УДК 631.81.095.337 : 631.811.98

THE INFLUENCE OF NEW DOMESTIC MICROFERTILIZER AVATAR-1 ON WINTER SOFT WHEAT PRODUCTIVITY

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The results of field experiments demonstrate the high efficiency of the new domestic microfertilizer avatar-1 and its composition with salicylic acid and selenium citrate chelate for growing Kalynova variety soft winter wheat. Chemicals provide significant increase of grain yield, content of protein and gluten in it, more efficient use of phosphorus and nitrogen both of fertilizers and soil by plants.

Microfertilizer, salicylic acid, selenium citrate chelate, Triticum aestivum L., winter wheat, yield and grain quality.

About 45 million hectares of arable land in Ukraine are characterized by low and very low content of mobile compounds of such necessary for plants biogenous microelements as zinc, copper, manganese, cobalt, molybdenum, boron etc. [1]. If complex microelements are not used, this leads to a decrease in the activity of enzymes and enzyme systems in plants, decline of macrofertilizers, plant development retardation, seed maturation, reduced plant resistance to adverse environmental conditions and crop deseases, decrease in plant productivity and product quality.

The main microfertilizers in Ukrainian market are preparations based on mineral salts and chelates with use of EDTV or OEDP as ligand. In their application

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it is consumed up to 227 g of microelements per 1 hectare of arable land. Foreign microfertilizers (the Netherlands, Belgium, France, Hungary, Poland, United Kingdom, etc.) require considerable currency expenditures. Prices for them and raw material for their production increase annually. That's why it was very timely developed and registered in 2011 a new complex microfertilizer avatar-1 in Ukraine, which contains derived from colloidal solutions of metals complex of citrate chelates Cu, Mn, Zn, Fe, Mg, Mo, Co, Ge [2].

According to the results of our laboratory and vegetation experiments with wheat, the same efficiency of this microfertilizer in comparison with the traditional one is achieved at 15 or more times lower expenditure of microfertilizers per unit of processed seed mass. In addition, under the created stressful conditions of wheat growing (acute shortage of phosphorus in the diet), avatar-1 provided the increased activity of antioxidant enzymes of plants (catalase – up to 26%, guaiacolperoxidase - up to 35%), decrease down to 30% of malondialdehyde content in leaves, indicating less intensive course of lipid peroxidation. The preparation also contributed to the increase up to 40% or more of acidophytic activity (working of H^+ - pumps) of root system in 7-day shoots - an essential process that largely determines the intensity of mineral absorption by root cells.

Aim of research — the definition of effectiveness of microfertilizer avatar-1 and its composition with compounds of antioxidant action [3-5] - salicylic acid and selenium citrate chelate in the field experiment in growing Kalynova winter soft wheat.

Materials and research methodology. The study was conducted in Boryspil district of Kyiv region on dark gray podzolic soil, characterized by medium provision of nitrogen and phosphorus compounds, and high provision of potassium.

Experiments based on fourfold repetition; the area of cultivated land for each version was 120 m^2, of the accounting one - 90 m^2. The versions were allocated systematically. The predecessor was potato. Farming was typical for the Forest-Steppe zone of Left Bank Ukraine, and adapted to the conditions of the economy. Mineral fertilizers (ammonium nitrate, superphosphate, potassium chloride) were

applied in a dose of $N_{150}P_{45}K_{80}$. Basically fertilizers provided 40% of the total normal range of nitrogen - N_{60}. The rest was used by fertilizing in the most crucial phases of plant growth and development: the first (N_{60}) - in early spring plant vegetation (the second phase of organogenesis), the second (N_{30}) - in the early phase of the stem elongation (the fourth stage of organogenesis).

The experiment was conducted in two-factor experiment scheme:

- Factor A - pre-seeding seed treatment with microfertilizer avatar-1 and avatar-1 in compound with salicylic acid and selenium citrate chelate;
- Factor B – top dressing of plants with aqueous solution of avatar-1.

Seeds of the control version before sowing were treated only with fungicide maxim star FS 025, t.k.s. 1.5 l/t To the working solution for pre-seeding treatment of experimental seeds, apart from disinfectants, were added microfertilizer avatar-1 (2 l/t) to one version, and avatar-1 (2 l/t) together with salicylic acid (140 mg/m) and selenium citrate chelate (40 mg Se/ton) to the other version.

Top dressing of vegetative experimental plants with microfertilizer avatar-1 (0.5 l/ha per 300 liters of water) was carried out twice - in tillering and booting stages. Therewith, microfertilizer was combined with chemical means of plant protection in one working solution. The experiment included the integrated system of crop protection from plant deseases and pests.

Harvesting was carried out by trial sheaves.

Determining of structure of winter wheat harvest was carried out by Maysuryan's method.

The content of protein in grain was determined by infrared spectroscopy on the device Infratek 1225, of wet gluten – by water-soluble substance washing off (all-Union State Standard 27839-88), of phosphorus - photometrically by Denizhe's method in A. Levitsky's interpretation.

Statistical analysis of the obtained parameters was performed by correlation and variance analyses according to Dospyehov with the help of computer programs Exel and Agrostat.

