Influence of root feeding fertilizers on yield and quality of winter wheat grain in conditions of the central zone of Orenburg region

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Abstract. Agriculture continues to move forward confidently. Before our eyes, the agrarian industry is reviving, becoming stronger, taking a strong position at the forefront of the Russian economy. The most important achievement of 2017 was a record grain harvest of 130 million tons. This result was achieved not only by increasing the cultivated areas, which increased by 620 thousand hectares in 2017, but also thanks to the record yield, which amounted to 28 kg / ha, which is 80% higher than in 2000. The maximum harvest in the history of new and Soviet Russia, which will ensure our country a strong leadership in the world wheat market. Russian agriculture remains a driver of the country's economic development. For the second year in a row, we get a record harvest of not only grain, but also sugar beets and sunflowers, the production of soybeans, rapeseed and greenhouse vegetables is growing. In the new season, grain exports will reach 45 million tons, including more than 35 million tons of wheat. Russia is expanding the geography of its presence, having mastered new directions for the supply of agricultural products. At the end of 10 months of 2017, grain exports increased by 22% compared to the same period in 2016 and amounted to 32 million tons. During the same time, the export of Russian wheat exceeded 24 million tons, which is 23% more than a year earlier. In Russia, over 17 years, the volume of grain production increased 2 times, sugar beet and sunflower - 2-3 times, soybeans and rapeseed - 10, greenhouse vegetables - 1.8, poultry meat - 6, pork - 2. Fish - 2 times. Greenhouse vegetable growing and horticulture are developing intensively. Progress is being made in the development of animal husbandry and aquaculture. The dairy industry is undergoing a significant transformation, and production volumes on farms are growing. These are new growth points for the agro-industrial complex. Thanks to the achievements of domestic scientists, grain production of agricultural crops can be increased due to many factors. One of the factors is foliar dressing with liquid micro- and macro-fertilizers. Therefore,
we studied various combinations of liquid micro-, macrofertilizers, as well as the biological product Albit, in order to identify the best option and recommend it for production.

1. Introduction

Location and climatic conditions of the area

The territory of the educational and experimental field of the OGAU is located in the southeastern part of the Orenburg Cis-Urals and is part of the Orenburg administrative region. It is a wavy-rugged plain lying at an altitude of 200 to 400 m above sea level, dissected by erosional valleys and ravines. Almost in the middle of the Southern Urals there is the General Syrt Upland, the watershed ridges and ridges of which alternate with vast leveled terraces of large rivers. [1-6].

The Orenburg region has a continental climate. One of the indicators of the continentality of the climate is large annual temperature amplitude (the difference between the average temperatures of the warmest and coldest months). For Orenburg, this amplitude, according to long-term average data, is 36 °C. The absolute amplitude (the difference between the absolute maximum and the absolute minimum) reaches 87 °C.

The average long-term temperature of the warmest month (July) is 20.9°C, and the coldest month (January) is 14.9°C. The warm period (the average daily temperature is above 0°C) accounts for 206 days, the cold - 159 days. The beginning of the spring growing season (the transition of the average daily temperature through 5°C) is observed on April 17-19, the end of the autumn growing season - October 10-13. The beginning of an active growing season (the transition of the average daily temperature through 10°C) occurs in the spring from April 30 to May 2, in the fall - from September 22 to 25. The sum of positive temperatures above 5°C is 2600-2800°C, the sum of temperatures above 10°C is 2400-2600°C.

The average annual precipitation is 367 mm with sharp fluctuations in one direction or another, the value of the GTC is 0.6-0.8. Moreover, during the warm period 60% of precipitation falls out of their annual amount.

