CZU: 631.147 https://doi.org/10.53040/ppap2023.18

BIOENGINEERING COMPLEXES FOR ECOLOGIZATION OF AGRICULTURAL PRODUCTION

CHERNOVA Irina
Engineering and Technological Institute "Biotechnica" National Academy of Agrarian Sciences of Ukraine
https://orcid.org/0000-0002-9995-3834,
e-mail: bioischernova@ukr.net

Summary. The article is devoted to the issue of determining the methodological foundations of the development of bioengineering complexes for obtaining ecologically clean agricultural products, which is directly related to the production and use of biological plant protection agents. Research methods are systemic, interdisciplinary and synergistic approaches. An analysis of scientific works related to the chosen research direction was carried out, the concept of "agricultural bioengineering complex" was summarized. The properties of agricultural bioengineering complexes and the main regularities of their functioning are defined. Criteria for evaluating bioengineering complexes have been determined.

Keywords: *bioengineering complexes, evaluation criteria, biological plant protection agents*

Introduction. One of the main directions of the use of biotechnology in the agro-industrial complex (plant breeding) is the development of biological means of protection and biostimulation of plants and the production of biofertilizers [1]. Modern biological methods of protecting agricultural crops from pests include the use of entomophages and preparations based on the vital products of micro- and macro-organisms [2].

At the same time, the production and use of biological plant protection products is associated with agricultural bioengineering complexes containing biological (insects, microorganisms), technical (equipment for cultivating and storing biological means, intelligent information systems, etc.) and agrobioengineering components.

The purpose of the research was to determine the methodological foundations of the development of bioengineering complexes for obtaining ecologically clean agricultural products.

Materials and methods. At present, known studies on the development of bioengineering complexes relate to:

– improvement of the methods of a system approach to the development of bioengineering complexes and equipment for their operation in adaptive technologies for growing entomocultures [3];

– development of laboratory climatic complexes for experiments with biological objects [4];

– development of technological complexes for mass production of entomophages [5, 6];

– development of structural and intellectual methods of designing bioengineering complexes for the production of entomocultures [7];

– development of artificial food for arthropod entomophagous [8];

– additional biological control, based on multiple introduction of mass-produced biological control agents as predators or parasitoids for the purpose of temporary control or even destruction of pest populations [9];

– development of an intelligent decision support system in entomophages production [10];

– development and application of soft computing (artificial neural networks, fuzzy logic, genetic algorithms) in agricultural and biological engineering [11];

– using an artificial neural network to predict crop yields using various crop performance factors [12];

– development of a neural network to solve the task of classifying the quality of entomological products in the production of entomophages [13];

– optimization of the production of biological preparations in the direction of increasing its energy efficiency [14];

– determination of the methodological foundations of designing adaptive agrobioengineering systems [15].

Research methods are systemic, interdisciplinary and synergistic approaches.

Results and discussion. The concept of "agricultural bioengineering complex" is summarized, which includes (figure):

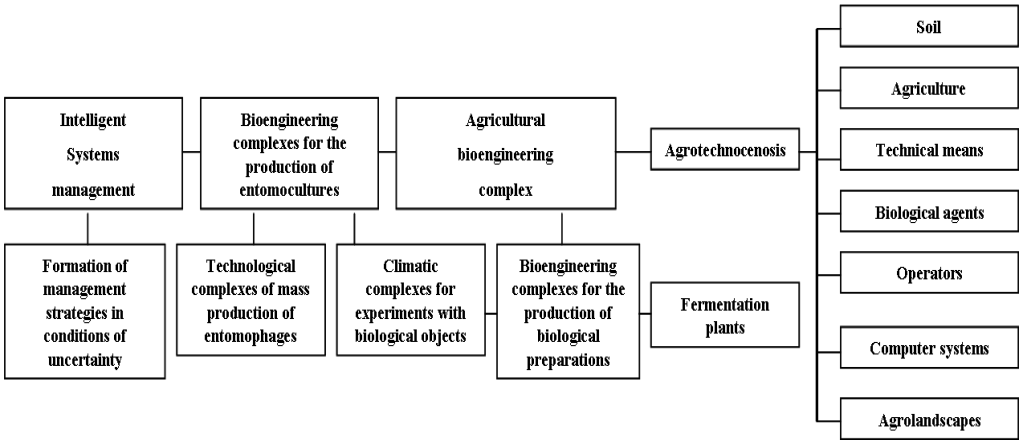
– bioengineering complexes for the production of entomocultures [3-10, 13];

– bioengineering complexes for the production of biological preparations [14];

– adaptive agrobioengineering system or agrotechnocenosis [15], which contains soil, agriculture, technical means, biological agents, operators; computer systems of information collection, analysis, forecasting and management of technological processes [16];

– agrolandscapes as systems for obtaining the maximum amount of agricultural products [17], one of the levers of management of nature use [18]. For example, there are known studies on the complex interaction between several pests, natural enemies and landscape composition [19].

