

ANNOTATION

for the dissertation work of Turebaeva Sagadat Dauletbekovna on the topic “Features of the use of fertilizers when cultivating winter wheat under zero-tillage conditions in rainfed areas of Southern Kazakhstan,” submitted for the degree of Doctor of Philosophy (PhD) in the specialty 6D080800 - Soil science and agrochemistry

Relevance of the research topic

Currently, the yield of winter wheat in small and medium-sized peasant farms and manufacturing enterprises has sharply decreased. The reason for this is the untimely implementation of agrotechnological measures when growing crops and the lack of a developed crop rotation system. It is well known that currently the costs of basic tillage of field soils and grinding of soils before planting crops account for 40-50% of its total amount, and reducing these costs is one of the pressing problems of agricultural science.

Even modest climate change, especially decreased rainfall and sharp increases in temperature, negatively impacts crop yields and threatens grain production in arid and semi-arid regions. In this regard, Kazakhstan's agriculture is very sensitive to climate change, so wheat yields in the country could decrease by up to 70% with climate change. In connection with the transition to free market relations, decisions are being made that affect adaptation to climate change and efforts are being made to introduce resource-saving technologies. The latter includes the use of “zero” tillage or direct sowing of grain, the use of which in the world community has increased by 142 million hectares. However, in Kazakhstan, especially in its southern regions, due to objective and subjective reasons, as well as due to low and insufficient financial and technical conditions of various agricultural formations, systematic agrotechnological measures recommended for planting and growing crops in agricultural crops are not carried out. Therefore, for the purpose of economical tillage, there is a need to research and implement effective direct seeding technology that meets market competition.

One of the important ways to increase the efficiency of crop cultivation and production technology is to optimize plant nutrition. Many studies have been devoted to studying the problems of using fertilizers and their effectiveness. However, in the south of Kazakhstan, the problem of growing winter wheat using resource-saving technology with zero tillage (that is, with direct sowing) is one of many priority tasks and is beginning to be developed only recently. The problems of using fertilizers, microfertilizers and growth regulators for direct sowing of winter wheat in the rainfed lands of southern Kazakhstan and determining their optimal doses and timing of application in rainfed farming conditions still require more extensive research and their scientific justification. Previous studies have not studied scientifically based nutrition systems, types of fertilizers, rates of their application, the influence of the timing of fertilizer application on the growth and development and productivity of crops.

Considering the soil and climatic characteristics of the southern region of Kazakhstan, such research work has not been carried out previously. If we take into account the fact that the sierozem soils of rain-fed lands in the southern region of Kazakhstan always lack the nutrients needed by plants, it becomes clear that the scientific research carried out is one of the pressing problems of the agricultural sector and is of priority importance.

Thus, for the first time in the southern region of Kazakhstan, the determination of the most effective rates of macro- and microfertilizers and plant growth regulators and the development of methods for their use for direct sowing of winter wheat without tillage in rainfed farming conditions is of particular interest to science and has particular practical importance in production grains of winter wheat.

The purpose of the dissertation research:

Determination of scientifically based norms, methods and timing of fertilizer application for direct sowing of winter wheat without tillage on rainfed lands of Southern Kazakhstan.

Research objectives:

- determine the characteristics of the growth and development of winter wheat depending on the rate, methods and timing of fertilizer application in the “zero” technology system for processing ordinary sierozem soils;

- to study the features of the formation of the crop structure depending on the level of humidity and the application of fertilizers during direct sowing of winter wheat without processing ordinary gray soils in the region of rain-fed farming;

- determine the degree of weed infestation of fields during direct sowing of winter wheat and the effect of treatment with new systemic herbicides;

- determine the economic and bioenergy efficiency of fertilizers used in the agrotechnological system of direct sowing of winter wheat.

Research methods:

The common sierozem soils of Southern Kazakhstan and the zoned winter wheat variety Steklovidnaya 24, included in the list of breeding achievements approved for cultivation in the Turkestan region, were selected as objects of study. The research work was carried out in the following short-rotation six-field crop rotation system on rainfed land (alfalfa 1 year + safflower; alfalfa 2 years; alfalfa 3 years; winter wheat; safflower; cultivation of winter wheat with “zero” technology, i.e. direct sowing without tillage). In the specified crop rotation, the research and cultivation of winter wheat using “zero” technology was carried out after the safflower crop. Since safflower is sown in early spring, measures taken before sowing the seeds in the fields made it possible to reduce infestation from overwintered weeds. On the experimental plots, the study of macro- and complex microfertilizers, as well as stimulants of plant growth and development, was carried out in the following quantities (kg/ha a.s.): control (without fertilizers); with autumn sowing of seeds, simultaneous application of phosphorus fertilizer (P₃₀); with autumn sowing of seeds, simultaneous application of phosphorus fertilizer (P₄₅); application of (P₃₀) when sowing in autumn and (N₅₀) in the tillering phase in early

spring; application of (P₃₀) when sowing in autumn and (N₇₀) in the tillering phase in early spring; application of (P₄₅) when sowing in autumn and (N₅₀) in the tillering phase in early spring; application of (P₄₅) during autumn sowing and (N₇₀) in early spring during the tillering phase and seed treatment, use of microfertilizers (2.0 l/ha) + plant growth stimulator (0.5 l/ha) during tillering and the beginning of heading. Depending on the above experimental options, mineral macro- and microfertilizers, and plant growth stimulants were used in the growth and development phases of winter wheat crops and their differences in yield formation were determined.

