

ABSTRACT

of the dissertation by Abunasyr Sharifullaevich Dzhanbatyrov entitled “Development of biological measures for the control of basic apple pests” submitted for the degree of Doctor of Philosophy (PhD) in the specialty 6D081100 – “Plant Protection and Quarantine”

Relevance of the research topic

The dissertation is devoted to the development and implementation of biological methods for protecting apple trees against major pests under the conditions of southern and southeastern Kazakhstan.

In 2015, the Republic of Kazakhstan adopted the Law “On the Production of Organic Products”, which provides for reducing the use of chemical pesticides and widely introducing biological plant protection methods. In this regard, the development of environmentally safe technologies for protecting fruit crops, ensuring the production of high-quality and competitive products, is of particular relevance.

The present dissertation is aimed at developing and implementing biological plant protection products against the major pests of apple trees in order to increase the production of environmentally friendly products for domestic consumption and export. During the research, beneficial insect species were identified, local populations of entomophages were studied, biological preparations and pheromone traps were used, and technologies for the biological protection of apple orchards were improved.

Among the major pests of apple trees, including leafrollers, fruit mites, weevils, and others, the codling moth is the most widespread and harmful species. In some years, crop damage caused by this phytophagous pest reaches 100%. Highly toxic pesticides are still widely used to control the pest, which has a negative impact on the environment and the safety of agricultural products. Therefore, the development of a biological protection system for apple orchards against the codling moth and other pests is an important scientific and practical task.

Aim of the research

To develop and implement a biological protection system for apple orchards against major lepidopteran pests under the conditions of southern and southeastern Kazakhstan.

Research objectives:

1. To study the species composition of the major apple pests and local populations of specialized entomophages (parasitoids and predators).
2. To investigate the distribution, harmfulness, and developmental characteristics of the codling moth (*Laspeyresia pomonella* L.) and other apple pests in orchards of southern and southeastern Kazakhstan.
3. To search for local populations of specialized entomophages (parasitoids and predators) of the codling moth and other major pests in orchards of southeastern Kazakhstan and in mountain fruit forests on Sievers' apple (*Malus sieversii*).

4. To develop and improve methods for monitoring the codling moth and its entomophages using agroclimatic indicators and the calculation of accumulated effective temperatures (AET).
5. To determine the flight dynamics of the codling moth, economic thresholds of harmfulness, optimal treatment periods, and phenological characteristics of major lepidopteran pests of apple orchards.
6. To implement a male-mating-disruption technology for the codling moth in order to reduce pest population density.
7. To develop a biological protection system for apple orchards using pheromones, entomophages, and biological preparations to regulate populations of major phytophagous pests.

Research methods

The objects of the study were the major pests of apple trees and their entomophages. The subject of the research was biological protection methods against the major lepidopteran pests of apple trees. Field and laboratory studies were conducted using generally accepted methods of entomology and plant protection.

Research results

The feasibility of using local entomophage species capable of increasing the sustainability of apple orchard agroecosystems was substantiated.

Biological, integrated, and chemical apple orchard protection schemes were developed. In 2022, yield under the biological protection treatment was 22.3 t/ha, compared with 19.2 t/ha under the integrated protection treatment and 19.9 t/ha under the chemical protection treatment.

Based on the research results, 10 scientific publications were published, including 3 articles in journals recommended by the Committee for Quality Assurance in Science and Higher Education of the Ministry of Science and Higher Education of the Republic of Kazakhstan, 1 article in a journal indexed in Scopus, 3 articles in journals included in the Russian Science Citation Index (RSCI), and 3 papers in proceedings of international scientific and practical conferences.

A utility model patent entitled “Method for Protecting Pome Fruit Orchards against the Codling Moth (*Laspeyresia pomonella* L.) and Oriental Fruit Moth (*Grapholita molesta* Busck.)” No. 5375 was obtained on November 25, 2020. A certificate of state registration of copyright was also obtained for the work entitled “Recommendations on Criteria for Selecting Bioagents (Entomophages) for the Control of Major Pests of Fruit and Berry Crops”, No. 8299, dated February 20, 2020.

The results of the research were implemented in orchards of Almaty Region over a total area of 65 ha, as confirmed by 7 implementation certificates.

Significance of the results obtained

During the study, 343 species of phytophagous organisms were identified, including 66 species belonging to lepidopteran pests. For the first time, data were obtained on 11 species of harmful mollusks, 4 of which were recorded for the first time as pests of apple trees. The most harmful species were the garden snail *Fruticicola lantzi* Lindholm and the grey field slug *Deroceras reticulatum* (Müller).

A total of 363 species of entomophages were identified, including 42 specialized parasitoids of lepidopteran pests. It was established that the parasitoid *Mastrus ridens* (Horstmann) is a promising entomophage for mass rearing and application against the codling moth.

High efficacy of biological preparations against the codling moth was established. The preparation “Akkobelek” reduced pest abundance by up to 90.1%, “Bitoxibacillin” by 87.6%, “Green Gold” by 87.2%, and “Lepidocide” by 89.5%. Against the apple ermine moth, the efficacy of the preparations was as follows: “Akkobelek” – 86.1%, “Green Gold” – 84.1%, “Bitoxibacillin” – 83.3%, “Lepidocide” – 85.2%, and “Entolek” – 95%.

High biological efficacy against the rose tortrix was also observed for “Akkobelek” – 87.1%, “Green Gold” – 88.0%, “Bitoxibacillin” – 85.4%, and “Lepidocide” – 87.5%.

