

Conference Paper

Efficiency of Application of Mineral Fertilizers for Winter Wheat on Leached Black Chernozem

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Abstract

The article considers the issue of productivity and economic efficiency of the use of slow-acting nitrogen fertilizers obtained using the "Si" technology of winter wheat. The studies were carried out in 2014–2017 in the northern forest-steppe zone of the Tyumen region on the experimental field of the Agrotechnological Institute of the GAU of the Northern Trans-Urals. increased winter wheat grain yield. Winter wheat productivity according to the studied options on average over the years of research ranged from 3.36–3.41 t/ha, which is higher than the control about the option of 0.27–0.32 t/ha. The economic efficiency of the fertilizers used was determined by the cost of increasing the crop and the cost of obtaining it. Analysis of economic efficiency showed that when sowing the nitrogen fertilizer, urea encapsulated by Si technology (30 kg/ha d.v.) received the highest profitability – 81.68 %. The resulting conditionally net income in this option amounted to 1663.4 rub/ha. In the sixth version of the experiment (encapsulated urea according to the "Si" technology (60 kg/ha a.v.) + KCl (30 kg/ha a.a.) + P₂O₅ (40 kg/ha a.a.)) profitability – 76.0 %. Obtained conditionally net income in this embodiment amounted to 1222 rubles/ha. The return on fertilizer use ranged from 4 to 85 %.

Keywords: winter wheat, mineral fertilizers, productivity, economic efficiency, profitability.

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1. Introduction

Ensuring food security of the Tyumen region is the most important strategic task of the agro-industrial complex. Winter crops are rightfully considered promising crops. According to the Department of Agriculture of the Tyumen Region, winter wheat productivity in the region increased from 2.11 t/ha in 2016 to 3.15 t/ha in 2018.

Winter wheat has a high potential and responsiveness to the application of mineral fertilizers. At the present stage, the productivity of winter crops is not fully realized [1–4].

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In connection with an increase in the supply of mineral fertilizers and the expansion of fertilized areas under crops, the introduction of the most effective doses and methods of using mineral fertilizers in the regions is of great importance [5, 6].

Many scientists believe that soil cultivation is considered one of the factors for increasing the productivity of grain crops [7, 8]. Meanwhile, as the materials of I.G. Yulushev, there is no alternative to fertilizers, without fertilizers it is impossible to work profitably on the land [9]. The main measures that take into account soil and climatic resources and biological characteristics of plants and increase the efficiency of the use of mineral fertilizers should be aimed at their scientifically-based, rational use, taking into account the results of agrochemical examination of soils, with the calculation of fertilizer doses for the planned crop [10--12].

High yields with good product quality, obtained using fertilizers, must meet the criteria of economic feasibility. Rational use of fertilizers allows you to recoup not only the costs of their acquisition and introduction, but also gives the economy a profit [13, 14].

2. Methods and Equipment

2.1. Methods

At the State Agrarian University of Northern Trans-Urals, a new technology for coating granules of nitrogen fertilizers with a water-insoluble silicate composition with the inclusion of a urease inhibitor has been developed [15, 16].

In this regard, the aim of the research is to study the effect of slow-acting nitrogen fertilizers on the productivity and economic efficiency of the use of slow-acting nitrogen fertilizers obtained using the "Si" technology of winter wheat.

For three years, a field experiment was conducted on the SAI test field of the Northern Trans-Urals to study the effect of mineral fertilizers on winter wheat productivity. The soil in the experiment is leached chernozem, the humus content is 7.65--9.05 %. In the experiment we studied the registered variety of winter wheat Novosibirsk 32 with six variants of fertilizer application according to the experimental design. The sowing date is the first decade of September (September 4--5). The repetition in the experiment is fourfold, the plot area is 30 m². Agricultural technology generally accepted for culture in the region. The predecessor is pure steam.

Studied 6 options for experience:

1. No. 1 -- control (without fertilizing);

2. No. 2 -- carbamide (60 kg/ha ai);
3. No. 3 -- encapsulated carbamide according to the "Si" technology (60 kg/ha ai);
4. No. 4 -- encapsulated carbamide according to the "Si" technology (30 kg/ha ai);
5. No. 5 -- encapsulated carbamide according to the "Si" technology (60 kg/ha ai) + KCl (30 kg/ha ai);
6. No. 6 -- encapsulated carbamide according to the "Si" technology (60 kg/ha a.a.) + KCl (30 kg/ha a.a.) + P₂O₅ (40 kg/ha a.a.).

Fertilizers were applied simultaneously with sowing. Accounting and observations were performed in accordance with generally accepted methods, the results were processed by the dispersion method.

The economic efficiency of the production of winter wheat was evaluated by yield and the cost of obtaining it, using routings and guidelines.

3. Results

On average for 2014--2017 the yield of winter wheat in the control (without the use of fertilizers) was 3.04 t/ha. The yield increases due to the use of the studied fertilizers of the experimental variants varied from 0.02 t/ha to 0.51 t/ha (Fig. 1).

The highest grain yield of winter wheat over the years of research was noted in the sixth version of the experiment (urea encapsulated by "Si" technology (N (60 kg/ha a.a.) + KCl (30 kg/ha a.a.) + P₂O₅ (40 kg/ha a.a.)) -- 3.55 t/ha, which is 0.51 t/ha higher than the control version. This is 16.81 % of the increase in yield. The yield in the third, fourth and fifth variants was close in magnitude and amounted to 3.36--3.411 t/ha, respectively, which is 0.27--0.32 t/ha higher than the control option (3.04 t/ha).

In 2014--2015 maximum yield was noted in the fourth embodiment, the urea encapsulated according to the "Si" technology (30 kg/ha a.a.) and amounted to 2.73 t/ha. Yields on the fifth, third and sixth options are slightly lower -- 0.45; 0.37 and 0.31 t/ha, respectively. In the second variant, a slight excess of the control variant by 0.17 t/ha was noted.

