CROP PRODUCTION

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THE STRUCTURE OF PRODUCTIVITY OF SPRING WHEAT DEPENDING ON THE VARIETY AND FOLIAR TREATMENT WITH MANGANESE, COPPER AND MOLYBDENUM

Research article

Abstract

The article presents the results of research on the structure of productivity of spring wheat depending on the variety and use of trace elements of manganese, copper, molybdenum and "Ultramag Combi". It was found that the best productivity indicators were formed by the spring wheat variety Yoldyz. The optimal combination of microelements that positively affect the structure of spring wheat productivity has been established. The best indicators of the structure of the spring wheat yield of Tulaykovskaya 10 and Tulaykovskaya 108 varieties were formed when foliar treatment of crops with a paired mixture of copper and molybdenum with nitrogen, and Yoldyz varieties - manganese and copper, as well as manganese and molybdenum with nitrogen. Foliar treatment with a multi-component preparation "Ultramag Combi", as well as separately applied nitrogen in amide form, was less effective.

Keywords: spring wheat, leached Chernozem, variety, manganese, copper, molybdenum, Ultramag Combi, yield, yield structure.

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СТРУКТУРА ПРОДУКТИВНОСТИ ЯРОВОЙ ПШЕНИЦЫ В ЗАВИСИМОСТИ ОТ СОРТА И ВНЕКОРНЕВОЙ ОБРАБОТКИ МАРГАНЦЕМ, МЕДЬЮ И МОЛИБДЕНОМ

Научная статья

Аннотация

В статье приводятся результаты исследований урожайности и структуры продуктивности яровой пшеницы в зависимости от сорта и применения микроудобрительных препаратов марганца, меди, молибдена и ультрамага комби. Было выявлено, что наилучшие показатели продуктивности сформировались у яровой пшеницы сорта Йолдыз. Установлено оптимальное сочетание микроэлементов, положительно влияющих на структуру продуктивности яровой пшеницы. Наилучшие показатели структуры урожая яровой пшеницы сорта Тулайковская 10 и Тулайковская 108 складывались при внекорневой обработке посевов парной смесью меди и молибдена на фоне азота, а сорта Йолдыз – марганца и меди, а также марганца и молибдена на фоне азота. Внекорневая обработка поликомпонентным препаратом Ультрамаг комби, а также отдельно применяемым азотом в амидной форме была менее эффективной.

Ключевые слова: яровая пшеница, чернозем выщелоченный, сорт, марганец, медь, молибден, Ультрамаг комби, урожай, структура урожая.

1. Introduction

Currently, in a changing climate and limited resources, additional opportunities must be found to ensure sustainable crop yields. A key role in ensuring stable yields is played by the use of varieties that have significant productivity potential and are resistant to adverse environmental factors. New varieties of selection of the Tatar research Institute of agriculture that combine high yield with increased adaptive potential, such as the Yoldyz variety, may be of interest [2]. Also of interest is the spring wheat variety Tulaykovskaya 108, as a variety of the Volga steppe agroecological group, which showed an advantage over the best breeding samples of the Samara research Institute of agriculture [11].

Regulation of mineral nutrition can be considered as a means of overcoming stressful conditions for the development of grain crops. Currently, a variety of fertilizers and stimulants based on trace elements (such as Zhuss, Reakom, Kristalon, Aquamix, Tensokokteyl, Mikrovit, Nutrivant, Microel, Micromak, Ultramag Combi, Azosil) have been created. There is information about their effectiveness [4], [5], [8]. The authors provide data on an increase in yield by 13-36 % and an increase in crop quality under the influence of micro-fertilizers [1]. There is also a further development of the production of micro-fertilizers , their modification on the basis of components of amino acids, humic and fulvic acids, polysaccharides, vitamins [9]. However, the use of complex micronutrients in the studies of some scientists [6] has shown mixed effectiveness and requires additional study. Also of interest is the varietal reaction of cereals to the use of multicomponent fertilizers.