A total of 2,071 codling moth larvae were collected from 1,000 trapping belts. In early spring, more than 350 overwintering larvae of the pest were detected under the bark of tree trunks.

The highest level of larval parasitism was recorded in the “Olzhas” peasant farm in 2021 and 2023, amounting to 23.9% and 40.5%, respectively. In the orchard of the Biotechnology Laboratory of the Kazakh Research Institute of Plant Protection and Quarantine, the parasitism rate in 2022–2023 was 26.6% and 29.0%, respectively, whereas in the “Alatau” peasant farm it was 5.5%.

Under laboratory conditions, the parasitoid *Habrobracon hebetor* Say parasitized codling moth larvae at a rate of 68.7%, while under field conditions its efficacy was 48.3%.

Scientific novelty

For the first time, 343 species of phytophagous organisms and 363 species of entomophages were identified and characterized in apple orchards of southern and southeastern Kazakhstan. The feasibility of using local entomophage species capable of increasing the sustainability of apple orchard agroecosystems was substantiated.

Main provisions submitted for defense

The efficacy of biological preparations was evaluated, and the flight dynamics of the codling moth were studied based on accumulated effective temperatures. For the first time, a predictive model of pest development was developed for the conditions of the region.

The research results can be widely used in orchards of southern and southeastern Kazakhstan to obtain environmentally safe apple products. The developed biological protection measures make it possible to significantly reduce yield losses caused by the codling moth and other pests.

The species composition of the major apple pests and local populations of specialized entomophages (parasitoids and predators) was studied. The distribution, harmfulness, and developmental characteristics of the codling moth (*Laspeyresia pomonella* L.) and other apple pests in orchards of southern and southeastern Kazakhstan were investigated. Local populations of specialized entomophages (parasitoids and predators) of the codling moth and other major pests were identified

in orchards of southeastern Kazakhstan and in mountain fruit forests containing Sievers' apple.

Methods for monitoring the codling moth and its entomophages using agroclimatic indicators and accumulated effective temperatures (AET) were developed and improved. The flight dynamics of the codling moth, economic thresholds of harmfulness, treatment periods, and phenological characteristics of the major lepidopteran pests of apple orchards were determined.

A male-mating-disruption technology for the codling moth was implemented to reduce pest population density. A biological protection system for apple orchards was developed using pheromones, entomophages, and biological preparations to regulate populations of major phytophagous pests.

Relationship of the dissertation topic to the state program

The dissertation was carried out at the Zh. Zhiembayev Kazakh Research Institute of Plant Protection and Quarantine in 2018–2020 within the framework of the project “Applied Scientific Research in the Field of Plant Protection and Quarantine to Ensure Phytosanitary Safety of the Republic of Kazakhstan”, implemented under Budget Program 255 “Creation of Conditions for the Development of Production, Processing and Sale of Crop Production”, Subprogram 106 “Program-Targeted Financing of Scientific Research and Activities in the Field of Crop Production”, Specificity 156 “Payment for Consulting Services and Research”.

Further research was continued in 2021–2023 within the framework of grant financing under project ZhTN AR09259748, “Development of a Technology for Biological Control of the Codling Moth *Laspeyresia pomonella* L. and Lepidopteran Pests Using Entomophages, Pheromones, and Biological Preparations”.

Contribution of the doctoral student to each publication

In 2018–2023, the applicant conducted the main part of the field and experimental research. Field materials collected on the major apple pests and their entomophages were analyzed. Field and laboratory trials of the developed biological protection measures were conducted, and the obtained data were subjected to statistical analysis.

The integrated set of recommended protection measures against the codling moth and major apple pests was implemented under commercial orchard conditions. Based on the main results of the dissertation research, 10 scientific papers were published, including 3 articles in journals recommended by the Committee for Quality Assurance in Science and Higher Education; 1 article in a Scopus-indexed journal with an impact factor (*OnLine Journal of Biological Sciences*, Volume 23, No. 1, 2023, pp. 1–6, DOI: 10.3844/ojbsci.2023.1.16; Impact Factor – 0.178; Q3; CiteScore – 1.0; percentile – 54% in the Agricultural and Biological Sciences subject area); 3 articles in Russian scientific journals indexed in the Russian Science Citation Index (RSCI); and 3 papers in proceedings of international scientific and practical conferences.

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The results of the research were successfully implemented in orchards of Almaty Region over a total area of 65 ha, as confirmed by 7 implementation certificates.

The research materials related to the dissertation topic were presented at a meeting of the Academic Council of the NJSC “Kazakh National Agrarian Research University”, as well as at the Zh. Zhiembayev Kazakh Research Institute of Plant Protection and Quarantine LLP.

The research results were also presented at the international scientific conference “Formation and Development of Plant Protection and Quarantine Science in the Republic of Kazakhstan”, dedicated to the 60th anniversary of the Institute and the 100th anniversary of scientific research in the field of plant protection in Kazakhstan (Almaty, December 6, 2018).

In addition, the research results were presented at the All-Russian Scientific Conference “Climate Change and Seasonal Dynamics of Landscapes” (Yekaterinburg, April 21–24, 2021) and the International Scientific and Practical Conference “Innovations in Science and Practice” (Ufa, December 27, 2021).

Following the international scientific and practical conference, the research paper “Neuropterans and scorpionflies of apple orchards in southeastern Kazakhstan” was awarded a First-Degree Diploma in the category “Best Scientific Work”.

Volume and structure of the dissertation

The total volume of the dissertation is 172 pages. The dissertation consists of an introduction, 6 sections, a conclusion, recommendations for agricultural production, and appendices. The work contains 34 tables and 87 figures. The reference list includes 171 sources.