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Productivity of winter wheat depending on presowing cultivation of seeds

Klipakova Yu.[1], Priss O.[2], Belousova Z.[3], Yere-menko O.[4]

Taurian state agrotechnological university, B. Khmel-nytskyi avenue, 18, Melitopol, Zaporizhzha oblast, 72310, Ukraine; e-mail: [1]yu.klipakova@gmail.com, [2]olesyapriss@gmail.com, [3]zoiazolotukhina@gmail.com, [4]ok.eremenko@gmail.com

The purpose. To establish influence of antifungal and antifungal-insecticidal mixtures for presowing cultivation of seeds separately, and also in the joint with growth regulator of plants AKM on form of elements of structure of a crop and productivity of plants of winter wheat. **Methods.** Before sowing seeds were treated with different seed dressers of antifungal action and antifungal-insecticidal mixture: Raksil Ultra (0,25 l/t), Lamardor (0,2 l/t), mixture of Lamardor (0,2 l/t) + Gaucho (0,25 kg/t), and also their mixture with growth regulator of plants — AKM (0,33 l/t). As control they used the alternative treated by water. The account of elements of structure of a crop and determination of biological productivity was spent by conventional techniques. Content of malonic dialdehyde in leaves of plants of winter wheat during vegetation was determined using spectrophotometric method on response to 2-thiobarbituric acid and then was converted on dry weight. **Results.** It is established that formation of elements of structure of crop and productivity of probed variety of winter wheat are influenced with the level of oxidative stress in plants. Application of the selected seed dressers promotes lowering of peroxidation of lipids that positively influenced backfilling of productive shoots, length and amount of ears, quantity of seeds in an ear and mass of 1000 seeds. Addition to seed dressers of AKM reinforced their action. **Conclusions.** The best indexes of elements of structure of a crop and productivity have been generated by plants at use of presowing treatment with Lamardor + Gaucho, and Lamardor + Gaucho + AKM. That has allowed realizing genetic potential of productivity on 47 and 51 % accordingly. Positive effect to presowing treatment of seeds on development of plants is stipulated by lowering activity of peroxidation processes.

Key words: *winter wheat, seed dresser, growth regulator of plants, structure of crop, productivity, malonic dialdehyde.*

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Introduction. Yield and product quality are the most important indicators of plant productivity when growing agricultural crops. This is especially true for Ukraine, where the leading branch of agriculture is grain production, and winter wheat is the main grain crop. The size of the yield depends on agronomic techniques that have a significant effect on the grain productivity of the plants [1, 2]. The unsatisfactory phytosanitary condition of the fields, provoked by short crop rotations, does not allow the producers to sow seed material without chemical treatment because of the risk of harvest losses up to 30%. Therefore, the modern intensive technology of winter wheat cultivation involves seed treater application before sowing [3, 4]. The presowing seed treatment factor is quite significant and has a big impact on the initial phase of plant development, which is reflected in productivity. It was determined that when using fungicide-insecticide preparations, the amount of productive stems increases by 4.1-4.6%, grain weight from one ear – by 3.7%, and the yield – by 7.9 - 8.5% [5]. However, the use of this group of chemicals leads to chemical stress on the seeds and young plants during germination and autumn vegetation. Adding plant growth regulators (PGR) to presowing treaters partially eliminates the negative influence of the treaters and is one of the ways to increase the implementation of the biological potential of the crop. The positive effect of such compositions is, largely, to increase plant resistance to adverse environmental factors, reduce herbicide and insecticide-fungicide rates when used in combination with growth regulators, increase yield and improve grain quality [6].

The **aim** of the research was to determine the influence of fungicidal and fungicidal-insecticidal mixtures for presentive seed treatment separately and in combination with AKM plant growth regulator of on the formation of elements of yield structure and yield of winter wheat plants.

Materials and methods of the research. Field trial was conducted during 2014-2017 in a stationary experiment of the Department of crop production at the educational and production center of the Tavria state agrotechnological university, which is located in Lazurne village of Melitopol district of Zaporizhzhya region. The soil of the experimental field is southern chernozem (black soil) with humus content of 3.5%, easily hydrogenated nitrogen (by Cornfield) - 94.6 mg/kg, mobile phosphorus (by Chirikov) - 135.0 mg/kg and exchangeable potassium (by Chirikov) – 165.0 mg/kg of soil, pH_{KCl} - 6.8. The previous crop in the rotation is bare fallow.

Weather conditions of vegetation periods during the research years were characterized as sufficiently moisturized (2015 and 2017) or slightly arid (2016). However, hydrothermal coefficient of separate months (May, June) had a more significant influence on the formation of the yield elements and the yield of winter wheat [7].

The research used Shestopalivka winter wheat variety, which is recommended for growing in the Steppe of Ukraine [8].

Before sowing, seeds were treated with fungicide and fungicide-insecticide mixture (factor A): Raxil Ultra (0.25 l/t), Lamardor (0.2 l/t) and Lamardor (0.2 l/t) + Gaucho (0.25 kg/t) [9], and plant growth regulator (factor B): AKM (0.33 l/t) [10]. Presowing seed treatment was carried out with the indicated preparations 1-2 days before sowing by incrustation method in the calculation of 10 liters of working solution per 1 ton of seeds. The control variant had treatment with water in the amount of 10 l/ton.

