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Milling And Baking Qualities Of Winter Wheat After Pre-Sowing Seed And Foliar Treatment With Microelements-Synergists.

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ABSTRACT

The focus of the study was on the influence of pre-sowing seed treatment and top dressing with non-reutilizable trace elements (zinc, manganese) in field and production settings on yield, milling and baking parameters of winter wheat. The experiments conducted proved an increase in the yielding capacity. They also showed an improvement of milling and baking qualities of grain.

Keywords: winter wheat, vitreousness, zinc, manganese, yield, test weight, mass fraction of gluten.

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INTRODUCTION

Winter wheat is one of the most important crops that possesses a high potential of the yielding capacity. In order to realize this potential to a greater extent, at present time, it is required to create flexible science-intensive technologies of cultivation that will incorporate new low-cost elements and will increase the gross grain harvest.

One of the promising areas in this respect is pre-sowing seed and foliar treatment with limiting micronutrients, especially synergistic ones, which are co-factors of enzymes. They enhance metabolic processes, increase plant resistance to stressful conditions, increase crop yields and improve the quality of agricultural produce. Because of a low extent of application trace elements can be referred to low-cost elements of technology which makes them attractive from an economic point of view.

The use of microelements - synergists provides wide opportunities for improving the technology of growing winter wheat. Microelements being in the cells and plant tissues in low concentrations have a huge physiological and biochemical influence on the productive activity, stimulate assimilation and energy processes, increase yield and quality of produce. [1,2,3,4,5] Our studies conducted on sugar beet have demonstrated that the application of trace elements and growth regulators is a factor of raising the yield and quality of sugar beet roots. [9,10,11] The goal of the research is to study milling and baking qualities of winter wheat grain after the treatment with non-reutilizable microelements - synergists (zinc, manganese) at the end of the second stage of organogenesis in field and production experiments.

Objectives and methods of research Field experiments were carried out in 2014-2016 on the experimental field of Stolypin Ulyanovsk State Agrarian University. The soil of the experimental plot is average loam, leached black soil of medium thickness with a low content of humus. The humus content is 4.3%. The availability of mobile phosphorus is elevated, of exchangeable potassium is high. The content of P_2O_5 is 115, K_2O is 139 mg / kg soil. The content of microelements in the soil of the experimental plot in mg / kg is as follows: Mn - 30; Mo is 0,2; Zn = 0,2; Cu – 0,18; Co – 2,2; J - 2,8. Among the micronutrients studied, the content of Mn in the soil is low, and Zn is very low. The reaction of the medium in the plow layer is weakly acidic - pH = 6.1. The degree of base saturation is 26.5 meq / 100 g soil. The farming technique is generally accepted for this crop with the use of modern machines. 0.1% zinc sulphate and manganese sulfate solutions were used to treat seeds before sowing, in view of the amount of 10 liters per ton of seeds. Similar concentrations were used for foliar application of 180 liters per 1 ha. The experimental crop is winter soft wheat, the variety - Saratovskaya 17. Field experiments were conducted in 4-fold repetition on plots with a registration area of 15 m^2. The location of the plots is randomized.

The scheme of the field experiment:

The control group - water treatment, 2) $MnSO_4$, 3) $ZnSO_4$, 4) $MnSO_4$ + $ZnSO_4$-seed pre-treatment, 5) $MnSO_4$, 6) $ZnSO_4$, 7) $MnSO_4$ + $ZnSO_4$- pre-sowing treatment plus foliar treatment at the end of the second stage of organogenesis, 8) $MnSO_4$, 9) $ZnSO_4$, 10) $MnSO_4$ + $ZnSO_4$ - only foliar treatment at the end of the second stage of organogenesis.

The following observations, records and analyses were carried out in the experiments:

net photosynthesis efficiency was calculated by Kidd, West and Briggs' formula: NPE= <u>B2-B1</u>(L1+L2)n0,5 where NPE is the net efficiency of photosynthesis (g / m^2 per day); B_1 and B_2 - dry biomass of the harvest sample at the beginning and end of the accounting period, g; (L_1 + L_2) * 0,5 - the area of leaves at the beginning and at the end of the accounting period, m^2.; n - number of days in the accounting period;

the actual yield was recorded from the entire plot area with recalculation for 100% of purity and 14% of the moisture content (State standard 27548-97). The grain quality assessment was carried out through the following laboratory studies;

determination of the mass fraction of gluten - according to State standard R54478-2011;

determination of gluten quality – with the help of the device IDK-1;

the degree of gluten hydration was determined according to the method offered by B.P. Pleshkov [13];

vitreousness - with the help of a diaphanoscope by illuminating the investigated material (grain) with a directed light flux in accordance with State standard 10987-76;

test weight was determined on the basis of a grain unit scale;SR2010$

the yield was determined by the method of continuous threshing with help of the Terrion-Sampo SR2010 $ selection harvester. These results of the study were subjected to mathematical processing by dispersion analysis methods of [14].