The main source of water supply for plants throughout the summer period is moisture accumulated by spring in the root layer of the soil. Therefore, in the zone of insufficient moisture, the spring moisture reserves largely determine the conditions for the formation of the crop. [12-18]

Meteorological conditions of the research period

In 2018, during the period of sowing - seedlings, unfavorable weather conditions developed for winter wheat, because in the third decade of August and the first decade of September, only 0.8 and 0.1 mm of precipitation fell, respectively. In the second and third decades of September there is already 7.9 and 7.4 mm of precipitation. Closer to the end of the autumn growing season of wheat, in the first decade of October, there was much more precipitation of 18.4 mm. Then, until 2019, there was a non-significant amount of precipitation. Only in the third decade of November there was a lot of precipitation of 23.5 mm.

The temperature regime was optimal for winter wheat. Until 2019, the negative air temperature varied from -6.8 to -14.5°C.

In 2019, from April to June, climatic conditions were almost identical to those for the same period in 2018 in terms of air temperature and precipitation. But in July 2019, a large amount of precipitation fell, which adversely affected the process of grain ripening. So, in the first, second and third decades of July, 62.3, 28.2 and 14.5 mm of precipitation fell, respectively, while the average long-term norm for decades was 13 mm.

GTK in 2019 amounted to 0.68 units. and characterized the state of the weather as mild drought.

Experiment scheme, observation and research technique

The work was carried out at the Department of Agrotechnology, Botany and Plant Breeding in 2018-2019 at the educational and experimental field of the OSAU. A one-factor experiment was established with winter wheat of the Kolos Orenburg variety. Experience scheme:
The crops were fed in the heading phase with liquid nitrogen fertilizer Carb-N-Humik at a rate of 2.0 l/ha;
2. The crops were fed in the heading phase with liquid nitrogen fertilizer Carb-N-Humik at the rate of 2.0 l/ha + biological product Albit 40g/ha;
3. The crops were fed in the heading phase with liquid nitrogen fertilizer Carb-N-Humik at the rate of 0.5 l/ha + biological product Albit 40g/ha + liquid fertilizer Amino Zn at the rate of 0.5 l/ha;
4. For the control was adopted the option of crops, which were treated with water.

The experiment was carried out in three replicates, the accounting plot area is 40 sq.m.
The soil of the experimental site is southern chernozem, medium-thick, calcareous, heavy-loamy with a humus content of 4.4%, mobile phosphorus - 4.5%, nitrate nitrogen - 1.35, exchangeable potassium - 35 mg per 100 g of soil. The reaction of the soil solution is slightly alkaline (pH = 7.8).

2. Materials and Methods
1. Weight seeding rates were calculated taking into account the sowing qualities of seeds taken from the certificate of seed condition. The index of the numerical seeding rate was adopted as 5.0 million germinating seeds per hectare. Calculation of the seeding rate is carried out according to the formula:

\[
HB = A \times M_{1000} \times 100
\]

\[
PG
\]

\[
HB - \text{weight rate of seeding of seeds, kg/ha;}
\]
\[
A \text{ is the index of the numerical norm, million germinating seeds per hectare;}
\]
\[
M_{1000} - \text{weight of 1000 grains, grams;}
\]
\[
PG - \text{sowing capacity, \%}.
\]

\[
PG = H \times V, \text{ where:}
\]
\[
100
\]
\[
H - \text{seed purity,}\%;
\]
\[
B - \text{seed germination,}\%.
\]

Seeding rate at 5.0 million/ha - 225 kg/ha.

2. Field germination was calculated by dividing the number of emerging plants by 1 sq. m on the number of sown germinating seeds and expressed as a percentage.

3. Before harvesting by counting and dividing the number of preserved plants by 1 sq. m, the number of emerging seedlings was determined by the safety of plants.

4. The biological yield and the structure of the yield was determined by selection, counting and analysis of plants from 1 sq. M. m taken before cleaning. [21-23].

5. Determination of gluten, its quantity and quality.

6. Determination of natural weight. [6-8]

7. Economic efficiency was calculated on the basis of technological maps.

8. Mathematical processing of the results was carried out by the method of analysis of variance according to B.A. Dospekhov on a PC.