The aim of the work is to study the productivity and structure of the spring wheat crop depending on the variety and foliar treatment with a combination of manganese, copper and molybdenum, as well as the preparation Ultramag Combi.

2. Methods

The object of research was soft spring wheat of three varieties, cultivated in 2019 on leached heavy loam Chernozem. The research was carried out by setting up a field two factor experiment in six replications at the experimental field of the Mordovian research Institute of agriculture, a branch of the Federal research center of the North-East. The experiment had an area 1498 m^2 . The plot area of the first order is 50.4 m2 (14×3.6 m), the second order is 7.2 m2 (3.6×2 m).

The scheme of experience included 21 options: Factor A– spring wheat variety: 1) Tulaykovskaya 10 (standard); 2) Tulaykovskaya 108; 3) Yoldyz; factor B-foliar treatment with fertilizers: 1) control (tap water treatment); 2) N in amide form (background) - 0.39 kg / ha; 3) background + Mn+Cu (0.03 % by trace element); 4) background + Mn+Mo (0.03 % by trace element); 5) background + Cu+Mo (0.03 % by microelement); 6) background+Mn+Cu+Mo (0.03 % by microelement); 7) "Ultramag Combi"-2l / ha.

Variant № 7 used a multi-component liquid complex micro-fertilizer for grain crops Ultramag Combi company Shchelkovo Agrohim. The composition of the drug: nitrogen in amide form (195 g / l), magnesium (26 g/l), copper (11.7 g/l), iron (10 g/l), manganese (14.3 g/l), zinc (13 g/l), molybdenum (0.065 g/l), titanium (0.3 g / l). The drug was used in the recommended rate of the manufacturer (2 l / ha), with the rate of consumption of the working solution of 300 l / ha. In Option № 2 nitrogen was used in the form of urea in an amount equivalent to the introduction of "Ultramag Combi" (0.39 kg/ha). In variants № 3-6, paired and triple mixtures of Mn, Cu, and Mo trace elements were used in a total concentration of 0.03%, equivalent to the total concentration of trace elements in the working solution of Ultramag Combi. Sulphuric salts ($MnSO_4 \times 5H_2O$, $CuSO4 \times 5H_2O$) and $(NH_4)_6Mo_7O_{24} \times 4H_2O$ were used. Ethylenediamine tetraacetic acid disodium salt was used for chelation in a molar ratio of 1:1. In all variants (except for №. 7), the adjuvant "Adyu" (concentration in the working solution of 0.05%) was additionally used. All foliar treatments were performed twice in the tillering phase and earing.

In General, during the growing season of spring wheat, the Selyaninov hydrothermal coefficient (GTC) was 0.83, which is estimated as arid. The worst humidification conditions were formed from may to the second decade of June (the critical period), during this period only 47 mm of precipitation fell with an average annual rate of 75 mm. The average GTC for may was 0.57, which is estimated as the average degree of drought.

Observations, surveys and analyses were conducted in accordance with conventional methods.

3. Results

On average, the productivity of spring wheat of the Yoldyz variety exceeded that of the control variety (Tulaykovskaya 10) by 43 g/m2 (19.5%), and of the Tulaykovskaya 108 variety by 30 g/m^2 (13 %). (Table 1). On average, for all varieties (column 5 of table 1), the use of foliar treatment with fertilizers caused a tendency to increase the yield relative to the control. However, on a nitrogen background and with the use of Ultramag Combi, the increase in grain yield was mathematically unreliable. The use of a triple mixture of trace elements on the background of nitrogen increased grain productivity by 27 g/m^2 (12.9 %) in relation to the control. The greatest positive impact on grain productivity was caused by the paired use of copper and molybdenum with nitrogen - an increase in productivity was observed both in relation to the nitrogen background (by 35 g/m^2, or 15.3 %), and in relation to a triple mixture of trace elements (25 g/m^2, or 10.5 %).

