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Optimization Of Mineral Nutrition Of Winter Wheat In Leached Chernozem Conditions

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ABSTRACT

The article presents the results of studying the methods of liquid complex microfertilizers application (Micromak, Microel) and mineral fertilizers during the cultivation of winter wheat on leached chernozem. The methods and rates of fertilizer application have been determined, which ensure an increase in yield, vitreous content and protein content in the grain.

Keywords: microfertilizers, winter wheat, microelements, leached chernozem

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INTRODUCTION

In recent years, interest in microelements has increased in connection with an in-depth study of plant nutrition issues that have made it possible to discover the important physiological role of many chemical elements. The growth of production of highly concentrated fertilizers, the use of the best varieties and the introduction of mineral fertilizers in increased doses increases the deficit of trace elements in soils. The increase in crop yields against the backdrop of a high level of chemicalization of agricultural production contributes to the increase in the removal of chemical elements by plants and the depletion of soils, both macro- and microelements. This also dictates the need for widespread widespread use of microfertilizers in agriculture.

Plants absorb trace elements in small amounts, but they are necessary for the normal flow of a number of important processes, in particular for nitrogen metabolism, correction of enzyme activity and enhancement of photosynthesis. For example, boron, zinc, molybdenum promote the growth of photosynthesis activity. It is proved that trace elements have a positive effect on the ability of plants to withstand adverse factors during their cultivation. They improve cold, heat, salt, drought resistance, as well as resistance to lodging and fungal diseases.

MATERIALS AND METHODS

The place of conducting field research is the land use of the experimental agricultural station of the Stavropol State Agrarian University. The experimental site is located within the Stavropol Upland, at an altitude of 500-550 m above sea level. The relief of the territory is a slightly wavy plain, the mesorelief is a northern gentle slope with a steepness of about 1°.

The soil of the experimental site is chernozem leached powerful low-humus heavy loamy. At present, leached chernozem is characterized by average values of humus content (5.1-5.4%), nitrification ability (16-30 mg / kg), mobile phosphorus content (20-25 mg / kg by Machigin) and medium - potassium (220-270 mg / kg). The reaction of the soil solution in the upper soil horizons is neutral, the pH is within the range of 6.1-6.8. The content of total nitrogen is 0.25%, total phosphorus is 0.13-0.15%, total potassium is 2.3%.

The content of mobile forms of trace elements (according to 2009) is as follows: manganese - average (16 mg / kg), zinc - low (0.7 mg / kg), boron - high (2.87 mg / kg).

According to the average long-term data, 550-650 mm fall out in the test area per year, incl. during the active vegetation period of plants 450-470 mm of precipitation. The sum of the effective temperatures during the active vegetation period varies from 3000 to 3200 ° C. The hydrothermal coefficient varies within the limits of 1.1-1.3, which, according to the agroclimatic regionalization scheme of the Stavropol Territory, allows to locate the place of research at the border of the moderately moist and the zone of unstable hydration.

The scheme of the 3-factor experiment, presented in Table 1, is constructed by the method of split plots, the repetition is 3-fold, the plot area is 50 m^2. The width of the plot is 8 m, the length is 6.25 m. The total plot area is 50 m^2. Winter wheat was used as a precursor in the years of the experiments.

The subject of the research were the methods of application of liquid complex microfertilizers (Micromak, Microel) and mineral fertilizers. In the experiment on 3 feed backgrounds (control, $N_{30}P_{30}K_{30}$, $N_{7,5}P_{30}K_{30}$ - pre-seed method), the effect of various doses (0, 30, 60 kg / ha, after-sowing method) of early spring nitrogen fertilization, as well as separate application of microfertilizers on the productivity of winter wheat.

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Table 1: Schematic location of the plots in the experiment

Methods of application					
mineral fertilizers		Microfertilizers			
Pre-sowing	Additional fertilizing	Control (without treatment)	Seeds treatment *MM	Double spraying **ME(2 t.)	Seeds treatment + double spraying MM + ME (2 t.)
$N_0P_0K_0$-	0	1	2	3	4
	N30	5	6	7	8
	N60	9	10	11	12
$N_{30}P_{30}K_{30}$	0	13	14	15	16
	N30	17	18	19	20
	N60	21	22	23	24
$N_{7,5}P_{30}K_{30}$	0	25	26	27	28
	N30	29	30	31	32
	N60	33	34	35	36

