ANNOTATION

Of the dissertation by Karabayev Kuanysh Bakytkeldinovich on the topic "Application of innovative technologies to improve the fertility of light chestnut soils and corn productivity in Agropark of Kaskelen" submitted for the degree of Doctor of Philosophy (PhD) in the specialty 6D080800 – "Soil Science and Agrochemistry"

Relevance of the Research Topic.

At present, the growing demand of the population for livestock products is largely determined by the quality of feed production. In general, the further development of animal husbandry is based on providing the sector with high-protein and high-quality feed resources. In achieving this objective, maize plays a significant role. Under irrigated conditions, with full implementation of appropriate agrotechnical practices, maize can produce up to 100 centners per hectare of grain and 600–700 centners per hectare of organic biomass.

Soil is one of the national assets of the state and represents a vital strategic natural resource. Historical experience of civilizational development demonstrates that the prosperity and decline of any state are directly related to the condition of soil fertility. The degradation of soil fertility is not only a national issue but also a global challenge. According to estimates by the Food and Agriculture Organization of the United Nations (FAO), approximately 70% of the world's land area consists of low-productivity lands constrained by soil-climatic, topographic, or economic factors.

Monitoring studies conducted by scientists at the U.U. Uspanov Kazakh Research Institute of Soil Science and Agrochemistry have revealed changes in humus content across the main soil types in Kazakhstan and a decline in the potential fertility of soils. Losses of humus following the cultivation of virgin and fallow lands amount to one-third of its original content, including a 45–48% reduction in hydrolyzable nitrogen, and up to 57% under irrigation conditions. Annual humus losses in Kazakhstan's agriculture range from 0.5 to 1.4 tons per hectare.

One of the key factors in improving soil fertility is the use of fertilizers. Today, compared to 1985 a period of intensive fertilizer application in Kazakhstan - the use of mineral fertilizers per hectare of arable land has decreased by 15 times, and organic fertilizers by 25 times. This has contributed significantly to the destabilization of soil fertility.

Objective of the Dissertation Research.

To study the effects of mineral fertilizers and the bioorganic fertilizer BioEcoHum on the fertility of light chestnut soils, as well as on the productivity, growth, and development of maize under the conditions of LLP "Agropark Kaskelen".

Research Tasks

- To investigate the effects of applying mineral fertilizers and the bioorganic fertilizer BioEcoHum on light chestnut soils under maize cultivation conditions at LLP "Agropark Kaskelen";

- To evaluate the influence of mineral fertilizers and the bioorganic fertilizer BioEcoHum on maize productivity, growth, and development, and to identify differences between fertilization treatments;
- To assess the effectiveness of the combined application of the bioorganic fertilizer BioEcoHum with mineral fertilizers and their impact on soil properties and maize performance;
- To determine the effects of mineral fertilizers and the bioorganic fertilizer BioEcoHum on the characteristics of maize root system formation;
- To calculate the economic efficiency of using bioorganic and mineral fertilizers in maize cultivation.

Methods of Research

In accordance with the objectives and tasks of the study, phenological and biometric observations were carried out to monitor the growth and development of maize under field conditions. Observations were conducted at the main developmental stages of the crop: emergence, tasseling, and milk–wax ripeness.

During the implementation of the research project, all soil agrochemical studies were performed in compliance with current state standards and with strict adherence to technological and environmental safety requirements. Soil chemical analyses were conducted using the following methods:

- particle-size (granulometric) composition of light chestnut soil was determined according to the Kachinsky classification;
- humus content was determined by the Tyurin method (GOST 26213–91);
- total nitrogen content was determined by the Kjeldahl method (GOST 2610–84);
- easily hydrolyzable nitrogen compounds were determined using the Tyurin–Kononova method (GOST 26345–91);
- mobile forms of phosphorus and potassium were determined by the Machigin method (GOST 26205–91);
- soil reaction (pH) was measured by the potentiometric method;
- spatial data processing was performed using the specialized software MapInfo Professional.

Plant sample analyses included:

- measurement of plant height using a linear measuring tool across all replications;
- determination of leaf area and dry biomass using the gravimetric method;
- assessment of fresh and dry plant biomass;
- determination of root system mass using the border method of N.Z. Stankov;
- calculation of economic efficiency according to the methodology of P.P. Baranov.

Results of the Study

The application of mineral fertilizers at a rate of $N_{80}P_{100}$ resulted in a maize yield of 2.2 t/ha. The highest efficiency was observed when mineral fertilizers were

combined with the bio-organic fertilizer “BioEcoHum”: yield increased to 3.2 t/ha with a single foliar application and to 4.0 t/ha with a double foliar application.

These results demonstrate that the bio-organic fertilizer “BioEcoHum”, when applied in combination with mineral fertilizers, provides the most pronounced positive effect on the morphological structure of maize ears and significantly enhances crop productivity.

Based on the experimental data, the economic efficiency of applying mineral fertilizers at $N_{80}P_{100}$ in combination with the bio-organic fertilizer “BioEcoHum” with double foliar application was calculated. The results showed that the net profit from maize cultivation amounted to 108,780 KZT per hectare.