Agrotechnics of experience. Variety
The predecessor of winter wheat was pure fallow.

After harvesting the barley, the main cultivation was carried out to a depth of 25-27 cm. In the spring, when the soil was physically ripe, the moisture was closed in two tracks with harrows BZSS - 1.0.

Harrowing prevents the formation of a crust on the surface of the soil, and therefore reduces the evaporation of moisture from the soil.

When taking care of the steam, three cultivations were carried out with a KPS-4 cultivator to a depth of 5 - 6 cm, in order to destroy weeds.

Before sowing, winter wheat seeds were treated with a tank mixture: fungicide Triton at a rate of 0.5 l/t and insectoacaricide Kaiser at a rate of 0.5 l/t.

Sowing was carried out on August 30, 2018 with a seeding rate of 5.0 million viable seeds per hectare to a depth of 5-6 cm using the AUP-18.05 seeder. In the spring, on the physically ripe soil, the sowing of winter wheat was drilled.
During the earing phase of winter wheat, on June 15, 2019, fertilizing was carried out according to the experiment scheme.

Harvesting was carried out with a Terrion 2010 combine in the phase of full ripeness of grain on July 30, but first we collected sheaves from all variants of the experiment.

Direct combining is effective when harvesting at the beginning of full ripeness (the grain is hard, threshes well), while harvesting the maximum yield. [20-22]

Description of the variety

Ear of the Orenburg region. Pedigree: Ind. O. from a hybrid population created with the participation of varieties Donskaya Ostistaya, Albudum 114, Mironovskaya 808, Bogarnaya 56, Dne-Provskaya 521, etc.

Included in the State Register for the Ural (9) region. Recommended for cultivation in the Orenburg region.

A kind of lutescens. The bush is intermediate. The plant is of medium length - long. The wax coating on the upper internodes, ear and sheath of the flag leaf is very weak - weak. The spike is cylindrical, loose - of medium density, white, of medium length. The osteiform processes at the end of the spike are short. The pubescence of the apical segment of the spike axis on the convex side is absent or very weak. Shoulder straight - raised, medium width. The tooth is straight, very short. The lower spikelet has very weak pubescence on the inner side. Colored caryopsis. The mass of 1000 grains is 33-42 g.

The average yield in the Orenburg region is 14.8 c/ha. In the Western steppe and Central steppe zones of the Orenburg region, the increase to the standard Saratovskaya 90 was 1.6 c/ha with a yield of 25.4 c/ha. The maximum yield of 53.0 c / ha was obtained in the Republic of Bashkortostan in 2011.

Mid-season. The growing season is 289-326 days. Ripens 1-3 days earlier than standards Bezenchuskaya 380, Saratovskaya 90. Increased winter hardness, at the level of Saratovskaya 90 variety. Plant height 72-94 cm. Lodging resistance is at the level, drought resistance is slightly higher than Orenburgskaya 105, Saratovskaya 90 varieties.

Baking quality at the level of a good filler.

In the field, brown rust and powdery mildew were weakly affected, as well as the Saratovskaya 90 standard. In the region of tolerance, the defeat of hard smut was not observed. [11-24]

3. Results and Discussion

Field germination, safety and overall survival of plants

Germination is understood as the number of seeds that have formed normally developed sprouts, expressed as a percentage. [20-24]

In our studies, the field germination of winter wheat was high and amounted to 96.0%.