The seeds were sown in the third ten-day period of September - in the first ten-day period of October in a well prepared soil, with 5-6 cm sowing depth, and sowing rate of 5.5 million seeds per ha. The technology of winter wheat cultivation used is generally accepted for the zone of the Southern Steppe of Ukraine, besides the factors taken into consideration. The repeatability of the experiment is four-fold, the area of the experimental plot is 100 m^2, the account plot - 50 m^2.

Account of elements of the yield structure of the crop and the determination of biological yield was carried out according to generally accepted methods [11]. Determination of malondialdehyde (MDA) content in leaves of winter wheat plants during the vegetation was determined spectrophotometrically by reaction with 2-thiobarbituric acid [12] and counted per dry substance.

Dispersion and correlation analysis of the research results was carried out according to B.A. Dospekhov using MS Office 2010 and Agrostat New software [13].

Results of the research. The use of multi-component seed treaters significantly influences the occurrence of physiological and biochemical processes in tissues of winter wheat plants during the autumn period of vegetation and is reflected in the formation of the elements of yield structure (Table 1).

1. Elements of the yield structure of winter wheat (mean for 2015-2017)

Seed treater (factor A)	PGR (factor B)	Amount of prod. stems pcs./m^2	Length of the ear, cm	Amount in ear, pcs.		Mass, g	
				inflorescences	seeds	seeds in ear	1000 seeds
Control	No PGR	424	6.8	14.4	32.0	1.15	35.7
No treater	AKM	451	7.0	14.9	32.3	1.17	36.2
Raxil Ultra	No PGR	458	7.2	15.0	32.5	1.18	36.3
	AKM	494	7.5	15.4	32.8	1.21	36.8
Lamardor	No PGR	505	7.6	15.8	32.6	1.22	37.1
	AKM	542	8.0	16,5	33.5	1.26	37.5

Lamardor + Gaucho	No PGR	564	7.8	16.5	33.5	1.24	37.0
	AKM	594	8.2	17.1	34.4	1.28	37.3
LSD_{05}	factor A	14	0.2	0.3	0.3	0.02	0.5
	factor B	12	0.1	0.3	0.2	0.01	0.4

The amount of productive stems varies depending on the multi-directional action of chemicals selected for presowing treatment. On average, over the years, the smallest number of productive stems has been formed by the plants of the control variant - 424 pcs./m^2. The use of AKM PGR contributed to an increase of this indicator by 6.4% relative to control. Appliction of multicomponent fungicidal treaters (Raxil Ultra, Lamardor) and fungicide-insecticidal mixture (Lamardor + Gaucho) increased the number of productive stems in plants by 8.0-33.0% relative to control. A combination of treaters with AKM had a positive effect on plant development, which was manifested in the increase of this index by 1.2 – 1.4 times relative to control.

The use of selected treaters positively influenced the size of the ear, the length of which on average increased by 10.3% relative to control. An increase in the size of inflorescence by an average of 16.2% relative to control occurred when combined application of treater and AKM was used.

In the study of the number of inflorescences in the ear, it was found that the control variant was marked by the smallest values of this index. The use of AKM contributed to an increase in the number of inflorescences in the ear by 3.5% relative to control, and the selected treaters increased this figure by 4.4-14.8% relative to control. Combination of treaters with AKM increased their effect, which was reflected in the growth of the number of inflorescences by 7.2-19% relative to the variant without the use of chemical treatment of the seeds.

The number of grains in the ear is an important indicator of the yield structure. It depends on the number of flowers in the ear, which begin to form in the stage of stem elongation (the formation of the elements of the flower) and ends with the formation of the flower and their amount, which falls on the period of earing and flowering of the plants [14].

The positive effect of presowing seed treatment showed itself in the increase in the number of grains in the ear in relation to the control variant by an average of 2.7% with the use of multi-component treaters and by 4.9% when combined with AKM relative to the control variant.

After the flowering of plants the period when the formation and development of the grain in the ear goes next. It is at this time that the conditions in which the process of the grain mass formation proceeds and they affect two indicators of the yield structure - the mass of grains of one ear and a mass of 1000 seeds.

The weight of grains from one ear and mass of 1000 seeds increased by 5.2% and 3.1%, respectively, in comparison with the control variant when using multi-component treaters. Adding AKM to the treater tank mixes increased their effect, which was reflected in the increase in the weight of grains from one ear by 8.7%, and the weight of 1000 seeds - by 4.2% compared with the control.

Thus, the obtained data shows that the use of seed treaters and PGR influences the formation of the elements of the yield structure and the yield of winter wheat in general. On average over the years of research, the lowest yield at 4.84 t/ha was formed in the control version (Table 2).

