

## ANNOTATION

**The dissertation of Soltanaeva Akerke Myrzabaevna, titled "The Influence of Sulfur Fertilizers on the Chemical Composition of Soil and the Yield of Winter Wheat," is submitted for the degree of Doctor of Philosophy (PhD) in the specialty 6D080800 - Soil Science and Agrochemistry.**

### **Relevance of the Research Topic.**

Ensuring food security is a priority for any country, and grain production plays an important role in this process. Winter wheat occupies a special place in the southeastern region of Kazakhstan. To obtain high yields of winter wheat, it is necessary to implement a scientifically based fertilization system, and the influence of precipitation and air temperature on increasing its yield is significant.

To achieve a bountiful harvest of winter wheat on irrigated lands in the southeastern region of Kazakhstan, the following measures must be implemented: crop rotation, new selections, sowing, rational use of irrigation and various fertilizers, etc.

As a result of continuous sowing of winter wheat in one place, a lack of crop rotation, untimely sowing, systematic omission of irrigation, and improper application of fertilizers, the yield decreases, and its quality declines. In this regard, winter wheat crops become susceptible to various diseases and are affected by pests, which also influences wheat yield and grain quality indicators.

Winter wheat yields have not exceeded 20 centners per hectare in recent years. This is due to a sharp reduction in agricultural production and the fact that large research centers and farms have been left without financial assistance, while economic conditions have worsened.

These conditions resulted in a reduction in the area of irrigated wheat sowing and a lack of equipment for specialized work. Due to the emergence of such difficulties, new projects have arisen in the field of science.

Soil is the main source of plant life and the primary means of production. By maintaining the initial parameters of soil fertility and supplementing all the nutrients taken from the soil, we can guarantee a stable harvest of various crops. Providing crops with a balanced amount of nutrients is one of the main conditions for achieving high yields.

The restoration of soil fertility is a long-term process. A comprehensive study of agrochemical and agrophysical indicators of soil fertility is conducted annually, including the determination of humus content, macro- and microelements, and the qualitative and quantitative composition of soil microorganisms. Additionally, depending on soil indicators, cultivation, irrigation, fertilization, and plant protection methods, as well as crop rotation types, require a comprehensive soil analysis. Therefore, it is necessary to continue and expand scientific research on soil fertility

restoration. Data from long-term experiments on soil fertility are very important and necessary both scientifically and practically.

To assess the level of knowledge on the research topic, literary sources were analyzed.

The intensive use of natural resources has led to an unprecedented increase in soil degradation. Excess or insufficient amounts of nitrogen, phosphorus, and sulfur often become limiting factors, affecting biogenic nutrients and plant productivity. Optimized fertilizers, balanced in nutrients, have been found to positively impact crop yield and plant product quality.

An increase in soil fertility and crop yields under the influence of organic and mineral fertilizers has been noted in the works of foreign and Kazakh scientists.

The key to high soil fertility, increased crop yields, and environmental safety of ecosystems is a balanced form of mineral nutrition, considering the content, distribution, and transformation of all elements in the soil. Along with nitrogen, phosphorus, and potassium, sulfur is second only to protein nitrogen in importance. Sulfur is a crucial macroelement for metabolic processes in plants, including protein synthesis.

Fertilizers are one of the main factors in obtaining a high-quality harvest of agricultural crops, as well as in maintaining and increasing soil fertility. In soil with all the necessary nutrients and favorable climatic conditions, plants grow and develop well.

Additionally, nutrient reserves in the soil may be reduced due to their limited availability.

For full plant growth and development, the following macroelements are necessary: N, P, K, Mg, Ca, Fe, and S. Sulfur is one of the most important and irreplaceable elements of mineral nutrition in grain crops. It is an essential nutrient for improving the quality and growth of agricultural crops and optimizing protein metabolism. With insufficient sulfur, plant development stops, plants become more susceptible to diseases, leaves fall off, and crops deteriorate. Additionally, sulfur ensures good nitrogen absorption, making it the most important macroelement for winter wheat after the primary components.

Since it is commonly believed that sulfur needs are fully met by the atmosphere and other types of fertilizers, the application of sulfur-containing fertilizers has not been given due attention. However, studies by leading global experts in agrochemistry have shown that sulfur deficiency results in decreased crop yield and quality, as well as economic losses. Sulfur promotes root system growth, enhances nutrient absorption, and supports the accumulation of essential elements in plants. The use of sulfur-containing fertilizers, widely recognized in scientific studies, is crucial for improving the quality of crop products and their cultivation across various soil and climatic zones.

Sulfur also helps plants better absorb nitrogen and phosphorus, increasing their resistance to drought and disease. This highlights the need for further research into the use of sulfur-containing fertilizers in the cultivation of grain, legume, and cereal crops.

In recent years, increasing attention has been given to the sulfur requirements of agricultural crops, as long-term farming practices have led to a decrease in sulfur supply to the soil. The use of sulfur-containing fertilizers is becoming increasingly relevant in improving crop yields, modifying crop rotation structures, reducing the volume of organic fertilizers, and addressing the consequences of reduced sulfur-containing fertilizer and pesticide use.

### **The Purpose and Objectives of the Study**

The purpose of the dissertation is to develop effective methods for applying sulfur-containing fertilizers, specifically monoammonium phosphate (MAPS), to winter wheat crops in grey-brown soil conditions. The use of MAPS is a promising approach for the development of the agricultural sector.

