# Complex water-soluble microelements fertilizer effectiveness on grain yields

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**Abstract.** Microelement fertilizers (boron, molybdenum, copper, zinc, etc.) play an important role in modern crop production technologies to increase yields and product quality, along with macro fertilizers (nitrogen, phosphorus, potassium). Microelements are needed by plants in very small quantities - their content is one thousandth of a percent of the plant mass. However, each of them has a strictly defined function in metabolism and plant nutrition and cannot be replaced by any other element. Microelements are part of a large number of enzymes. Due to redox processes, enzymes regulate plant respiration, under their influence the chlorophyll content increases, photosynthesis improves, assimilative activity of plants increases. Microelements improve plant metabolism, eliminate functional disorders, activate physiological and biochemical processes. Under the action of microelements, the resistance of plants to fungal and bacterial diseases, to sudden changes in temperature and soil moisture, to winter conditions increases. The supply of microelements to plants is determined by the level of their presence in the soil. The purpose of the research - to determine the effectiveness of different types of application (seed treatment, crop treatment) of the complex water-soluble fertilizer with microelements Novofert on winter wheat crops, in the conditions of grey forest soils of the agricultural complex "Rus", Rylsky district, Kursk oblast.

## 1 Introduction

Microelements cannot be replaced by other substances, and their deficiency must necessarily be compensated taking into account the form in which they will be in the soil. Plants can use microelements only in the water-soluble (mobile) form, and the immobile form can be used by the plant after complex biochemical processes involving humic acids of the soil. In most cases these processes are very slow. Microelements take the most active part in many life processes occurring in plants at the molecular level. Acting through the enzyme system or directly binding to plant biopolymers, microelements can stimulate or inhibit the processes of growth, development and reproductive function of plants [1,2,3].

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## 2 Justification of research objectives

Arable soils of farms in Kursk region have different degrees of microelement supply. The main source of microelements entering the soil are soil-forming rocks. Peculiarities of parent rocks and soil cover determine provincial peculiarities of microelement distribution on the territory of Kursk region [4, 5, 6, 7].

Table 2. Gross content of microelements in the main soil-forming rocks of Ukraine.

Soil-forming rocks Content of microelements, mg/kg

In the first agro-soil district of the region (area of gray forest soils) the content of most microelements is lower than in the second agro-soil district - area of chernozem soils (Table 1).

**Table 1** - Content of microelements in soils of Kursk region, mg/kg

| Agro-soil districts of Kursk oblast | Microelementcontent, mg/kg | | | |
|---|---|---|---|---|
| | B | Z n | Cu | Mn |
| 1. Area of gray-forest soils | 0.28-0.57 | 0.4-2.5 | 0.04-0.20 | 3.2-21.0 |
| 2. Areasofchernozemsoils | -- | 0.5-5.2 | 0.10-0.52 | 5.4-22.0 |

The general regularity in the distribution of microelements in the soil cover of Kursk region is an increase in their content from the soils of north-western areas (1st agro-soil district) to the soils of south-eastern areas (2nd agro-soil district).

According to the data of soil surveys of the 1st agro-soil district of Kursk region (no systematic survey of soils of the 2nd agro-soil district was conducted), 38.7% or 229722 ha of 593445 ha of arable land have low (0-0.33 mg/kg), 61.27% or 363542 ha - average (0.34-0.70 mg/kg) and only 0.03% - high (more than 0.70 mg/kg) level of content of mobile form of boron. That is, in terms of mobile boron content the soils of Kursk region are low-supplied with this microelement.

The area of soils with low level of content of mobile forms of copper (0-0.20 mg/kg) is 58.1% of the surveyed area of arable land, average (0.21-0.50 mg/kg) - 40.5% and high (more than 0.50 mg/kg) - 1.4%. That is, by the content of mobile forms of copper the soils of Kursk region are low in this microelement [8,9,10,11].

The area of soils with low content of mobile forms of zinc (0-2 mg/kg) is 97.3% of the surveyed area of arable land, average (21-0.5 mg/kg) 1.2% and high (more than 5.0 mg/kg) -1.5%. Manganese content in soils of Kursk region varies from 7 to 20 mg/kg and gradually increases in the direction from south to north, reaching the highest values in gray forest soils. The area of soils with low content of active forms of manganese (0-10 mg/kg) is 87.4% of the surveyed area of arable land, average (10-20 mg/kg) 12.2% and high (more than 20 mg/kg) - 0.4%.