RESULTS

The results of field experiments for 2014-2016 show that micronutrients exert influence on the formation of the assimilation apparatus and its photosynthetic activity. It has been ascertained that the use of trace elements increases the efficiency of photosynthesis (Table 1).

Table 1: Net photosynthesis efficiency of winter wheat, g/m^2 a day.

Variants	Tillering – shooting	Shooting – ear formation	Ear formation - milky maturity	Mean values
Control group	5,56	8,66	6,98	7,06
$MnSO_4$	6,28	9,07	7.22	7,52
$ZnSO_4$	6,31	9,11	7,26	7,56
$MnSO_4$ + $ZnSO_4$	6,33	9,15	7,31	7,59
$MnSO_4$ (+ foliar treatment).	6,41	9,18	7,24	7,61
$ZnSO_4$ (+foliar treatment).	6,43	9,21	7,28	7,64
$MnSO_4$ + $ZnSO_4$ (+foliar treatment).	6,46	9,23	7,35	7,68
$MnSO_4$ _ foliar treatment.	6,46	9,23	7,26	7,65
$ZnSO_4$ _ foliar treatment.	6,47	9,24	7,27	7,66
$MnSO_4$ + $ZnSO_4$ _ foliar treatment.	6,48	9,25	7,29	7,67

Net photosynthesis efficiency on average for 3 years increases by 6,5 – 8,6 %, the greatest efficiency is observed at the phase of shooting and ear formation. The yielding capacity increases due to the rise of NPE (table 2).

Table 2: Yielding capacity of winter wheat, t/ha.

Variants	Years of studies				Increment	
	2014	2015	2016	Mean values	t/ha	%
Control group	4,39	1,90	4,32	3,54	-	100
$MnSO_4$	4,73	2,16	4,72	3,87	0,33	109,3
$ZnSO_4$	4,82	2,44	4,96	4,07	0,53	115,0
$MnSO_4$ + $ZnSO_4$	4,86	2,38	5,57	4,27	0,73	120,6
$MnSO_4$ (+ foliar treatment).	5,15	2,44	5,43	4,34	0,80	122,6
$ZnSO_4$ (+ foliar treatment).	4,94	2,43	5,54	4,30	0,76	121,5
$MnSO_4$ + $ZnSO_4$ (+ foliar treatment).	5,00	2,48	5,74	4,41	0,87	124,6
$MnSO_4$ _ foliar treatment	4,52	2,28	4,50	3,77	0,23	106,5
$ZnSO_4$ _ foliar treatment	4,56	2,23	4,74	3,84	0,30	108,5
$MnSO_4$ + $ZnSO_4$ _ foliar treatment	4,53	2,38	4,96	3,96	0,42	111,9
LSD 05	0,245	0,15	0,41	-	-	-

The data of statistical processing shows a reliable increment in the yield. On average, over the years of research on experimental variants, the yield increased by 0.33-0.87 t / ha with yields in the control group of

3.54 t / ha. The highest yields were obtained on variants with joint application of zinc and manganese, both in the treatment of seeds, and with foliar treatment. This is due to the synergistic effect of these two d-elements of the sub-subgroups of Mendeleev's periodic system of chemical elements. For the production tests, two variants were taken: 1) Control group - seeds and vegetative plants were treated with water. Experimental groups - seeds before sowing and vegetating plants were treated with a solution of $MnSO_4$ + $ZnSO_4$ (together) (Table 3).

Table 3: Yields of winter wheat at Agro-industrial complex «Novotimersyansky», t/ha

Variant	Area	2014	2015	2016	2017	Average yields	Increment	
							t/ha	% in relation to control
Control(seeds and seedlings treated with water)	50	2,58	3,00	3,60	4,80	3,49	-	100,0
Experimental group (seeds and seedlings treated with solution $MnSO_4$ + $ZnSO_4$	500	3,00	3,50	4,03	5,50	4,00	0,51	114,6

The highest yield was obtained in the more favorable years of 2016-2017 by meteorological conditions.

