ANNOTATION

of the dissertation by Yeleuov Baglan Muratuly entitled
«Agroecological assessment of the prederessors of spring wheat in the rotations of Northern Kazakhstan using elements of precision farming»,
submitted for the degree of Doctor of Philosophy (PhD)
in specialty 6D080100 – Agronomy

1. Relevance of the Research Topic

Spring wheat is a strategically important major cereal crop in Kazakhstan. Its yield and grain quality depend on many factors, among which the preceding crop plays a particularly important role. The predecessor directly affects the soil water regime, nutrient reserves, accumulation of organic matter, phytosanitary condition, and development of soil biota. Therefore, a comprehensive assessment of the agroecological condition of spring wheat following different predecessor crops is an important task of modern agricultural science.

Precision agriculture technologies are increasingly being introduced into agricultural production. Geographic information systems, agrochemical mapping, satellite monitoring, and variable-rate fertilizer application make it possible to identify spatial variability in soil fertility and improve the effectiveness of agronomic decisions. However, the comprehensive agroecological assessment of spring wheat predecessors using precision agriculture elements under the conditions of Northern Kazakhstan remains insufficiently studied.

In recent years, soil fertility assessment has expanded beyond agrochemical and agrophysical indicators to include the biological condition of the soil. The structure and biodiversity of the soil microbiome are considered important indicators of agroecosystem stability. Accordingly, investigating the soil bacteriobiome formed under different predecessor crops using high-throughput 16S rRNA MiSeq sequencing is of particular scientific interest.

Therefore, a comprehensive agroecological assessment of the effects of different spring wheat predecessors on soil fertility, the biological stability of agroecosystems, crop yield, and economic efficiency, using elements of precision agriculture in Northern Kazakhstan, is of scientific and practical relevance.

2. Purpose of the Dissertation Research

The aim of the research is to comprehensively assess the effects of different spring wheat predecessors on the agroecosystem under the conditions of Northern Kazakhstan using elements of precision agriculture and to provide a scientific rationale for their environmental and production efficiency.

3. Object of Research

The object of the research is the agroecological condition of spring wheat fields on the southern chernozem soils of Northern Kazakhstan, assessed using elements of

precision agriculture and considering the conditions formed after different predecessor crops.

4. Subject of Research

The subject of the research is the effect of spring wheat predecessors on soil agroecological properties, phytosanitary condition, microbiological activity, yield and grain quality, as well as the patterns involved in assessing these changes using elements of precision agriculture.

5. Research Objectives

To achieve the aim of the dissertation, the following objectives were established:

– to determine the effects of different predecessors on the soil water regime;

– to assess the effects of predecessors on soil agrochemical properties;

– to determine the role of predecessors in shaping phytosanitary conditions;

– to assess the spatial variability of fields using elements of precision agriculture;

– to investigate the effects of different predecessors and tillage systems on soil microbiome structure;

– to determine the effects of predecessors on spring wheat yield and grain quality;

– to substantiate the environmental and economic efficiency of different predecessors.

6. Scientific Novelty

For the first time under the conditions of Northern Kazakhstan, a comprehensive agroecological assessment of different spring wheat predecessors was conducted using elements of precision agriculture.

Patterns were established in the effects of different predecessors on the soil water regime, agrochemical and agrophysical properties, and phytosanitary condition.

Spatial field heterogeneity associated with predecessor effects was identified using agrochemical mapping, soil electrical conductivity assessment, and satellite monitoring.

For the first time, 16S rRNA sequencing was used to assess the effects of different predecessors and tillage systems on the taxonomic structure of the soil microbiome, and indicator taxa characterizing the biological stability of agroecosystems were identified.

A relationship was established between the agroecological effects of predecessors, spring wheat yield, and grain quality.

7. Provisions Submitted for Defence

The following main scientific statements are submitted for defence:

1. Different spring wheat predecessors have varying effects on the accumulation of plant-available soil moisture, nutrient availability, and the preservation of organic matter.

2. The use of precision agriculture elements makes it possible to identify spatial variability in soil fertility indicators and scientifically substantiate agronomic decisions.

3. Changes in predecessor crops affect soil biological activity and determine the formation patterns of nematode communities and the taxonomic structure of the soil bacteriobiome.

4. Significant differences in phytosanitary conditions occur under different predecessors, influencing the ecological stability of the agroecosystem.

5. Spring wheat yield and grain quality are shaped by the agroecological effectiveness of the predecessor crop.

6. A comprehensive assessment using precision agriculture elements identified environmentally and economically efficient predecessors for spring wheat under the conditions of Northern Kazakhstan.