Analysis of the content of the main microelements in the soils of Kursk region showed that they have low provision with boron, copper, zinc, manganese. The content of microelements in soils of Kursk region gradually increases in the direction from north to south, reaching the highest values in typical chernozems (2 agro-soil district).

Gray forest soils of all subtypes with light granulometric composition and low humus content are least provided with mobile forms of microelements (1 agro-soil district).

In this regard, in each farm of the region it is necessary to conduct agrochemical survey and determine the content of active forms of microelements in the soil. This will allow to identify areas with insufficient content of certain elements and, depending on cultivated crops, to order compositions of microfertilizers.

Having provided the region's agriculture with the necessary assortment and quantity of microfertilizers, it is possible to find the most correct scientifically-based, optimal solutions

for balanced complex nutrition of agricultural crops and on this basis to increase their yield and quality of products [12,13,14,15].

## 3 Results

In order to implement the set goal in agricultural complex "Rus" of Rylsky district, an experiment was laid to study the effectiveness of using complex water-soluble fertilizer with microelements Novofert on winter wheat crops. The research was conducted in crop rotation with the following crop rotation: 1. Clean fallow 2. Winter wheat 3. Sugar beet 4. Spring wheat, spring barley.

**Table 2.** Scheme of field experiment and content of variants

| Seedtreatment | Seedtreatment | |
|---|---|---|
| | tillering | inthetubingphase |
| 1. Control (Lamador 0.2 l/t) | Kalibr (40 g/ha) | *Tilt*(0.7 l/ha) |
| *2*.Novofert 20-20-20 MgO + ME (100 g/t)+Lamador (0.2 l/t). | Kalibr (40 g/ha) | *Tilt*(0.7 l/ha) |
| *3*.Novofert 20-20-20-20 MgO + ME (100 g/t)+Lamador (0.2 l/t) +Novofert 20-20-20-20 MgO+ME, crop treatment (fall) in tillering phase. (3 kg/ha) | Kalibr (40 g/ha) | *Tilt*(0.7 l/ha) |
| *4*.Novofert 20-20-20 MgO + ME (100 g/t)+Lamador (0.2 l/t). | Novofert 20-20-20-20 MgO +ME crop treatment (spring) at tillering phase (3 kg/ha) + Kalibr (40 g/ha) | *Tilt*(0.7 l/ha) |
| *5*.Novofert 20-20-20-20 MgO + ME (100 g/t)+Lamador (0.2 l/t) +Novofert 20-20-20-20 MgO+ME, crop treatment (fall) in tillering phase. (3 kg/ha) | Novofert 20-20-20-20 MgO +ME crop treatment (spring) at tillering phase (3 kg/ha) + Kalibr (40 g/ha) | Novofert NPK 3.5-18-33.5 + O.5 B+ME (3 kg/ha); treatment of crops in the tube emergence phase |

Novofert is a water-soluble, complex (nitrogen-phosphorus-potassium) physiologically balanced fertilizer containing meso- (magnesium, calcium, sulfur) and microelements (copper, iron, zinc, manganese) in chelate form, as well as boron, molybdenum in mineral form. Novofert is an inducer of plant immunity, has adaptogenic properties, promotes anti-stress resistance of plants to unfavorable environmental conditions (drought, frost, etc.), has high chemical purity and solubility, increases yield and quality of products. The preparation is intended for seed treatment, foliar treatment of plants and can be used practically at all stages of the vegetation period (from seed treatment to additional fertilization after the stress suffered by plants). Novofert fertilizers are compatible with most pesticides. Effect of Novofert complex water-soluble fertilizer with microelements on yield and grain quality of winter wheat. Higher indicators of yield structure and good phytosanitary condition of crops in the variants with the use of complex water-soluble fertilizer with microelements Novofert provided higher yield of winter wheat (Table 3).Seed treatment with complex water-soluble fertilizer with microelements Novofert at a dose of 100 g/t contributed to an increase in winter wheat yield by 3.0 c/ha at NSR05 -1.4-1.6 c/ha. Seed treatment with Novofert at a dose of 100 g/t) and fall fertilization of winter wheat crops at a dose of 3 kg/ha increased yield by 13.4 c/ha.