To study the dynamics of nitrogen and phosphorus content in ordinary gray soil in the above-mentioned 5-field crop rotation, before sowing winter wheat, at the stages of booting, heading and full ripening of grain, soil samples were taken from depths of 0-20 and 20-50 cm.

According to the research scheme, phosphorus fertilizers (P₃₀ and P₄₅ kg/ha based on the active substance) were used in combination with nitrogen fertilizer. When sowing winter wheat seeds to a depth of 4-5 cm with a Brazilian seeder *Fankhauser 2115*, designed for “zero” technology, simultaneous application of phosphorus fertilizers (ammophos) to a depth of 8-10 cm was carried out, and nitrogen fertilizers (ammonium nitrate) were applied in early spring during the tillering of winter wheat - at the beginning of the spring growing season of its growth and development (March). In the eighth version of the experiment, before sowing winter wheat with treatment against diseases with the fungicide "Raxil-0.4 l/t", 0.5 l/t of the plant growth stimulator "Vympel" + 1.0 l/t of the microfertilizer "Oracle" were simultaneously applied. A mixture of the plant growth stimulator of the same name “Vympel” 0.5 l/ha + 2.0 l/ha microfertilizer “Oracle” was used to treat winter wheat during the period of tillering and the last appearance of leaves (before the appearance of the ear).

Depending on the growth and development of weeds at the end of March (03/31/2020), the herbicides Ballerina 0.5 l/ha + Lastik extra 0.8 l/ha were preliminarily individually mixed with water and the fields were sprayed during the periods of initial weed growth and tillering of winter wheat.

It is known that the integral indicator of soil fertility is the yield of agricultural crops. The grain yield of winter wheat was determined by the following indicators: the number of spikelets on one plant; number of spikelets and flowers on one ear; mass of 1000 grains, measured in grams.

Each experimental variant was placed on an area of 332 square meters. In it, the plot area of each repetition was 83 square meters. The number of repetitions is 4 times.

During the experiments, field observations, calculations and laboratory analyzes were carried out using well-known methods. The results of the study were subjected to analysis of variance using the method of B.A. Dospekhov.

Main provisions submitted for defense

1. When cultivating winter wheat using “zero” technology in the conditions of southern Kazakhstan, the features of changes in seasonal and long-term amounts of

nutrients in ordinary sierozem soils due to the use of mineral fertilizers and a plant growth stimulant have been determined;

2. When cultivating winter wheat using “zero” technology in the conditions of the south of Kazakhstan, effective doses of mineral fertilizers and plant growth stimulants were determined based on its yield and quality indicators;

3. The types and effective standards of herbicides have been determined to improve the phytosanitary condition of fields when growing winter wheat under conditions of processing ordinary sierozem soils using “zero” technology;

4. The economic and bioenergy efficiency of mineral fertilizers and plant growth stimulants for the cultivation of winter wheat under zero-tillage conditions of rain-fed sierozem soils has been determined.

Description of the main results of the study

In the conditions of rainfed agriculture in Southern Kazakhstan, the structure, composition and properties of sierozems, long-term dynamics of the content of basic nutrients in them before sowing winter wheat were studied. Research has shown that the application of nitrogen and phosphorus fertilizers to ordinary sierozem soils increases the yield of winter wheat and replenishes the reserves of nitrate nitrogen and available phosphorus. In studies, the combined use of nitrogen and phosphorus fertilizers created conditions for the active use of their reserves in the soil. In soils under winter wheat, nitrate nitrogen is actively used by the plant during the heading phase, and its amount in the 0-20 cm layer decreased by 40-60% compared to the booting period. In the options in which the maximum doses of nitrogen fertilizers are combined with phosphorus ($P_{30}N_{70}$ and $P_{45}N_{70}$), the amount of nitrates in sierozem soil from the time of harvesting to heading in 2019-2021 decreased from 33.7 to 20.8 mg/kg, from 42.3 up to 19.4 mg/kg, from 44.6 to 24.0 mg/kg and from 32.8 to 18.4 mg/kg, from 38.6 to 14.7 mg/kg, from 42.3 to 20.8 mg/kg.