On average, for four years the increase was 14.8%, which is by 0.51 t / ha higher than in the control group, with the yield in the control group of 3.49 t / ha. In all the years of research, under the influence of zinc and manganese, an increment of 0.42 t / ha - 0.7 t / ha was obtained. As a result of the application of this agronomic technique, the farm obtained additional grain of 210 tons in 2014; 250 tons in 2015; 215 tons in 2016; 255 tons in 2017. The increase in the yield is due to the fact that at the initial stage of ontogeny, growth processes intensified, at the tillering nodes there was a more intensive accumulation of carbohydrates and bound water, especially in the second phase of hardening. As a result of these physiological and biochemical processes, winter hardiness, the preservation of plants and the efficiency of photosynthesis increase in experimental plants.

The conducted studies show that non-reutilizable microelements-synergists in the technology of winter wheat cultivation contribute to improving the quality of grain, especially milling and baking qualities. Milling properties depend on vitreousness, the weight of 1000 grains and test weight (Table 4,5,6)

Table 4: Vitreousness of winter wheat grain

Variant	Vitreousness, %			
	2014г.	2015	2016	Mean values
Control group	74,0±1,50	80,83±1,04	77,88±0,48	76,6
$MnSO_4$(seed treatment)	81,0±3,77	83,0±1,80	85,0±1,09	83,0
$ZnSO_4$(seed treatment)	78,67±4,25	83,83±1,61	85,88±1,71	82,8
$MnSO_4$+ $ZnSO_4$(seed treatment)	85,67±3,33	81,17±0,58	84,38±0,85	83,8
$MnSO_4$(seed treatment + foliar treatment)	80,67±2,36	82,33±1,15	79,0±1,08	80,7
$ZnSO_4$(seed treatment + foliar treatment)	76,0±1,32	82,67±1,04	79,75±1,45	79,5
$MnSO_4$+ $ZnSO_4$(seed treatment + foliar treatment)	77,17±3,62	81,17±3,06	81,38±0,95	79,9
$MnSO_4$(foliar treatment)	76,83±4,54	81,17±1,26	80,0±1,41	79,3
$ZnSO_4$(foliar treatment)	80,0±4,44	82,17±2,25	80,88±2,87	81,0
$MnSO_4$+ $ZnSO_4$(foliar treatment)	84,33±4,04	81,17±0,58	81,33±2,12	82,3

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The data of table 4 shows that in all variants total vitreousness is higher than 60%, this corresponds to the parameters of strong wheat varieties (Class I). Vitreousness is increased by 1.9-6.2% under the influence of microelements. The test weight for the years of research with the use of microelements amounts to 756.5-770.7 g / l, which is 9.1-23.3 g / l higher than in the control group (Table 5). On average, in terms of the test weight winter wheat corresponds to the 2nd class of harvested wheat.

Table 5: Test weight of winter wheat.

Variant	Test weight, %			
	2014	2015	2016	Mean values
Control group	795,5±3,42	738,7±2,55	709,41±4,25	747,4
$MnSO_4$(seed treatment)	811,75±3,30	751,95±8,64	728,37±6,74	764,1
$ZnSO_4$(seed treatment)	804,25±6,13	779,43±5,31	728,63±1,69	770,7
$MnSO_4$+ $ZnSO_4$(seed treatment)	805,5±7,33	750,98±7,81	728,85±3,3	761,9
$MnSO_4$(seed treatment + foliar treatment)	800,75±4,57	757,95±4,78	711,78±5,77	756,9
$ZnSO_4$(seed treatment + foliar treatment)	796,0±1,63	771,43±7,62	712,44±5,89	767,5
$MnSO_4$+ $ZnSO_4$(seed treatment + foliar treatment)	797,75±6,18	756,75±8,52	716,56±5,31	756,5
$MnSO_4$(foliar treatment)	805,75±6,65	763,03±8,6	712,86±3,76	760,6
$ZnSO_4$(foliar treatment)	800,5±4,43	766,35±7,97	715,18±2,6	760,9
$MnSO_4$+ $ZnSO_4$(foliar treatment)	805,75±7,16	756,65±5,95	715,05±5,45	758,2

This is connected with the increase of the weight of 1000 grains in experimental variants (table 6).