8. Relationship of the Dissertation Research to Research Projects and State Programs

The dissertation was carried out within the framework of budget-funded projects under activity O.0892, «Development of a precision agriculture system for crop production in northern Kazakhstan using information technologies, crop production technology elements, variable-rate nutrition, plant protection products, and machinery for profitable production based on a comparative study of different cultivation technologies» (state registration No. 0118RK01276; implementation period: 2018-2020), and activity O.0988, «Development and scientific substantiation of technical and technological parameters for adapting remote sensing and precision agriculture technologies to current production needs of agro-industrial complex entities, and establishment of the required reference database» (state registration No. 0121RK00778; implementation period: 2021-2023).

9. Practical Significance of the Results Obtained

The research expands traditional approaches to assessing spring wheat predecessors in Northern Kazakhstan and provides a scientific basis for a comprehensive agroecological assessment system integrating agrochemical, agrophysical, phytosanitary, and biological indicators. For the first time, the structure of the soil bacteriobiome under different tillage systems was assessed using 16S rRNA MiSeq technology, demonstrating the role of microbial diversity in agroecosystem stability. The effect of No-Till technology was characterized not by an increase in the total number of microorganisms, but by a reorganization of the taxonomic structure of microbial communities.

The results may be used when introducing precision agriculture technologies, designing crop rotations, applying fertilizers at variable rates, managing soil fertility, and improving spring wheat production technologies. The findings are recommended for implementation in the production practices of agricultural enterprises.

10. Personal Contribution of the Doctoral Candidate

The doctoral student independently formulated the scientific concept and aim of the dissertation, defined the research objectives, developed the experimental programme, and justified the research direction.

The doctoral student directly participated in organizing and conducting field studies aimed at assessing spring wheat predecessors in Northern Kazakhstan, selecting experimental sites, carrying out field observations and measurements, collecting soil and plant samples, and preparing them for laboratory analysis.

The study investigated the effects of predecessors on soil moisture reserves, agrochemical and physical properties, retention of plant residues, weed distribution, and phytosanitary condition; the resulting data were analysed.

Using elements of precision agriculture, the doctoral student assessed spatial field heterogeneity, determined the variability of agrochemical indicators, mapped soil fertility parameters, and used the resulting data to support production decisions.

A comprehensive analysis was also conducted of spring wheat yield and quality after different predecessors, plant nutrition characteristics, soil microbiological condition, and the environmental and economic efficiency of the technologies studied.

The doctoral student independently performed statistical processing and scientific interpretation of the experimental results, prepared the main dissertation chapters and scientific publications, and developed the conclusions and practical recommendations based on the research findings.

The results were used to develop practical recommendations for selecting spring wheat predecessors under Northern Kazakhstan conditions and improving the environmental and production efficiency of agriculture through the use of precision agriculture elements.

11. Approbation of the Dissertation Results

The main scientific statements and research findings were presented and discussed at scientific seminars and conferences and received positive evaluations:

– meetings of the Department of Agronomy of Akhmet Baitursynuly Kostanay Regional University and the university's annual scientific councils (Kostanay, 2019–2021);

– scientific seminar «Fundamentals of Precision Agriculture» (Astana, 25 January 2019);

– First International Forum of Young Scientists (Almaty, 11 February 2019);

– online seminar «Digital Transformation in Agriculture» (Zarechnoye village, Kostanay District, 9 July 2020);

– online seminar «Differentiated Precision Agriculture Technologies» (Zarechnoye village, Kostanay District, 23 July 2020);

– scientific seminar «Effective Technologies in Agriculture of Kostanay Region» (Kostanay District, 30 October 2020);

– online seminar «Digitalization of Agriculture: Main Directions and Development Trends» (Zarechnoye village, Kostanay District, 16 December 2020);

– online seminar «Elements of the Precision Agriculture System» (Zarechnoye village, Kostanay District, 23 December 2020);

– international scientific and practical conference for young scientists «Integrated Plant Protection System: Current Status and Prospects» (Almaty, 2022);

– international student scientific and practical conference «Current Issues and Achievements in Scientific Research» (Kostanay, 2023);

– scientific and practical conference «Current Directions and Achievements of Agricultural Science in Addressing Agro-Industrial Complex Challenges» and the 13th regional scientific and practical conference «Current Directions in Agricultural Science in the Works of Young Scientists» (Barnaul, Federal Altai Scientific Centre of Agrobiotechnology, 2025);

– recommendations on insecticide use in Kostanay Region (Kostanay, 2025).

12. Publications

A total of 11 scientific works have been published based on the dissertation research, including: 1 article in a journal indexed in Scopus; 4 articles in scientific 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; 2 articles in journals indexed in the Russian Science Citation Index; 3 publications in proceedings of international scientific and practical conferences; and 1 scientific and practical recommendation with an ISBN.

13. Scope and Structure of the Dissertation

The dissertation comprises 125 pages of computer-processed text and consists of an introduction, five chapters in the main body, conclusions, recommendations for production, prospects for future research, and appendices. It contains 47 tables and 16 figures. The reference list includes 202 sources.