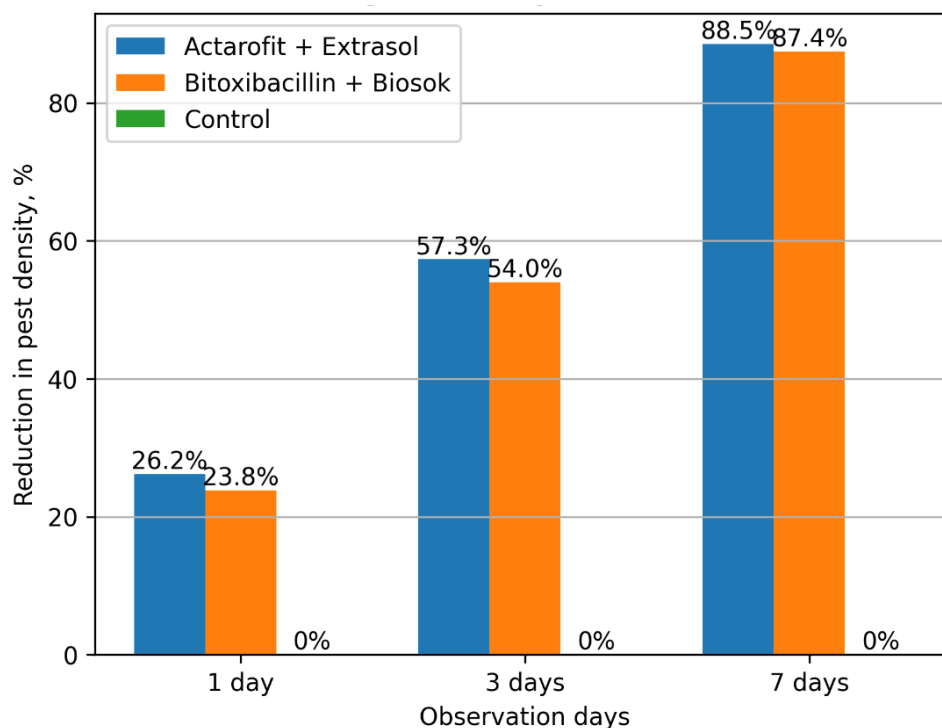


Figure 4 – Biological efficacy of biopreparations against wheat thrips on winter wheat crops, 2025

The biological efficacy of the preparations Aktorofit 1.8 (*Streptomyces avermitilis*), 0.9 L/ha + Extrasol (*Bacillus subtilis* Ch-13), 2.0 L/ha, applied using unmanned aerial vehicles (UAVs)

against wheat thrips on wheat crops demonstrated high biological effectiveness, reaching 88.5% on the seventh day after treatment.

In this regard, the application of biological preparations based on entomopathogenic microorganisms and biologically active substances was a scientifically justified and timely measure. These treatments made it possible to reduce pest populations to a safe level and maintain the phytosanitary well-being of agricultural crops.

The biological preparations used differ from chemical plant protection products by their environmental safety—they do not harm the environment, including beneficial insects such as pollinators. For this reason, they are particularly suitable for ecological (organic) farming, which is becoming increasingly popular. In addition, biological products do not cause pest resistance or pathogen tolerance, allowing them to be effectively used for many years without the need to increase the dosage of the active ingredient.

To study the development of beneficial insects and evaluate the effectiveness of entomophages, as well as to attract them, a field rack (stand) was installed. Nectar-producing plants were sown around the rack, which helped attract various species of entomophages (Figure 5).

Entomophages such as predatory beetles, hoverflies, parasitoid wasps, and other insects require additional nutrition, especially during periods when their prey is less abundant. Nectar and pollen help them survive, reproduce, and actively prey on pests. The advantage of sowing nectariferous plants is the increase in biodiversity, which contributes to reducing the need for plant protection treatments using pesticides.



Figure 5 – Rack for the release of entomophages in the demonstration field of organic farming, Kazakh Research Institute of Crop Production and Agriculture, 2025

Within the framework of the research conducted at the demonstration site of organic farming, a comprehensive monitoring of the population dynamics of harmful organisms and the activity of natural entomophages was carried out. The obtained data indicate the significant role of bioagents and beneficial insects in maintaining the phytosanitary condition of agroecosystems.

Thus, the monitoring results confirm the effectiveness of the biological plant protection system, based on the use of a complex of natural entomophages and colonized bioagents. This approach ensures the sustainable suppression of pest populations at a level that does not require the

use of chemical plant protection products and contributes to maintaining the ecological balance within the agrocenosis.

The selection of biological plant protection agents, including biological products, entomophages, and pheromone traps, with the determination of the optimal timing and application rates considering the distribution and harmfulness of pests, is a key stage in the effective and environmentally safe protection of agricultural crops. The assessment of the biological efficiency of the selected methods makes it possible to reduce pest populations below the economic threshold of harmfulness, while minimizing losses and contributing to the sustainable development of agroecosystems.