Table 6: Weight of 1000 winter wheat grains

Variant	The weight of 1000 grains, gr.			
	2014	2015	2016	Mean values
Control	37,91±0,4	30,53±0,67	30,92±0,34	33,1
$MnSO_4$(seed treatment)	39,92±0,62	32,03±0,95	32,48±0,6	34,8
$ZnSO_4$(seed treatment)	39,81±1,01	31,53±0,88	33,6±0,37	35
$MnSO_4$+ $ZnSO_4$(seed treatment)	40,22±0,61	31,33±0,67	34,17±0,81	35,2
$MnSO_4$(seed treatment + foliar treatment)	38,78±0,55	31,43±0,73	33,69±0,84	34,9
$ZnSO_4$(seed treatment + foliar treatment)	39,46±0,56	31,6±1,78	31,68±0,42	34,3
$MnSO_4$+ $ZnSO_4$(seed treatment + foliar treatment)	39,68±1,61	30,95±0,47	34,49±0,42	35,1
$MnSO_4$(foliar treatment)	39,47±0,4	31,4±0,99	32,53±0,77	34,4
$ZnSO_4$(foliar application)	41,23±0,98	31,4±0,63	31,19±0,26	34,6
$MnSO_4$+ $ZnSO_4$(foliar application)	39,30±0,60	31,58±2,51	32,28±0,95	34,4

The analysis of the obtained data allows us to draw a conclusion that the stimulating concentrations of microelements - manganese and zinc synergists in pre-sowing seed treatment and foliar treatment have a significant effect on the milling properties of winter wheat grain in comparison with foliar application of individual microelements.

An important indicator that characterizes the milling and baking qualities of the grain of winter wheat is the mass fraction of gluten. The results are given in table 7.

Table 7: Influence of trace elements – synergists on the mass fraction of gluten

Variant	Mass fraction of gluten, %			
	2014	2015	2016	Mean values
Control group	25,2	27,8	25,0	26,0
$MnSO_4$(seed treatment)	25,4	31,3	27,6	28,7

$ZnSO_4$(seed treatment)	25,0	32,5	29,8	29,1
$MnSO_4$+ $ZnSO_4$(seed treatment)	25,4	31,1	30,5	28,9
$MnSO_4$(seed treatment + foliar treatment)	27,0	28,3	27,7	28,1
$ZnSO_4$(seed treatment + foliar treatment)	27,3	29,9	27,8	27,8
$MnSO_4$+ $ZnSO_4$(seed treatment + foliar treatment)	26,5	29,0	26,8	28,2
$MnSO_4$ foliar treatment ()	26,6	29,6	26,5	27,4
$ZnSO_4$(foliar treatment)	26,8	29,8	26,8	27,5
$MnSO_4$+ $ZnSO_4$(foliar treatment)	26,5	29,3	27,1	27,50

Under the influence of zinc and manganese, regardless of the methods of application, an increase in the mass fraction of gluten on average for 3 years by 1.4 - 3.1% occurred, the greatest increase was observed in 2015. The used micronutrients influenced the quality group of gluten (Table 8)

Table 8: Gluten deformation index

Variant	GDI, units.			
	2014	2015	2016	Mean values
Control group	48,5	55,5	55,5	53,2
$MnSO_4$(seed treatment)	48,5	56,5	46,6	50,5
$ZnSO_4$(seed treatment)	48,5	58,0	57,5	53,6
$MnSO_4$+ $ZnSO_4$(seed treatment)	46,0	54,0	47,8	49,2
$MnSO_4$(seed treatment + foliar treatment)	47,0	52,0	53,9	50,9
$ZnSO_4$(seed treatment + foliar treatment)	48,0	47,5	45,7	47,1
$MnSO_4$+ $ZnSO_4$(seed treatment + foliar treatment)	41,0	48,0	51,3	50,1
$MnSO_4$(foliar treatment)	46,0	47,0	44,9	45,9
$ZnSO_4$(foliar treatment)	43,5	45,0	60,8	49,7
$MnSO_4$+ $ZnSO_4$(foliar treatment)	39,5	55,0	52,6	49,0

According to the measurements with the IDK-1 device, the treatment of seeds and vegetating plants and meteorological conditions promoted the formation of grains of I and II quality groups.

CONCLUSIONS

The use of non-reutilizable microelements, in the technology of winter wheat cultivation, makes it possible to draw the following conclusions:

1. Under the action of trace elements, irrespective of the methods of application, an increase in the net photosynthesis efficiency on average by 6.5-5.6% occurs in all phases in comparison with the control group.
2. With the use of microelements-synergists, the yield of winter wheat grain increases by 9.3-24.6% on average over 3 years, depending on the method of application, with the highest yield obtained on a variant with joint seed treatment and foliar application with two trace elements.
3. In production settings, on average for 4 years, the yield increases by 0.51 t / ha, with a yield in the control group of 3.49 t / ha, which is 14.6%.
4. Under the influence of the microelements used, milling and baking qualities are improved due to the increase in vitreousness, the actual mass and the increase in the mass fraction of gluten.

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