The use of phosphorus and nitrogen macro- and microfertilizers during direct sowing of winter wheat in rainfed farming conditions creates optimal conditions for good growth and development of the crop and obtaining high yields. At the same time, higher biomass was formed in variants with the combined use of phosphorus and nitrogen fertilizers. The combined use of nitrogen fertilizers with phosphorus fertilizers (for example: $P_{30}N_{70}$) made it possible to obtain 34.8 t/ha of winter wheat grain in 2019, 34.3 t/ha in 2020 and 30.1 t/ha in 2021. That is, over three years in the indicated variant, compared to the control, 22.4, 21.1 and 19.2 t/ha of additional products were obtained, respectively.

The use of phosphorus and nitrogen macrofertilizers when cultivating winter wheat by direct sowing on ordinary sierozem soils in rainfed farming improves the quality indicators of wheat grain. In variants of combined use of phosphorus and nitrogen fertilizers, grain glassiness increased to 12-26%, protein content to 1.6-1.9%, dry gluten to 5.0-7.4% compared to the control.

The use of herbicides on an experimental field of directly sown winter wheat on rainfed lands in the south of Kazakhstan showed their high efficiency. Compared to the

control, the use of herbicides leads to a reduction in the number of weeds by 90-91%, their weight by 89-92%, and an improvement in the overall phytosanitary condition of the fields. This, in turn, contributed to an increase in winter wheat yields by 33-40%.

Peasant farms engaged in growing winter wheat on rainfed lands in the south of Kazakhstan are recommended to carry out the following activities:

1) when cultivating agricultural crops by direct sowing to constantly increase the fertility of ordinary gray soils, obtaining high and high-quality yields from them, in the fall, add 30-45 kg of phosphorus and in early spring 50-70 kg of a.i. nitrogen fertilizers can increase yields up to 2-3 times;

2) in soils with an increased supply of mobile phosphorus and nitrate nitrogen, during seed treatment, the plant growth stimulator “Vympel 0.5 l/t” + microfertilizer “Oracle -1.0 l/t” is simultaneously used and the fields are treated with their mixture in an amount of 0.5 l/ha + 2.0 l/ha of winter wheat during the period of tillering and the appearance of the last leaf (before heading) allows to achieve high yields;

3) when growing winter wheat by direct sowing, it is necessary to treat it with the herbicides Ballerina (0.5 l/ha) and Lastik Top (0.5 l/ha). This reduces field weediness by more than 90%, and also creates conditions for obtaining a high-quality and high harvest.

Justification of the novelty and importance of the results obtained

For the first time, the influence of macro- and micromineral fertilizers and plant growth stimulants on the dynamics of the content of basic nutrients in the soil, on growth and development, as well as the structure of the yield of winter wheat in the “zero” technology system of ordinary gray soils in the conditions of rainfed agriculture in the southern region of Kazakhstan was studied. The biological effectiveness of new systemic herbicides was determined depending on the type and number of weeds. The effectiveness of applied fertilizers under local prevailing weather conditions was studied and an economic analysis was carried out.

Research data on the optimal effective rates of macro- and micromineral fertilizers and plant growth stimulants in the “zero” technology system on rain-fed ordinary sierozem soils of the southern region of Kazakhstan, the timing of their application to the soil, makes it possible to develop a scientifically based fertilizer system that ensures gluten content in a short-crop six-field crop rotation winter wheat grains of at least 28.0% and obtaining a yield of at least 25-30 t/ha. This, in turn, helps to improve the well-being of workers and farmers of small and large agricultural structures in Southern Kazakhstan by reducing the cost of winter wheat, increasing income and profitability of production.

Compliance with areas of scientific development or government programs

In 2019-2021, the doctoral student’s research work was carried out mainly within the framework of the scientific and technical program on the topic “Develop a system for the use of fertilizers and growth stimulants on winter wheat crops with zero tillage in rainfed conditions in the south of Kazakhstan” (state registration №BR10764908).

Description of the doctoral student's contribution to the preparation of each publication

The doctoral student participated in the development of the research program and methodology, in field experiments and in their implementation during the dissertation work. She took an active part in calculating the rates of macro- and micromineral fertilizers and plant growth stimulants and in studying their effect on the dynamics of basic nutrients. In addition, she participated in all stages of winter wheat cultivation, carried out biometric measurements and phenological observations, and determined their productivity. The doctoral student analyzed soil and plant samples taken in the field according to the research methodology and, finally, participated in processing the results. The author, based on the results of research on the topic of the dissertation, published a total of 12 scientific works, including 3 articles in scientific publications recommended by the Committee for Control in Education and Science of the Ministry of Education and Science of the Republic of Kazakhstan, 2 articles in a scientific journal included in the Web of science and Scopus databases, 7 articles in collections of international conferences and 1 certificate of implementation in production received.

Scope and structure of the dissertation

The dissertation consists of 128 pages of computer text, including normative references, definitions, symbols and abbreviations, introduction, 6 sections, conclusions, bibliography, recommendations and appendices. The list of references contains 126 domestic and foreign titles. The structure of the dissertation consists of 28 tables, 6 figures and 11 appendices.