**Table 3.** Effect of Novofert complex water-soluble fertilizer with microelements on winter wheat yield, 2020 - 2022.

| Options | Yield, c/ha | | | 3-year average | Overmeasure to control, c/ha |
|---|---|---|---|---|---|
| | 2010 | 2011 | 2012 | | |
| 1. Control | 26.4 | 39.5 | 40.9 | 35.6 | - |
| *2.*Novofert (100 g/t) seed treatment | 28.6 | 42.8 | 44.4 | 38.6 | 3.0 |
| *3.*Novofert (100 g/t) seed treatment + Novofert (3 kg/ha) seed treatment (fall) in tillering phase | 36.4 | 54.3 | 56.3 | 49.0 | 13.4 |
| *4.*Novofert (100 g/t) seed treatment + Novofert (3kg/ha) crop treatment (spring) in tillering phase. | 33.5 | 49.8 | 51.7 | 45.0 | 9.4 |
| *5.*Novofert (100 g/t) seed treatment+Novofert (3 kg/ha) seed treatment (autumn) in tillering phase + Novofert (3 kg/ha) seed treatment (spring) in tillering phase+ Novofert (3 kg/ha); seed treatment in the tube emergence phase | 37.2 | 55.7 | 57.7 | 50.2 | 14.6 |
| NWR05 | 0.9 | 0.7 | 1.0 | | |

The efficiency of spring fertilization of winter wheat crops (Novofert at a dose of 3 kg/ha) on the same background of seed treatment (Novofert at a dose of 100 g/t) slightly decreased and amounted to 9.4 c/ha.

The highest yield of winter wheat in all years of research was obtained in the variant with seed treatment (Novofert at a dose of 100 g/t) and three times treatment of crops (in autumn in the phase of tillering Novofert at a dose of 3 kg/ha + in spring in the phase of tillering Novofert at a dose of 3 kg/ha + in the phase of emergence into the tube Novofert at a dose of 3 kg/ha) - 50.2 kg/ha with yield in the control variant equal to 35.6 kg/ha.

The results of the analyses indicate an insignificant effect of complex water-soluble fertilizers with microelements Novofert in seed treatment and autumn treatment of crops in the tillering phase on the content of crude gluten in winter wheat grain - 27.7-28.4% with gluten content of 27.5 %in control.

**Table 4.** Effect of complex water-soluble fertilizer with microelements Novofert on crude gluten content in winter wheat grain (2020- 2022)

| Options | Glutencontent, % | | | 3-year average | Overmeasure to control, % |
|---|---|---|---|---|---|
| | 2010 | 2011 | 2012 | | |
| 1. Control | 26.6 | 27.3 | 28.8 | 27.5 | - |
| *2.*Novofert (100 g/t) seed treatment | 26.8 | 27.5 | 28.9 | 27.7 | 0.2 |
| *3.*Novofert (100 g/t) seed treatment + Novofert (3 kg/ha) seed treatment (autumn) in tillering phase | 27.5 | 28.1 | 29.6 | 28.4 | 0.9 |

| | | | | | |
|---|---|---|---|---|---|
| *4.*Novofert (100 g/t) seed treatment + Novofert (3kg/ha) crop treatment (spring) in tillering phase. | 28.2 | 28.8 | 30.4 | 29.1 | 1.6 |
| *5.*Novofert (100 g/t) seed treatment+Novofert (3 kg/ha) seed treatment (autumn) in tillering phase + Novofert (3 kg/ha) seed treatment (spring) in tillering phase+ Novofert (3 kg/ha); seed treatment in the tube emergence phase | 30.4 | 31.1 | 32.8 | 31.4 | 3.9 |

The efficiency of using Novofert in seed treatment and spring treatment of crops in the tillering phase was much higher and amounted to 1.6%. The highest content of crude gluten in winter wheat grain was obtained in the variant with seed treatment and three times treatment of crops (in autumn in the phase of tillering + spring in the phase of tillering + in the phase of tube emergence) - 31.4% or 3.9% higher than in the control.

## 4 Conclusions

As a result of the conducted research the high efficiency of complex water-soluble fertilizer with microelements Novofert on winter wheat crops at different methods of its application was established, seed treatment with Novofert (20-20-20 MgO+ME) at a dose of 100 g/t increased winter wheat yield by 3.0 c/ha or 8.4% and practically had no effect on the content of crude gluten in the grain.

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