To achieve this goal, the following tasks were set:

- To study the influence of sulfur-containing fertilizers (MAPS) on the chemical properties (N, P, K, S) of soil at different stages of winter wheat growth;
- To examine the effect of sulfur-containing fertilizers (MAPS) on the accumulation, growth, and development of dry biomass in winter wheat;
- To analyze the impact of sulfur-containing fertilizers (MAPS) on the yield of winter wheat crops;
- To assess the influence of winter wheat yield on quality and agrochemical indicators;
- To evaluate the economic efficiency of using mineral fertilizers for winter wheat.

### **Research Methods**

The study was conducted on grey-brown soils of the Kazygurt district in the Turkestan region, using winter wheat of the "Krasnovodopadskaya-210" variety. The research involved comparing the availability (intake) of conventional non-sulfur monoammonium phosphate (MAP) fertilizer with elemental granulated sulfur-containing fertilizer (MAP + S), as well as MAP + S with zinc (MAP + S, Zn).

### **Scientific Novelty of the Work**

For the first time, the sulfur content in grey-brown soils of the southern region of Kazakhstan and winter wheat was determined. Based on the climatic conditions of the studied soil, effective experimental methods for applying fertilizers containing micronized sulfur (monoammonium phosphate MAP, P<sub>2</sub>O<sub>5</sub> - 46%, N - 11%, S - 11%, Zn - 1%, sulfur particle size ranging from 5 to 200 microns) were developed. According to optimal research results, there is potential in Kazakhstan to micronize

simple sulfur, which is widely used in agricultural production, and mix it with MAP at the domestic enterprise "KazPhosphate."

### **Key Provisions Recommended for Defense**

-Effective application methods of sulfur-containing monoammonium phosphate (MAPS) fertilizers have been developed for winter wheat grown in grey-brown soils of the Kazygurt district.

-Determination of the total and mobile sulfur content in grey-brown soils of the Kazygurt district.

-Analysis of the influence of sulfur-containing fertilizers (MAPS) on the agrochemical properties of grey-brown soils.

-Evaluation of the effect of sulfur-containing fertilizers (MAPS) on the growth, yield, and quality of winter wheat.

### **Characteristics of the Main Results of the Study**

The influence of sulfur-phosphorus fertilizers (MAPS) on the chemical composition of grey-brown soils, as well as on the productivity, development, and ripening of winter wheat, was studied. Work was carried out to assess the economic efficiency of using sulfur-phosphorus fertilizers on winter wheat, to minimize the negative impact of fertilizers on the environment and soil, and to determine the dynamics of the nutrient regime compared to the initial state.

The studied grey-brown soils of the Kazygurt district in the Turkestan region have a low content of humus, mobile nitrogen, and phosphorus, with a moderate content of exchangeable potassium. The use of mineral fertilizers influenced the nutrient regime of the studied soils, as well as the productivity, ripening, and development of grain crops.

### **Compliance with Scientific Development Directions or Government Programs**

The dissertation work was carried out as part of scientific projects funded by the grant budget program of the Ministry of Education and Science of the Republic of Kazakhstan No. 0709: "Preservation and Development of the Economy of Kazakhstan" for 2015-2017. The project was aimed at developing effective methods for using sulfur-containing fertilizers for grain crops.

### **Description of the Doctoral Student's Contribution to Each Publication**

Based on the dissertation materials, the co-authors published 8 scientific papers, including: 3 articles in publications 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; 3 articles in the materials of international scientific and practical conferences; 1 article in a journal indexed in the Scopus database; 1 recommendation was developed.

**The main provisions of the dissertation were presented at international conferences, including:**

Current State, Traditions, and Innovative Technologies in the Development of the Agro-Industrial Complex, materials of the international scientific and practical conference within the framework of the XXVIII International Specialized Exhibition "Agrocomplex-2018," Bashkir State Agrarian University, 2018; V International Scientific Conference "Farabi Alemi", Almaty, Kazakhstan, 2018; XV Youth International Scientific and Practical Conference of Students, Graduate Students, and Young Scientists "Step into the Future: Theoretical and Applied Research of Modern Science", St. Petersburg, Russia, 2018.

### **Publications Recommended by the Committee for Control in Social Sciences of the Republic of Kazakhstan**

The influence of sulfur-containing phosphorus fertilizers on soil fertility and productivity of winter wheat in southern Kazakhstan, Bulletin of the National Academy of Sciences of the Republic of Kazakhstan, Series of Agrarian Sciences, 6(42), 2017; The effect of sulfur-containing fertilizers on the yield and quality of winter wheat, Izdenister, Natizheler, No. 4, 2020. Almaty, KazNAU; Changes in the fertility indicators of grey-brown soils depending on the use of sulfur-containing phosphorus fertilizers, Soil Science and Agrochemistry, No. 4, 2020. Almaty, KazNIIPiA named after U. Uspanov.

### **Publication in Journals Included in the Scopus Database**

Effect of sulfur-containing fertilizers on the chemical properties of soil and winter wheat yield. Bulgarian Journal of Agricultural Science, 24 (No. 4), 2018.

Recommendation for Production: Application of sulfur-containing phosphorus fertilizers for winter wheat in the conditions of the South Kazakhstan Region. Almaty, 2017. – 14 pages.

### **Dissertation Volume and Structure**

The dissertation consists of 146 pages, including an introduction, five sections, a conclusion, a recommendation for production, a list of references, and appendices. The dissertation data are illustrated with 27 tables and 16 figures, including 11 diagrams. The list of references includes 173 sources.