By the Tulaykovskaya 108 variety, the use of nitrogen, as well as the paired use of Mn and Cu and, especially, Cu and Mo, caused a tendency to increase the grain productivity by 25, 20 and 28 g/m^2 in relation to the control (without fertilizers) . By the Tulaykovskaya 10 variety, a significant increase in grain productivity relative to the control was observed in the variant with paired application of Mn+Mo with nitrogen (+50 g/m^2, or 26 %) and with paired application of Cu+Mo with nitrogen (+76 g/m^2, or 40%). It is worth noting that the variant with Cu+Mo on the background of nitrogen is effective both in relation to the nitrogen background (+69 g/m^2, or 35 %), and in relation to the triple mixture of trace elements on the background of nitrogen (+44 g/m^2, or 19.6 %). The Yoldyz variety had a significant increase in grain productivity relative to the control in all variants with the use of trace elements with nitrogen, including when using The Ultramag Combi preparation (+53...+75 g/m^2). It is noteworthy that the most effective option was the paired introduction of Mn and Cu against the background of nitrogen:

the yield increase was 72 g/m^2 (34.5 %) in relation to the control, 53 g/m^2 (22 %) in relation to the nitrogen background. Slightly less effective was the option with the paired introduction of Mn and Mo against the background of nitrogen – the increase in grain yield was 62 g/m^2 (29 %) in relation to the control.

Table 1 – Spring wheat grain yield

Experience option				
factor B (foliar treatment with fertilizers)	Factor A (spring wheat variety)			
	1)Tulaykovskaya 10	2)Tulaykovskaya 108	3) Yoldyz	Average by factor B
1	2	3	4	5
1) Control	192	221	217	210
2)N	199	246	239	228
3)N+Mn+Cu	218	241	292	250
4) N+Mn+Mo	242	235	279	252
5) N+Cu+Mo	268	249	270	262
6)N+Mn+Cu+Mo	224	214	272	237
7) "Ultramag Combi"	194	222	275	230
Average by factor A	220	233	263	–
LSD $_{05}$ particular differences 1	76			
particular differences 2	40			
Factor A	29			
Factor B	23			

Thus, the use of more than 2 microelements in a mixture, including multicomponent preparations, during foliar treatment was less effective than the paired use of individual microelements. This is probably due to a decrease in the concentration of important trace elements in the mixture, as well as possible processes of antagonism. Earlier studies of D. I. Ivanov and co-authors in a laboratory experiment with Tulaykovskaya 10 spring wheat have established the phenomenon of antagonism when Mn+Co, Cu+Zn, Cu+Co, Mo+Co are used together [3]. The phenomen of synergy were established when Mn+Mo, Mn+Cu, Mo+Cu were used together.

The data shown in table 2 allows you to determine which of the elements of the structure provided the resulting level of yield.

On average, the number of preserved plants by the end of vegetation in The Tulaykovskaya 108 variety is less than in the control one (Tulaykovskaya 10) by 165 PCs/m^2 (1.2 times) and less than in the Yoldyz variety by 1.5 times. On average, the experiment showed a tendency to increase the number of plants by 20 PCs/m^2 in relation to the control on the nitrogen variant.

It was found that the number of plants of the Tulaykovskaya 108 variety did not change from the applied fertilizers. By the Tulaykovskaya 10 variety, separately applied nitrogen did not significantly affect the number of plants that preserved up to harvesting. In relation to the nitrogen background, the triple mixture of trace elements increased the number of preserved plants by 51 PCs/m^2 (19 %). However, this indicator increased more in relation to the nitrogen background in the variant with a paired introduction of Mn and Cu (+61 PCs/m^2, or by 22.5 %).