Figure 1. The structure of the agricultural bioengineering complex



The properties of agricultural bioengineering complexes are complexity, functioning in conditions of disturbances, the presence of a biological component, the use of humans in decision-making processes, an interdisciplinary component (biological, technical, mathematical, technological, agrobioengineering).

The main regularities of the functioning of bioengineering complexes are defined:

– the need for fundamental knowledge regarding the peculiarities of the processes of production and application of entomocultures and biological preparations; the peculiarities of the cultivation of agricultural crops;

– application of specialists from various fields (agrobioengineers, biologists, agronomists, technologists, specialists in computer sciences);

– having experience in the use of technical means and biological agents in techno- and agrocenoses;

– implementation of information and communication technologies for analysis, processing, generalization of information on the number of pests, norms of use of biological preparations, type of agricultural landscape, etc., support for decision-making in conditions of uncertainty.

Criteria for evaluating bioengineering complexes have been determined. So, it is advisable to evaluate bioengineering complexes according to:

– the productivity of agrotechnology;

– level of quality of entomological products;

– quality of microbiological preparations;

– the level of automation of entomological and microbiological production;

– the level of labor and energy costs in the production of a unit of ecologically clean agricultural products;

– degree of biologization of plant protection [16].

It is appropriate to assess the quality level of entomological products by the coefficient of stability of homeostasis, which characterizes the constancy of entomophages with changes in the parameters of the technocenosis and is calculated as the ratio of the number of indicators corresponding to normative values to the number of investigated indicators [20].

To ensure high effectiveness of microbiological preparations, it is necessary to evaluate the quality (determination of the titer) - the content of the amount of the active agent (spores, cells, metabolites) in a unit of mass or volume [21].

The degree of biologicalization of plant protection is determined by the share of the use of entomological and microbiological preparations in relation to the total volume of technological operations for plant protection [16].

Conclusions. Research results can be useful in the processes of organic production of agricultural products; at the same time, a synergistic approach to the management of elements of agricultural technologies, technical means and biological agents is a significant factor in increasing its effectiveness.

References

1. Horova A. I., Lysytska S. M., Pavlychenko A. V., Skvortsova T. V.(20 12).Biotekhnolohii v ekolohii: navch. posibnyk [Biotechnology in ecology: a study guide]. Dnipropetrovsk: Natsionalnyi hirnychyi universytet, 184.

2. Zhuikov O. H. (2022). Biolohichnyi metod zakhystu roslyn u suchasnomu orhanichnomu zemlerobstvi Ukrainy: istorychni aspekty, trendy, perspektyvy [Biological method of plant protection in modern organic agriculture of Ukraine: historical aspects, trends, prospects]. *Ahrarni innovatsii*, 12, 23-27. https://doi.org/10.32848/agrar.innov.2022.12.4
3. Pishchanska N. O., Bulhakov V. M., Belchenko V. M. (2022). Bioinzhenerni kompleksy dlia realizatsii adaptyvnykh tekhnolohii vyroshchuvannia entomokultur [Bioengineering complexes for the implementation of adaptive technologies for growing entomocultures]. *Inform. biul. ITI «Biotekhnika» NAAN*, 1, 16-19. URL: https://biotekhnika.od.ua/uk/diialnist/publikatsii/189-materialy-mizhnar-naukkonf-odesa-4-5-zhovtnia-2022-r
4. Bespalov I. M. (2007). Laboratorni klimatychni kompleksy dlia doslidiv z biolohichnymy obiektamy [Laboratory climatic complexes for experiments with biological objects]. *Metodyka, mekhanizatsiia, avtomatyzatsiia ta kompiuteryzatsiia doslidzhen u zemlerobstvi, roslynnytstvi, sadivnytstvi ta ovochivnytstvi: zb. nauk. prats In-tu tsukr. buriakiv UAAN*. Kyiv, 9, 300 – 301.
5. Khodorchuk V. Ia., Bespalov I. M., Ivanovs S. (2022). Tekhnolohichnyi kompleks dlia promyslovoho vyrobnytstva zolotoochky zvychainoi – ahenta biolohichnoho zakhystu roslyn [Technological complex for the industrial production of *Chrysoperla carnea Steph*. – a biological plant protection agent]. *Inform. biul. ITI «Biotekhnika» NAAN*, 1, 20-22. URL: https://biotekhnika.od.ua/uk/diialnist/publikatsii/189-materialy-mizhnar-naukkonf-odesa-4-5-zhovtnia-2022-r
6. Molchanova E. D., Byletskaia T. A. (2016). Kompleksnaia systema massovoi narabotky brakona [Integrated system of mass production of bracon]. *Inform. biul. SPRS MOBB*, 49, 172 – 177.
7. Belchenko V. M., Chernova I. S., Tarhonia V. S. (2017). Metody rozroblennia bioinzhenernykh kompleksiv vyrobnytstva entomokultur [Methods of development of bioengineering complexes of entomocultures production]. *Visnyk ahrarnoi nauky*, 9, 49–52. https://doi.org/10.31073/agrovisnyk201709-09
8. Bout A., Ris N., Multeau C., Mailleret L. (2022). Augmentative Biological Control Using Entomophagous Arthropods. In: Extended