Research results and their analysis. In the economic and environmental aspects it was important to define in which technological operations the use of avatar-1 is the most effective: for pre-seeding treatment of seeds, for feeding vegetative plants, or in combination of both these operations. Data analysis for determining the impact of avatar-1 on structural indicators of grain yield (table 1.) demonstrates the high efficiency of application of this microfertilizer in particular for pre-seeding treatment of seeds (ver. 3). Measure increases number of grains in the main spike from 38.4 pc. on the control to 42.2 pc., mass of 1000 seeds - from 43.1 to 49.2 g, of 1 plant grain productivity - from 3.42 to 4.56 g. Twice feeding of vegetative plants with aqueous solution of avatar-1 (ver. 2) in terms of double use of the chemical per 1 ha of crops when compared to seed treatment with it turned out to be less effective: spike grain content increased up to 37.3 pc., the mass of 1000 seeds - up to 48.3 g, 1 plant grain production - up to 3.74 g

The most effective for pre-seeding treatment appeared the composition of avatar-1 (2 l/t) with salicylic acid (140 mg/m) and selenium citrate chelate (40 mg Se/t) (ver. 5). The number of grains of main spik of this version increased up to 46.0 pc., the mass of 1000 seeds - up to 50.8 g, the 1 plant grain production - up to 4, 97 g. This may be connected with the antistress effect of salicylic acid and selenium citrate chelate under unfavourable conditions of plant wintering and during the drought in june - july 2013.

Appliance of avatar-1 for top dressing of versions 4 and 6 favoured further increase of number of grains of main spike and grain productivity of the plant. However, attention is drawn to the fact that the application of the composition of avatar-1 with antioxidants just for seed treatment provides the same grain production of plants, as does the appliance of avatar-1 in two technological operations - for seed treatment and feeding of vegetative plants. This is supported by indicators of grain yield (table 2.). As a result of double fertilization of wheat with avatar-1 (ver. 2) the grain growth when compared to the control was 5.2 dt/ha, while applying it for pre-treatment of seeds - 11 dt/ha; in two technological operations - 14.9 dt/ha. The highest grain yield was obtained on versions 5 and 6 with application of composition

of avatar-1 with antioxidants (16.3 dt/ha higher than for the control) for pre-seed treatment and subsequent twice fertilizing of these plants with avatar-1 (19.1 dt/ha higher than for the control).

It should be mentioned that preparations applied in the experiment contributed significant increase in the efficiency of phosphorus use of both fertilizers and soil by plants: phosphorus bearing by grain yield due to plant feeding with avatar-1 exceeded the control by 14.4 %, while the processing of grain with this microfertilizer – by 24.2 %, while its application in two technological operations – by 34.7 %. The application of composition of avatar -1 with antioxidants for pre-seeding seed treatment provided increase of this index by 35.5 % when compared to the control; the grain of the version number 6 with the following feeding of plants with the solution of avatar- 1 - by 54.1 %. This is probably due to the proven while vegetation experiments the positive impact of preparations on the development of the root system of plants, and the intensity of discharge of organic acids and acid phosphatase by it, which improve the solubility of mineral and organic soil phosphates, thus improving phosphorus nutrition of plants. With the high cost of phosphate fertilizers and low rate of their use by plants such effects of new preparations should help to reduce the cost of grain by the use of lower doses of phosphate fertilizers.

It should be mentioned that even in harsh weather conditions observed in crucial growth phases, and in the case of identical providing with nitrogen fertilizers of plants of control and test plots, the appliance of avatar -1 and its composition with antioxidants resulted in a significant increase in qualitative grain yield of the third class. This can be explained by certain activation of metabolic processes in plants and additional branching of the root system that increases the amount of rhizosphere soil and strengthens the specific absorbtion of fertilizer elements from it. According to the data in table 3, as a result of plant feeding with aqueous solution of avatar- 1, the protein content in grain increased from 10.9 % in the control samples to 11.3 %, while pre-seeding treatment of seeds with this microfertilizer - up to 11.6 %, and while applying of the preparation in two technological operations (treatment of seeds and vegetative plants) - up to 12.0 %. Similarly the composition of avatar-1 with

antioxidants affected the grain quality: while their appliance for pre-treatment of seeds, protein content in grain increased up to 11.8 % and with following feeding of the version number 5 with aqueous solution of avatar-1 — up to 12%. The content of wet gluten in wheat due to the appliance of new preparations also increased - from 21.7 in the control to 22.7-24.2 %.

Thus, the experimental plants under the influence of new preparations had more rapid processes of protein synthesis, indicating the increase of the efficiency of use not only phosphorus but also nitrogen of fertilizers and soil by plants.

It should be mentioned that in the case of use of complex microfertilizer avatar-1 at doses employed in our field experiments per 1 ha of winter wheat, it is spent totally 2250 mg of costly microelements, which is significantly less than in the case of appliance of traditional chelated microfertilizer based on EDTV or OEDP.