Table 2 – The yield structure of spring wheat

Experience option		Number of preserved plants up to harvesting, PCs / m^2	Number of shoots, PCs/m^2		The coefficient of tillering		Number of grains per ear, PCs.	Weight of 1000 grains, g	biological yield, C/ha
Factor A (spring wheat variety)	factor B (foliar treatment with fertilizers)		total	productive	total	productive			
1) Tulaykovskaya 10	1) Control	265	363	300	1,37	1,13	20	32,3	19,5
	2)N	271	372	294	1,37	1,08	21	33,0	20,5
	3)N+Mn+Cu	332	432	346	1,30	1,04	22	32,9	25,5
	4) N+Mn+Mo	314	416	346	1,32	1,10	23	31,8	25,7
	5) N+Cu+Mo	294	388	331	1,32	1,13	24	33,3	26,8
	6)N+Mn+Cu+Mo	322	438	309	1,36	0,96	22	31,7	21,7
	7) "Ultramag Combi"	302	394	322	1,31	1,07	20	32,1	20,3
2) Tulaykovskaya 108	1) Control	142	208	175	1,46	1,23	29	41,0	20,6
	2)N	142	222	192	1,56	1,35	30	42,5	24,6
	3)N+Mn+Cu	134	212	187	1,58	1,40	31	42,1	24,4
	4) N+Mn+Mo	128	208	196	1,62	1,53	29	41,1	23,2
	5) N+Cu+Mo	134	210	187	1,57	1,40	32	42,0	24,7
	6)N+Mn+Cu+Mo	129	216	193	1,67	1,50	27	41,0	21,3
	7) "Ultramag Combi"	137	228	206	1,66	1,50	27	41,4	22,9
3) Yoldyz	1) Control	319	410	282	1,29	0,88	20	39,4	22,4
	2)N	361	462	326	1,28	0,90	21	39,5	27,5
	3)N+Mn+Cu	369	469	356	1,27	0,97	22	39,5	31,2
	4) N+Mn+Mo	335	411	325	1,23	0,97	22	40,1	28,5
	5) N+Cu+Mo	322	413	333	1,28	1,04	20	39,6	26,8
	6)N+Mn+Cu+Mo	304	433	333	1,43	1,10	21	40,2	27,9
	7) "Ultramag Combi"	348	425	343	1,22	0,99	21	39,2	27,6
LSD_{05} particular differences 1		116	127	83	–	–	8	4,9	–
LSD_{05} particular differences 2		44	53	46	–	–	3	1,8	–

On the Yoldyz variety, the use of nitrogen background, as well as the preparation Ultramag Combi, caused a tendency to increase the number of plants that preserved up to harvesting (+42⋯ +29 PCs/m^2). A mathematically significant increase in the number of plants to harvest was observed in the variant with Mn and Cu on the background of nitrogen (+50 PCs/m^2 in relation to the control, +65 PCs/m^2 in relation to the variant with a triple mixture). The Tulaykovskaya 108 variety had fewer stems than the Tulaykovskaya 10 variety, by 186 PCs/m^2 (or 46 %) on average experience. The number of stems of Tulaykovskaya 10 and Yoldyz varieties was identical.

The use of foliar nutrition had a significant impact on the number of stems. Background application of nitrogen caused a tendency to increase this indicator. The greatest effect in increasing the number of stems was provided by paired application of Mn+Cu against the background of nitrogen (+44 PCs/m^2, or 13.5%), as well as the use of a triple mixture of trace elements against the background of nitrogen (+35 PCs/m^2, or 10.7 %). On Tulaykovskaya 108 variete the use of foliar top dressing did not cause a significant increase in the total number of stems. On the Tulaykovskaya 10 variety, a significant increase in the total number stems was observed when using a triple mixture of trace elements with nitrogen (+75 PCs/m^2, or 20.7 %), as well as when adding Mn+Cu in pairs with nitrogen (+69 PCs/m^2, or 19%). In relation to background nitrogen application, the increase in the number of stems was 66-60 PCs/m^2. In the Yoldyz variety, the largest increase in the total number of stems in relation to the control was on the variant with paired Mn+Cu introduction against the background of nitrogen (+59 PCs/m^2, or, 14.4 %). The change in the number of productive stems generally followed the same pattern as the total number of stems. Tulaykovskaya 108 varie had the least number of productive stems (41.7 % less than Tulaykovskaya 10 and 37.9 % ‑ than Yoldyz). It is worth noting that the lower density of plants of the Tulaykovskaya 108 variety was compensated by a large coefficient of productive bushiness: 1.23‑1.53 against 0.96‑1.13 for Tulaykovskaya 10 and 0.88-1.10 for Yoldyz. On the variety Tulaikovskaya 108 the greatest tendency to increase the number of productive stems was caused by the drug Ultramag Kombi and pair introducing Mn and Mo on the background of nitrogen, On the variety Tulaikovskaya 10 ‑ pair introduction Mn+Cu, and Mn and Mo on the background of nitrogen, On the Yoldyz variety ‑ Mn+Cu on the background of nitrogen and drug Ultramag Kombi.