Biocontrol. Xavier Fauvergue, Adrien Rusch, Matthieu Barret, Marc Bardin, Emmanuelle Jacquin-Joly, Thibaut Malausa, Christian Lannou (editors) Springer, Dordrecht., 43-53. https://doi.org/10.1007/978-94-024-2150-7_4

9. Lysenko V., Chernova I. (2020). Intelligent Decision Support System in Entomophages Production, 2020 IEEE International Conference on Problems of Infocommunications. Science and Technology (PIC S&T). Kharkiv, Ukraine, 2020, 225-228, https://doi.org/10.1109/PICST51311.2020.9467999
10. Yanbo Huang, Yubin Lan, Steven J. Thomson, Alex Fang, Wesley C. Hoffmann, Ronald E. Lacey. (2010). Development of soft computing and applications in agricultural and biological engineering. *Computers and Electronics in Agriculture*, 71, 2, 107-127. https://doi.org/10.1016/j.compag.2010.01.001
11. Siti Khairunniza-Bejo, Samihah Mustaffha, Wan Ishak Wan Ismail. (2014). Application of Artificial Neural Network in Predicting Crop Yield: A Review. *Journal of Food Science and Engineering*, 4, 1, 1-9.
12. Chernova I. S., Lysenko V. P. (2023). Mashynne navchannia v upravlinni vyrobnytstvom entomofahiv [Machine learning in entomophages production management]. *Enerhetyka i avtomatyka*, 2, 18-26.
13. Yaroshevsky V. (2019). Energy efficiency research of fermentation medium agitation in manufacturing of microbiological plant protection products. *Agricultural Science and Practice*, 6(2), 76-83. https://doi.org/10.15407/agrisp6.02.076
14. Tarhonia V. S. (2014). Metodolohichni osnovy konstruiuvannia adaptyvnykh ahrobioinzhenernykh system [Methodological foundations of designing adaptive agrobioengineering systems]. *Tekhniko-tekhnolohichni aspekty rozvytku ta vyprobuvannia novoi tekhniky i tekhnolohii dlia silskoho hospodarstva Ukrainy: zbirnyk nauk. pr. UkrNDIPVT imeni L. Pohoriloho*, Doslidnytske, 18 (32), 2, 14-22.
15. Tarhonia V. S., Lisovyi M. M., Kyrylenko Yu. S., Drozd P. Yu. (2015). Intehrovane vykorystannia biotekhnolohichnykh alternatyv v adaptyvnykh ahrobioinzhenernykh systemakh [Integrated use of

biotechnological alternatives in adaptive agrobioengineering systems]. *Peredhirne ta hirske zemlerobstvo i tvarynnytstvo,* 57, 181-192.

16. Bielova N. V. (2015). Ahrolandshafty Peredkarpattia, yikh heoekolohichna otsinka ta shliakhy optymizatsii [Agrolandscapes of Precarpathia, their geoecological assessment and ways of optimization]: dys. … kand. heohr. nauk: 11.00.11. Ivano-Frankivsk, 250.
17. Zhulkanych V. O. (2018). Ekoloho-ekonomichni y orhanizatsiini vazheli upravlinnia pryrodokorystuvanniam [Ecological, economic and organizational levers of management of nature use]. *Naukovyi visnyk Uzhhorodskoho universytetu*, 1 (51), 28-37. https://doi.org/10.24144/2409-6857.2018.1(51).28-37
18. Rrez, Brian A. Naicardo Perez-Alvault, Katja Poveda. (2018). Contrasting effects of landscape composition on crop yield mediated by specialist herbivores. *Ecological Applications*, 28, 3, 842-853. https://doi.org/10.1002/eap.1695
19. Lysenko V. P., Belchenko V. M., Chernova I. S. (2016). Prohnozuvannia yakosti entomokultur [Forecasting the quality of entomocultures]. *Visnyk ahrarnoi nauky,* 5, 52-54.
20. Tkalenko H. M. (2021). Zastosuvannia biolohichnykh insektytsydiv. Ovochi ta frukty [Use of biological insecticides. Vegetables and fruits]. URL: https://www.pro-of.com.ua/zastosuvannya-biologichnix-insekticidiv/