1. Influence of microfertilizer avatar-1, its composition with salicylic acid and citrate chelate selenium on structural indices of soft winter wheat crop Kalynova variety for its cultivation on agrofon $N_{150}P_{45}K_{80}$, 2012-2013

Application version of biologically active substances		Number of grains in the main spike, pieces	Weight of 1000 grains, g	Grain production of 1 plant, g
pre-seeding treatment	foliar application			
1. Maxim star FS 025, 1,5 l/t	**water, control**	**34,8 ± 1,6**	**43,1 ± 1,2**	**3,42 ± 0,17**
2. Maxim star FS 025, 1,5 l/t	avatar -1; 0,5 l/t, twice	37,3 ± 1,4	48,3 ± 1,4	3,74 ± 0,19
3. Avatar -1; 2,0 l/t	**water**	**42,2 ± 2,3**	**49,2 ± 1,6**	**4,56 ± 0,23**
4. Avatar -1; 2,0 l/t	avatar -1; 0,5 l/t, twice	47,3 ± 2,6	48,6 ± 1,3	4,97 ± 0,27
5. Avatar -1; 2,0 l/t; SA, 140 mg/t selenium citrate, 40 mg Se/t	**water**	**46,0 ± 2,2**	**50,8 ± 1,4**	**4,97 ± 0,24**
6. Avatar -1; 2,0 l/t; SA, 140 mg/t selenium citrate, 40 mg Se/t	avatar -1; 0,5 l/t; twice	48,8 ± 2,5	50,5 ± 1,3	5,39 ± 0,27

2. Influence of microfertilizer avatar-1, its composition with salicylic acid and citrate chelate selenium on phosphorus bearing by soft winter wheat crop Kalynova variety, agrofon - $N_{150}P_{45}K_{80}$, 2012-2013

Application version of biologically active substances		Grain yield		Contents phosphorus in grain, % P_2O_5 in dry matter	Phosphorus bearingby grain harvest	
		t/ha	± to control, %		kg P_2O_5/ha	± to control, %
pre-seeding treatment	foliar application					
1. Maxim star FS 025, 1,5 l/t	**water control**	**3,30 ± 0,17**	—	**1,137**	**37,52 ± 1,8**	—
2. Maxim star FS 025, 1,5 l/t	avatar -1; 0,5 l/ha	3,82 ± 0,20	15,7	1,124	**42,94 ± 2,0**	14,4
3. Avatar -1; 2,0 l/t	**water**	**4,40 ± 0,23**	**33,3**	**1,059**	**46,60 ± 2,2**	**24,2**
4. Avatar -1; 2,0 l/t	avatar -1; 0,5 l/ha, twice	4,79 ± 0,21	45,1	1,055	50,54 ± 2,4	34,7
5. Avatar -1; 2,0 l/t; SA, 140 mg/t, selenium citrate, 40 mg Se/t	**water**	**4,93 ± 0,26**	**49,4**	**1,031**	**50,83 ± 2,6**	**35,5**
6. Avatar -1; 2,0 l/t; SA, 140 mg/t, selenium citrate, 40 mg Se/t	avatar -1; 0,5 l/ha; twice	5,21 ± 0,24	57,9	1,110	57,83 ± 2,9	54,1

3. Influence of microfertilizer avatar-1, its composition with salicylic acid and citrate chelate selenium on grain quality of winter soft wheat Kalynova variety for its cultivation on agrofon $N_{15}0P_{45}K_{80}$, 2012-2013

Application version of biologically active substances		Foliar application...			Summary protein in grain yield	
pre-seeding treatment	foliar application	harvest, t / ha	protein content, %	gluten content, %	t/ha	± to control,%
1. Maxim star FS 025, 1,5 l/t	**water, control**	**3,30 ± 0,17**	**10,9**	**21,7**	**0,360 ± 0,018**	—
2. Maxim star FS 025, 1,5 l/t	avatar -1; 0,5 l/ha	3,82 ± 0,20	11,3	22,7	0,432 ± 0,022	20
3. Avatar -1; 2,0 l/t	**water**	**4,40 ± 0,23**	**11,6**	**23,3**	**0,510 ± 0,027**	**41**
4. Avatar -1; 2,0 l/t	avatar -1; 0,5 l/ha, twice	4,79 ± 0,21	12,0	24,1	0,575 ± 0,025	59
5. Avatar -1; 2,0 l/t; SA, 140 mg/t selenium citrate, 40 mg Se/t	**water**	**4,93 ± 0,26**	**11,8**	**23,9**	**0,582 ± 0,031**	**62**
6. Avatar -1; 2,0 l/t; SA, 140 mg/t selenium citrate, 40 mg Se/t	avatar -1; 0,5 l/ha; twice	5,21 ± 0,24	12,0	24,2	0,625 ± 0,029	73

Conclusions. Application of the new domestic complex microfertilizer avatar-1 containing citrate chelates of eight biogenic microelements for soft winter wheat provides significant increase in grain yield and improves its quality. The preparation has greatly increased the efficiency of use of nitrogen and phosphorus of fertilizers and soil by plants. Avatar-1 efficiency as microfertilizer and antistress preparation increases when it is applied in the composition with salicylic acid and selenium citrate chelate.