Very few plants survived for harvesting, an average of 158 plants/m² according to the experience. The studied foliar feeding has an ambiguous effect on the number of preserved plants for harvesting. Thus, on the variants Carb-N-Humik and Carb-N-Humik + Albit + Amino Zn, the number of plants increased by 2 plants m², and on the variant Carb-N-Humik + Albit, on the contrary, decreased by 3 plant/m² relative to the reference case.

| Fertilizing in the heading phase | Number of seeded. viable seeds pcs./1 sq. m | Number has risen. plants per 1 sq. m | Number saved plant for harvesting pcs/per 1 sq. m | Field germination, % | Plant viability, % | Percent alive, % |
|--------------------------------|---------------------------------------------|-----------------------------------|-----------------------------------------------|---------------------|-------------------|------------------|
| Control                        | 500                                         | 480                               | 158                                          | 96,0                | 32,9              | 31,6             |
| Carb-N-Humik                   | 500                                         | 480                               | 160                                          | 96,0                | 33,3              | 32,0             |
In this regard, the safety and overall survival of plants was the highest on the variants Carb-N-Humik and Carb-N-Humik + Albit + Amino Zn, and the least on the variant Carb-N-Humik + Albit.

General and productive tillering

Distinguish between general and productive bushiness. The total bushiness is understood as the average number of stems per plant, regardless of the degree of development of the shoots. Productive bushiness is the average number of normally developed grain-producing stems per plant. [3-9].

We found that the productive tillering of winter wheat on average in the experiment was not small and amounted to 1.54 units. In the context of the studied variants of the experiment, the highest productive tillering was observed in the control variant and on the Carb-N-Humik + Albit variant, where it was 1.56 and 1.57 units, respectively (Table 2). The smallest productive bushiness is 1.49 units marked on the variant Carb-N-Humik + Albit + Amino Zn. It should be noted that the number of productive stems per unit area according to the variants of the experiment was practically at the same level and varied from 243 to 246 pcs/m², with the exception of the variant Carb-N-Humik + Albit + Amino Zn, where it was 239 pcs/m².

| Fertilizing in the heading phase | The number of surviving plants for harvesting, pcs/m² | The total number of stems pcs/m² | Number productive of those stems, pcs/m² | General bushiness | Productive bushiness |
|---------------------------------|---------------------------------|-------------------------------|------------------------------------------|------------------|-----------------------|
| Control                         | 158                             | 272                           | 246                                      | 1,72             | 1,56                  |
| Carb-N-Humik                   | 160                             | 272                           | 244                                      | 1,70             | 1,53                  |
| Carb-N-Humik+ Albit            | 155                             | 270                           | 243                                      | 1,74             | 1,57                  |
| Carb-N-Humik+ Albit+ Amino Zn  | 160                             | 266                           | 239                                      | 1,66             | 1,49                  |

The total tillering in the context of the experimental variants changed as well as the productive tillering.

Crop structure and yield of winter wheat

In 2019, winter wheat formed a biological yield typical for the arid Orenburg region. On average, for the studied variants of the experiment, it was 26.0 c/ha.
Foliar dressing in the heading phase helped to increase the yield of winter wheat. For example, the biological yield on the variant Carb-N-Humik + Albit + Amino Zn increased by 1.0 c/ha relative to the control variant and amounted to 26.0 c/ha (Table 3).

The highest biological yield of 26.5 c/ha was obtained on the variant where the feeding was made with the fertilizer Carb-N-Humik + Albit. The highest yield was obtained due to the largest mass of 1000 grains, 38.9 gr. Also noteworthy is the Carb-N-Humik variant, where the biological yield was 26.3 c/ha.

The smallest biological yield is 25.0 c/ha against the control background, which is associated primarily with the smallest number of grains in an ear of 27 pcs. and a mass of 1000 grains of 37.6 g.

Economic productivity in a similar way, depending on the studied options.

We found that top dressing contributed to an increase in the length of the spike, the number of grains in the spike, and the mass of grain from one spike relative to the control. For example, on the Carb-N-Humik + Albit + Amino Zn variant, the spike length increased to 7.5 cm, the number of grains per spike - up to 28, and the grain weight per spike - up to 1.09 g.