Here and below:

**MM - treatment of seeds by preparation "Micromak" in a dose of 2 l / t.*

***ME (2 t.) - non-root feeding by preparation "Microel" in a dose of 0.2 l / ha 2 times: 1-in the tillering phase, 2 - at the end of the tillering phase*

Ammonium nitrate, ammophos, nitroammophosco, potassium chloride were used as a pre-sowing fertilizer applied for presowing cultivation. As a post-sowing fertilizer introduced early in the spring into the tillering phase, ammonium nitrate was used. The use of microelements was combined with the main agrotechnical methods: treatment with "Micromakom" - with seed dressing, 2-fold non-root treatment with "Microel" (tillering phase and at the end of the tube exit phase) - using pesticides.

The studied preparations are highly effective complex microelement fertilizers, intended for preseeding seed treatment and non-root crop processing of crops, respectively (Table 2).

Table 2: The content of micro- and macroelements in the studied complex microfertilizers,%

Preparation	Microelement									Macroelement		
	Cu	Zn	B	Mn	Fe	Mo	Co	V	Mg	N	P	K
Micromak	3,6	3,3	0,38	0,32	0,45	0,58	0,23	0,08	1,4	4,8	0,9	7,0
Microel	0,64	1,36	0,15	0,29	0,40	0,44	0,084	-	0,89	0,49	-	0,06

RESULTS AND DISCUSSION

Three-year data indicate that fertilizers studied before fertilization (factor A) and nitrogen fertilizers used in early spring fertilizing (factor B) significantly increased the yield of winter wheat relative to the natural agrochemical background (Table 3).

Analysis of the results of the experiment under study indicates a significant role of the main fertilizer (A) in the formation of crop yield, the increment, depending on the background of the feed, was 0.34-0.49 t / ha. When choosing a fertilizer system for winter wheat, located after winter wheat in the zone of unstable moistening on leached chernozem, it is necessary to take into account the effectiveness of various types of fertilizers. Thus, reducing the nitrogen dose to 7.5 kg ai / ha from the full dose of N_{30} with equal amounts of P and K - 30 kg ai / ha, resulted in a significant decrease in productivity by 0.15 t / ha relative to the full dose basic fertilizer $N_{30}P_{30}K_{30}$.

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The maximum grain yield increase (0.49 t / ha) was obtained when $N_{30}P_{30}K_{30}$ was introduced as a background feed, the yield for three years of research was 3.75 t / ha.

Table 3: Influence of methods of applying macro- and microfertilizers on productivity (t / ha) of winter wheat (2015-2017)

Methods of application						A, HCP_{05} = 0,14	B, HCP_{05} = 0,14
macrofertilizers		microfertilizers, C*					
Pre-sowing, A	Additional fertilizing, B	Control	*MM	**ME (2t.)	MM + ME (2t.)		
$N_0P_0K_0$	0	2,87	3,34	3,36	3,46	3,26	3,52
	N30	3,46	3,73	3,66	3,89		3,90
	N60	3,70	3,84	3,77	4,01		4,10
$N_{30}P_{30}K_{30}$	0	3,35	3,84	3,82	3,97	3,75	
	N30	4,03	4,13	4,10	4,28		
	N60	4,29	4,39	4,30	4,55		
$N_{7.5}P_{30}K_{30}$	0	3,10	3,65	3,89	3,74	3,60	
	N30	3,67	3,91	3,86	4,13		
	N60	3,93	4,07	4,07	4,27		
C, HCP_{05} = 0,12		3,60	3,89	3,87	4,03	HCP_{05} = 0,42 S_x = 4,4	

On average, for three years of research on all backgrounds, the increment from pre-sowing application of nitrogen fertilizers was significant and amounted to 0.42-0.58 t / ha. The maximum productivity of winter wheat ensured the use in the early spring fertilizing of ammonium nitrate in a dose of 60 kg ai / ha, depending on the year of research the yield was from 3.52 to 4.78 t / ha.

The use of microfertilizers in the experiment (factor C) as a method for increasing the productivity of winter wheat has a significant and ambiguous effect on crop yields depending on pre-sowing application (factor A), application of nitrogen fertilizing (factor B), and the method of using microfertilizers themselves (factor C).