The number of grains in the ear varied significantly by variety. The maximum number of grains in the ear was typical for the Tulaykovskaya 108 variety (29 PCs / ear), the other two varieties had a smaller number of grains (21-22 PCs/ear). Varietal differences were also observed depending on the variant of mineral nutrition: the largest number of grains in the ear of Tulaykovskaya 10 and Tulaykovskaya 108 varieties was formed on the variant with paired Cu+Mo introduction witht the background of nitrogen, and in the Yoldyz variety ‑ Mn+Cu, as well as Mn and Mo with the background of nitrogen.

Also, spring wheat had significant varietal differences in the weight of 1000 grains. At the control (without the use of mineral nutrition), the lowest mass of this indicator was obtained in the Tulaykovskaya 10 variety (32.4 g), and the highest - in the Tulaykovskaya 108 variety (+8.6 g relative to the Tulaykovskaya 10). The Yoldyz variety is characterized by a smaller mass of 1000 grains (+7.1 g in relation to Tulaykovskaya 10). The use of foliar nutrition in all varieties causes a tendency to increase the mass of 1000 grains (by 0.7-1.5 g).

The biological yield of Tulaykovskaya 10 spring wheat was more correlated with the number of grains in the ear (r=+0.91), as well as with the number of productive stems (r=+0.84), than with the mass of 1000 grains (r=+0.32). The biological yield of Tulaykovskaya 108 spring wheat depended more on the mass of 1000 grains (r=+0.87) and the number of grains in the ear (r=+0.70) than on the number of productive stems (r=+0.26). The biological yield of spring wheat of the Yoldyz variety was provided both by the number of productive stems (r= + 0.92) and the number of grains in the ear (r=+0.82), but to a lesser extent by the mass of 1000 grains (r=+0.24).

As a result of multiple correlation analysis, the following model of spring wheat grain productivity (y, C/ha) was obtained for tulaykovskaya 10 (1), Tulaykovskaya 108 (2) and Yoldyz variety (3):

$$y= -51,53 + 0,80x_1+1,17x_2 + 0,07\ x_3, \quad (1)$$

$$y= -41,33 + 0,64x_1+0,28x_2 + 0,16\ x_3, \quad (2)$$

$$y= -47,71 + 0,59x_1+1,23x_2 + 0,08\ x_3, \quad (3)$$

where x_1 is the mass of 1000 grains, g;

x_2 - the number of grains in the ear;

x_3 - the number of productive stems, PCs/m^2.

Thus, of the three studied varieties of spring wheat, the best productivity indicators were formed in the Yoldyz variety. The best indicators of the structure of the spring wheat yield of Tulaykovskaya 10 and Tulaykovskaya 108 varieties were formed when foliar treatment of crops with a paired mixture of copper and molybdenum with nitrogen, and Yoldyz variety - manganese and copper, as well as manganese and molybdenum with nitrogen. Foliar treatment with a complex multicomponent preparation Ultramag Combi, as well as separately applied nitrogen in amide form, was less effective

Conflict of Interest

None declared.

Конфликт интересов

Не указан.

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