### Table 3. Harvest structure and yield of winter wheat in 2019

| Feeding in the heading phase | Number of product. stems, pcs/m² | Plant height, cm | Head length, cm | Number of spikelets per head | Number of grains per head | Grain weight per head, g | Weight of 1000 grains, g | Biological productivity, c/ha | Economic yield, c/ha |
|-----------------------------|----------------------------------|------------------|-----------------|-------------------------------|--------------------------|---------------------------|-------------------------|---------------------------|----------------------|
| Control                     | 246                              | 68               | 7,0             | 14                            | 27                       | 1,02                      | 37,6                    | 25,0                      | 21,8                 |
| Carb-N-Humik                | 244                              | 67               | 7,3             | 15                            | 28                       | 1,08                      | 38,5                    | 26,3                      | 23,3                 |
| Carb-N-Humik + Albit        | 243                              | 69               | 7,4             | 16                            | 28                       | 1,09                      | 38,9                    | 26,5                      | 23,4                 |
| Carb-N-Humik + Aльбит + Amino Zn | 239                              | 70               | 7,5             | 16                            | 28                       | 1,09                      | 38,8                    | 26,0                      | 23,0                 |

**НСР05 = 1.5 c/ha**

Quality indicators of grain

The main indicators of the quality of wheat grain are divided into three groups: physical (nature, weight of 1000 grains, vitreousness, sedimentation, falling number, as well as color, smell, admixture of spoiled grains, etc.), chemical (protein, gluten, starch, etc.), technological and baking (flour yield, flour strength, volumetric bread yield, etc.). [10-16].

The content of raw gluten on average in the experience was low and amounted to 23.7%. Foliar dressing during the earing phase of wheat did not affect the amount of gluten in the grain. According to the variants of the experiment, it varied from 23.6 to 23.8%. In all studied variants, gluten of the first quality group was formed (Table 4).
Table 4. Qualitative indicators of winter wheat grain in 2019

| Top dressing in the heading phase | Raw gluten amount, % | Raw gluten quality group | Nature, g/l |
|---------------------------------|----------------------|--------------------------|-------------|
| Control                         | 23,8                 | I                        | 756         |
| Carb-N-Humik                    | 23,6                 | I                        | 763         |
| Carb-N-Humik + Albit            | 23,8                 | I                        | 766         |
| Carb-N-Humik + Альбит + Amino Zn| 23,6                 | I                        | 762         |

In all variants of the experiment, the bulk grain mass met the requirements of high-quality wheat and was higher than 750 g/l.

Foliar dressing with the studied liquid fertilizers contributed to an increase in the full-scale grain weight. This increase varied from 6 to 10 g/L.

In all variants of the experiment, the grain belonged to the third class.

4. Conclusions

Scientific research carried out in 2019 in the conditions of the educational and experimental farm of the Orenburg State Agrarian University made it possible to draw the following preliminary conclusions and recommendations.

1. Field germination of winter wheat was high and amounted to 96.0%. Foliar dressing with fertilizers on the Carb-N-Humik and Carb-N-Humik + Albit + Amino Zn variants increased the number of plants to harvest by 2 pcs/m², and on the Carb-N-Humik + Albit variant, on the contrary, decreased by 3 pcs/m² relative to the control variant.

2. The highest productive tillering was observed in the control variant and on the Carb-N-Humik + Albit variant, where it was 1.56 and 1.57 units, respectively. The smallest productive bushiness is 1.49 units. marked on the variant Carb-N-Humik + Albit + Amino Zn.

4. The studied foliar dressing in the heading phase increased the yield of winter wheat by 1.2 - 1.6 c/ha relative to the control variant. Top dressing also contributed to an increase in the structural parameters of plants.

5. The content of wet gluten on average in the experience was low and amounted to 23.7%. Foliar dressing during the earing phase of wheat did not affect the amount of gluten in the grain. According to the variants of the experiment, it varied from 23.6 to 23.8%. The quality of gluten in all variants was the first group. The natural weight of winter wheat grain corresponded to high quality wheat and was above 750 g/l.

6. The largest profit is 1,641,744.46 rubles, the profitability level of 178.2% was provided by the option with feeding with liquid nitrogen fertilizer Carb-N-Humik.

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