Conclusion. The conducted studies confirmed the high efficiency of the biological protection system for cereal crops when using modern monitoring technologies and the application of biological preparations with the help of unmanned aerial vehicles (UAVs). Phytosanitary control made it possible to timely detect the approach of pest populations to the economic threshold of harmfulness and promptly carry out protective measures. The use of biological preparations ensured a significant reduction in the population of key pests without negative effects on beneficial entomofauna. Creating conditions for attracting entomophages further enhanced the natural regulatory mechanisms within the agrocenosis. This integrated approach contributes to the sustainable phytosanitary condition of crops and corresponds to the principles of organic farming. The results demonstrate the prospects of integrating biological methods and digital technologies for environmentally safe and economically efficient grain production.

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ҚАЗАҚСТАННЫҢ ОҢТҮСТІК-ШЫҒЫС ЖАҒДАЙЫНДА ҰҰА ҚОЛДАНУ АРҚЫЛЫ КҮЗДІК БИДАЙДЫҢ НЕГІЗГІ ЗИЯНКЕСТЕРІНЕ ҚАРСЫ БИОПРЕПАРАТТАРДЫҢ ТИІМДІЛІГІН БАҒАЛАУ

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Андатпа. Органикалық егіншіліктің дамуы жағдайында өсімдіктерді қорғаудың экологиялық қауіпсіз әдістерін енгізу ерекше маңызға ие. Зерттеудің мақсаты фитосанитарлық мониторинг негізінде биопрепараттар мен ұшқышсыз ұшу аппараттарын (ҰҰА) қолдану арқылы дәнді дақылдарды биологиялық қорғаудың тиімділігін бағалау болды. Зерттеулер Алматы облысында органикалық егіншілік демонстрациялық алқаптарында, «Қазақ Егіншілік және Өсімдік шаруашылығы ҒЗИ» ЖШС демонстрациялық полигонында жүргізілді.

Вегетациялық кезең барысында бидай егістерін зерттеу кезінде 16 зиянкес түрі анықталды. Күздік бидайдың түптену фазасында қызыл кеуделі астықтың сүлікше қоңызының (*Oulema melanopus* L.) саны 9–11 имаго/м²-ге, ал зиянды бақашық қандаласының (*Eurygaster integriceps* Put.) саны 0,6–0,7 имаго/м²-ге жетіп, экономикалық зияндылық шегіне жақындады. Түтікке шығу – масақтану фазасында бидай трипсінің (*Haplothrips tritici* Kurd.) зиянды саны тіркеліп, бір сабақта 7–8 имаго анықталды.

Биопрепараттарды ҰҰА қолдану арқылы шашу жоғары биологиялық тиімділікті қамтамасыз етті астықтың сүлікше қоңызына қарсы – 95,3%, зиянды бақашыққа қарсы – 91,0%, ал бидай трипсіне қарсы – 88,5%. Сонымен қатар, нектарлы өсімдіктер аймақтарын және жасанды ұя салу орындарын ұйымдастыру нәтижесінде пайдалы энтомофаунаның белсенділігі артқаны байқалды. Алынған нәтижелер органикалық егіншілікте өсімдіктерді кешенді биологиялық қорғаудың болашағы зор екенін дәлелдейді. Бұл тәсіл зиянкестер санын қауіпсіз деңгейге дейін төмендетіп, агроценоздардың экологиялық тепе-теңдігін сақтауға мүмкіндік береді.

Тірек сөздер: өсімдіктерді биологиялық қорғау, энтомология, қызыл кеуделі астықтың сүлікше қоңызы, зиянды бақашық, трипс, ұшқышсыз ұшу аппараты.

ОЦЕНКА ЭФФЕКТИВНОСТИ БИОПРЕПАРАТОВ ПРОТИВ ОСНОВНЫХ ВРЕДИТЕЛЕЙ ОЗИМОЙ ПШЕНИЦЫ ПРИ ПРИМЕНЕНИИ БПЛА В УСЛОВИЯХ ЮГО-ВОСТОКА КАЗАХСТАНА

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Аннотация: В условиях развития органического земледелия особое значение приобретает внедрение экологически безопасных методов защиты растений. Целью исследования являлась оценка эффективности биологической защиты зерновых культур с использованием биопрепаратов и беспилотных летательных аппаратов (БПЛА) на основе фитосанитарного мониторинга. Исследования проводились на демонстрационных полях органического земледелия в Алматинской области на демонстрационном полигоне ТОО «КазНИИЗиР». В течение вегетационного периода при обследовании посевов пшеницы выявлено 16 видов вредителей. На озимой пшенице в фазе кущения численность красногрудой хлебной пядицы (*Oulema melanopus* L.) достигала 9-11 имаго/м², клоп вредной черепашки (*Eurygaster integriceps* Put.) – 0,6-0,7 имаго/м², что приближалось к экономическому порогу вредоносности. В фазе выхода в трубку – колошения зафиксирована вредоносная численность пшеничного трипса (*Neplothrips tritici* Kurd.) 7-8 имаго трипса на стебель.

Применение биопрепаратов с использованием БПЛА обеспечило высокую биологическую эффективность: до 95,3% против пядицы, 91,0% против вредной черепашки и 88,5% против трипса. Дополнительно отмечена активизация полезной энтомофауны благодаря созданию нектароносных зон и искусственных гнездовий. Полученные результаты подтверждают перспективность комплексной биологической защиты растений в органическом земледелии, способствующей снижению численности вредителей до безопасного уровня при сохранении экологического равновесия агроценозов.

Ключевые слова: биологическая защита растений, энтомология, красногрудая хлебная пядица, вредная черепашка, трипс, беспилотный летательный аппарат