In the warmer 2016--2017. the maximum yield of winter wheat in the experiment was noted -- 4.58 t/ha when applying the sixth option, which is higher than the control by 0.71 t/ha. Significant yield increases were obtained in options 3, 4, 5 and 6: excess of 0.19--0.49 t/ha over control. The exception was the second version of urea (60 kg/ha a.a.), where a decrease in yield of 0.13 t/ha was noted.

The use of the studied nitrogen fertilizers increased the yield of winter wheat grain, except for the variant with fertilizers urea (60 kg/ha a.a.) -- 0.02 t/ha. In general, for the studied options, the yield increase was from 0.66 to 16.81%.

The economic efficiency indicators for the use of encapsulated carbamide according to the "Si" technology are presented in Table 1. The total amount of costs associated with the use of the studied fertilizers in the control version was 500 rubles/ha. The smallest amount of costs in the fourth option (urea encapsulated according to the "Si" technology (30 kg/ha ai)) -- 2037 rubles/ha. The largest amount of costs was noted in the sixth version of the experiment (urea encapsulated by "Si" technology (60 kg/ha a.a.) + KCl (30 kg/ha a.a.) + P₂O₅ (40 kg/ha a.a.)) -- 3878 rub/ha.

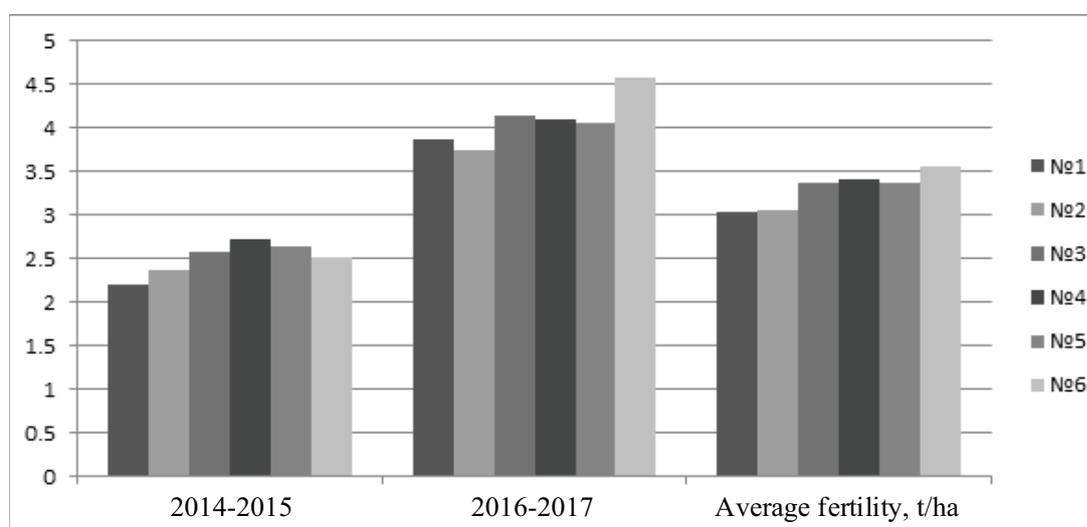


Figure 1: The yield of winter wheat, depending on the fertilizer used, 2014–2017.

TABLE 1: Economic efficiency of winter wheat production depending on the applied fertilizers (average for 2014–2017).

Nº	Indicators	Nº 1	Nº 2	Nº 3	Nº 4	Nº 5	Nº 6
1	Productivity when applying fertilizers, t/ha	3,04	3,06	3,36	3,41	3,36	3,55
2	Yield increase due to fertilizers, t/ha	x	0,02	0,32	0,37	0,32	0,51
3	The cost of an additional crop from 1 t, rub	x	200	3200	3700	3200	5100
4	Total cost, rub/ha	500	2991	3526	2037	3773	3878
5	Conditionally net income, rub/ha	x	--2797	--326	1663	--573	1222
6	Payback, %	x	4	57	x	85	x
7	The profitability of the use of fertilizers, %	x	x	x	82	x	76

* The purchase price of 1 ton of products is 10,000 thousand rubles.

An agrotechnical technique is considered economically viable if the proceeds from the sale of the grown products not only reimburse the costs of production, but also provide a net income. Thus, in our studies, 4 and 6 variants of the experiment are economically profitable when cultivating winter wheat.

4. Discussion

The economic efficiency of the fertilizers used was determined by the cost of increasing the crop and the cost of obtaining it.

Analysis of economic efficiency showed that when sowing nitrogen fertilizer, urea encapsulated by Si technology (30 kg/ha a.v.) received the highest profitability of 81.68 %. Received conditionally net income in this embodiment amounted to 1663.4 rubles/ha. In the sixth version of the experiment (urea encapsulated according to the "Si" technology (60 kg/ha a.a.) + KCl (30 kg/ha a.a.) + P₂O₅ (40 kg/ha a.a.)) profitability -- 76, 0 %. Obtained conditionally net income in this embodiment amounted to 1222 rub/ha. In other versions of the experiment, no profit was obtained at such costs. There turn on fertilizer use ranged from 4 to 85 %.

5. Conclusion

In the conditions of the northern forest-steppe of the Tyumen region, in different weather conditions, a positive effect of encapsulated fertilizers (urea encapsulated by "Si" technology) on the productivity of winter wheat was established. According to calculations on economic efficiency, the fourth option was the most appropriate option -- encapsulated carbamide according to the "Si" technology (30 kg/ha a.a.) with a yield of 3.41 t/ha, the profitability of which was 81.68 %.

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Conflict of Interest

The authors have no conflict of interest.

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