As a result of production trials and large-scale implementation of the bio-organic fertilizer “BioEcoHum” on an area exceeding 2,000 hectares in agricultural enterprises of the Almaty and Turkestan regions, a patent of the Republic of Kazakhstan No. 5712 dated December 31, 2020 was granted for the utility model “Method for the Application of Bio-Organic Fertilizer to Increase the Yield of Grain and Leguminous Crops.”

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The utility model belongs to the field of agricultural production, particularly to the preservation of soil fertility and the enhancement of crop productivity. The product is registered in the State Register of the Technical Regulation System and holds a Certificate of Conformity No. KZ.7500317.01.01.02417, valid until September 18, 2025. Serial production of the liquid humic biopreparation is certified by Standard ST 071240019657-LLP-01-2021.

Justification of the Significance of the Obtained Results.

Agrochemical and field studies were conducted at the experimental fields of "Agropark Ontustik" LLP in the Karasai district of Almaty region. Analytical data were summarized, a soil database was created, and agrochemical maps were developed for humus content, hydrolyzable nitrogen, available phosphorus, and exchangeable potassium. The doses of mineral fertilizers applied were calculated based on soil nutrient content and the planned yield. The morphological features and basic physicochemical properties of the soils were studied. Electronic versions of soil maps were created, which can be used for the effective use of land and crop rotation planning.

Field trials on the application of the bioorganic fertilizer "BioEcoHum" were conducted. One of the main factors is obtaining a high-quality maize yield using bioorganic fertilizers while maintaining soil fertility. Currently, seed treatment and leaf spraying with bioorganic fertilizers are becoming increasingly important for improving maize yield. The liquid bioorganic fertilizer "BioEcoHum" plays a crucial role in stimulating growth, increasing crop yield by 25-67%, and maintaining soil fertility. It contains various organic substances, macroelements (N, P, K, Ca, Mg), and micronutrients (Mn, Mo, Zn, Se).

The fertilizer "BioEcoHum" was applied for seed treatment at a rate of 2.5 liters per ton of seeds, with 10 liters of working solution, and for plant spraying at 5 liters per hectare in 200 liters of working solution. Maize plants were sprayed with the fertilizer solution at the 3-4 and 6-7 leaf stages.

Scientific Novelty.

For the first time, the effectiveness of the bioorganic fertilizer "BioEcoHum" in preserving the fertility of light chestnut soils in the south and southeast of Kazakhstan and in increasing maize yields has been determined.

Key Provisions Submitted for Defense.

1. It has been established that the application of bioorganic fertilizers under maize cultivation conditions on irrigated chestnut soils of the southern region of Kazakhstan has a significant effect on the soil humus regime.
2. It has been scientifically proven that the application of the bioorganic fertilizer “BioEcoHum” alone provides a stable increase in humus content in the 0–20 and 20–40 cm soil layers compared to the control treatment.
3. It has been substantiated that the combined application of mineral and bioorganic fertilizers enhances soil enrichment with organic matter and ensures the formation of the highest humus content values.
4. It has been demonstrated that double foliar application of the bioorganic fertilizer “BioEcoHum” is more effective in improving the humus status of chestnut soil compared to a single application.
5. It has been scientifically established that the integrated use of bioorganic and mineral fertilizers under maize cultivation conditions contributes to the preservation of agroecological sustainability and the improvement of chestnut soil fertility.

Connection of the Dissertation Topic with the State Program.

The dissertation work was conducted in 2018-2020 as part of the project: “Implementation of an innovative technology to improve soil fertility and crop yields (bioorganic fertilizers)” under budget program No. 267 “Increasing the availability of knowledge and scientific research”. Program code O.0908, No. 0118RK01386. The study was funded by the Ministry of Agriculture of the Republic of Kazakhstan.

Contribution of the Doctoral Student to the Preparation of Each Publication.

During the dissertation research, the doctoral student participated in the development of the program and research methodology and their implementation. He achieved the goals set for the scientific research work. In the fieldwork, light chestnut soil samples were collected at monitoring sites, and their coordinates were established. "BioEcoHum" was used for the treatment and spraying of maize crops with bioorganic fertilizer, and phenological observations were made on the maize to determine its productivity. The doctoral student fully participated in the laboratory analytical work, analyzing the results of the research and solving the set tasks through observation, accounting for research objects, and correctly applying research methods. All results and conclusions presented in the dissertation were formulated by the doctoral student with his direct involvement. The author actively participated in publishing the results in domestic and international journals. In line with the dissertation topic, the results of the scientific research work have been published in 7 scientific papers. These include 3 in scientific publications presented by the Committee for Control in the Field of Science and Higher Education of the Ministry of Education and Science of the Republic of Kazakhstan, 2 in international and

national conferences, and 2 in journals “Eurasian Journal of Biosciences” and “SABRAO Journal of Breeding and Genetics,” which are indexed in the Scopus database.

Volume of the Dissertation.

The total volume of the dissertation is 137 pages. It includes the introduction, 5 chapters, conclusion, production recommendations, and appendices. It also contains 20 tables and 21 figures. The reference list includes 145 sources.