The difference in yields between the separate use of microfertilizers Mikromak, Mikroel and their joint use significantly in average for three years the increment was 0.06-0.11 t / ha. The best result of the experiment is a joint application of microfertilizers to seed treatment and two-fold application of the microelement for growing winter wheat - 3.79 t / ha, which significantly exceeded not only the background - without microfertilizers, but also variants with separate use of MM and ME. The variant, which provided the maximum level of winter wheat productivity - 4.55 t / ha, is formed on the background of nutrition $N_{30}P_{30}K_{30}$ with the use of 60 kg of nitrogen per hectare in the early spring fertilization with seed treatment before sowing with Mikromak and two spraying of plants with Mekroel.

The studied methods of introducing micro- and macrofertilizers had a significant effect on one of the main indicators of grain quality-the content of raw gluten. The data given in Table 4 show that on average over three years all the investigated microfertilizers increased the gluten content in comparison with the variants without treatment with microelements by 0.6-1.5%. In this case, a significant difference was obtained in the variants with the joint application of microfertilizers.

The content of gluten in the grain with the combined use of microfertilizers was significantly higher than not only the options without micronutrient treatment, but also variants with a separate application of the Micromak preparation (seed treatment) - by 0.9%.

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Table 4: Influence of methods of introducing macro-microfertilizers on the content of raw gluten (%) in the grain of winter wheat (average for 2015-2017)

Methods of application						A, HCP_{05}=0,80	B, HCP_{05}= 0,80
macrofertilizers		microfertilizers , C*					
Pre-sowing, A	Additional fertilizing, B	Control	*MM	** ME (2 t.)	MM+ ME (2 t.)		
$N_0P_0K_0$	0	16,5	16,7	17,1	18,0	21,5	18,5
	N30	21,3	22,7	23,8	24,6		24,1
	N60	23,0	24,1	24,9	25,0		25,2
$N_{30}P_{30}K_{30}$	0	18,1	19,2	19,8	20,3	23,8	
	N30	25,5	25,4	24,7	25,5		
	N60	26,3	27,1	27,0	27,5		
$N_{7,5}P_{30}K_{30}$	0	17,6	18,6	19,3	20,9	22,6	
	N30	24,0	24,4	23,0	24,3		
	N60	24,7	24,0	24,9	24,9		
C, HCP_{05} = 0,90		21,9	22,5	22,7	23,4	HCP_{05} = 2,6 % Sx = 3,7 %	

All studied feeding backgrounds and doses of nitrogen fertilizing also provided a significant increase in the gluten content in the grain of winter wheat in comparison with the natural agrochemical background. At the same time, with an increase in the nitrogen dose both in the main fertilizer (from 7.5 to 30 kg / ha ai) and in top dressing (from 30 to 60 kg / ha ai), the average value of the analyzed indicator increased proportionally compared with the control by 1.1-2.3 and 5.6-6.7%, respectively. In addition, the dosage of N_{60} top dressing as well as the background of $N_{30}P_{30}K_{30}$ significantly exceeded doses of N_{30} and background $N_{7,5}P_{30}K_{30}$, respectively.

The greatest content of gluten (27.5%) was obtained on variants with the joint application of preparations against the background of $N_{30}P_{30}K_{30}$ + N_{60} (in top dressing). It should be noted that on the fertilized backgrounds, when there was a joint application of the analyzed microfertilizers, there was no reliable difference in the gluten content between the variants N_{30} and N_{60} used in top dressing.

CONCLUSIONS

The methods of applying microfertilizers significantly (0,27-0,43 t / ha) increased the productivity of the crop, and the maximum average yield - 4.03 t / ha was obtained on a variant of joint application of Micromak and Microel. The maximum level of productivity of winter wheat is 4.55 t / ha, it is formed against the background of pre-sowing application of $N_{30}P_{30}K_{30}$ and early spring feeding of N_{60} and the joint application of liquid complex microfertilizers Micromak and Microel.

The studied macro- and microfertilizers had a positive effect on the quality indicators of winter wheat grains, but on the average, according to experience, the pre-sowing application of $N_{30}P_{30}K_{30}$, early-spring fertilizing with doses of N_{30} and N_{60}, and the combined use of liquid microfertilizers Micromak and Microel contributed to the production of grade 3 grains. Maximum vitality (55%), gluten content (27.5%) and protein (14.2%) were obtained on variants with combined application of microfertilizers on the background of $N_{30}P_{30}K_{30}$ + N_{60} (in top dressing).

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