2. Biological yield of Shestopalivka winter wheat variety, t/ha (mean for 2015-17)

Seed treater (factor A)	PGR (factor B)	Biol. yield, t/ha	Increase compared to the control		Genetic potential realization, %
			± t/ha	%	
Control	No PGR	4.84	-		32
No treater	AKM	5.29	0.45	9	35
Raxil Ultra	No PGR	5.40	0.56	12	36
	AKM	5.96	1.12	23	40

Lamardor	No PGR	6.12	1.28	26	41
	AKM	6.82	1.98	41	46
Lamardor + Gaucho	No PGR	7.01	2.17	45	47
	AKM	7.61	2.77	57	51
LSD_{05}	factor A	0.28	-	-	-
	factor B	0.15	-	-	-

The use of AKM PGR for presowing treatment alone contributed to a 9.3% increase in yield compared with the control variant. Application of investigated seed treaters increased the yield by an average of 1.3 times in relation to control, which is explained by the protective effect from pathogenic microflora and pests during autumn vegetation.

When AKM was added to the treaters, the effect of the latter increases, which is manifested in the increase of the yield on average by 1.4 times relative to the control variant. It should be noted that during the years of study, the largest yield of plants was formed during presowing treatment with a fungicide-insecticidal mixture of Lamardor + Gaucho (7.01 t/ha) and Lamardor + Gaucho + AKM (7.61 t /ha).

In order to understand the effect mechanisms of fungicide-insecticidal mixtures and PGR on metabolic processes occurring in plant tissues, it is necessary to consider yield formation under stressful conditions. After all, effective formation of the elements of the yield structure occurs only if peroxide processes occur at a low level [15]. Moreover, as it is known, the intensification of peroxide processes occurs under stress conditions [16, 17]. The intensity of lipid peroxidation is judged by the level of MDA accumulation, which is a marker of oxidative stress (Table 3).

3. MDA content in leaves of plants of Shestopalivka winter wheat variety, nmol/g of dry matter (mean for 2014-2017)

Seed treater (factor A) Control	PGR (factor B) No PGR	Development stage						
		emergence	tillering		stem elongation	booting	flowering	milk ripe
			VE*	VR*				
No treater	AKM	204.5	202.2	215.2	177.1	141.5	124.4	98.2
Seed treater (factor A)	PGR (factor B)	193.6	191.4	205.0	162.3	130.1	116.6	92.6
Raxil Ultra	No PGR	188.4	185.1	196.4	158.4	129.0	112.2	86.6
	AKM	178.9	175.5	188.2	144.8	115.2	106.0	80.5
Lamardor	No PGR	168.8	166.3	174.2	146.5	115.7	98.5	75.2
	AKM	158.7	156.3	164.0	132.9	103.7	92.1	68.7
Lamardor + Gaucho	No PGR	159.1	155.2	158.3	139.6	105.3	92.9	70.8
	AKM	149.7	143.2	145.8	125.2	96.3	86.8	63.4
LSD_{05}	factor A	3.1	3.0	4.0	2.7	2.4	2.7	0.8
	factor B	4.3	2.8	2.7	2.1	1.3	1.3	1.2

* VE – vegetation end, VR – vegetation restart.

The highest MDA content was observed in the stage of emergence, which is explained by the significant influence of treatments on the tissues of the sprout. Thus, in the control variant and in the variant using AKM PGR, this figure was 204.5 and 193.6 nmol/g of dry matter, respectively. The use of multi-component treaters reduces the content of MDA by 7.9-22.2%, and the combination of selected seed treaters with AKM enhances the positive effect, which is manifested in lowering MDA by 12.5-26.8% relative to control. When studying the stage of autumn tillering, the decrease in the activity of peroxide processes in plant tissues of all experiment variants amounted to 1.1-4.3% in comparison with the stage of emergence. Such a decrease in MDA content positively influenced the development of plants in this development stage. The highest efficiency of reducing the intensity of free radical processes was noted in variants treated with Lamardor + Gaucho and Lamardor + Gaucho + AKM, where there was a decrease in MDA content by 2.4 and 4.3% relative to control compared to the stage of emergence, which accordingly affected the production of productive stems.

That is, the decrease in the level of intensification of free radical processes in the stage of autumn tillering positively influenced the formation of productive stems and the ears, which is confirmed by the inverse correlation between the number of productive stems of plants and the content of MDA in this phase of development (r = – 0.81 ÷ – 1,00), as well as the length of the ear and MDA content (r = – 0.76 ÷ – 0,99).

The restart of spring vegetation is characterized by high MDA content, which indicates the active occurrence of physiological and biochemical reactions in plants of the studied variety, with its physiologically dual nature [8]. In intensively growing or young parts of plants, an increased content of active forms of oxygen (AFO) is always formed as a by-product of the metabolism. However, in the absence of a sufficient amount of antioxidants in the cell, an excessive amount of AFO is produced that can initiate peroxidation [18].

Reducing the dynamics of MDA content in all experiment variants in the stage of stem elongation by 1.1–1.3 times compared with spring tillering positively influenced the formation of the number of inflorescences in the ear. It should be noted that with the transition of plants from the vegetative to the reproductive period there is a decrease in MDA content in all variants of the experiment by 1.2 – 1.3 times, which is explained by the protective function of carotenoids in plant leaves. They reach their maximum content and possess antioxidant properties precisely in the booting stage [19].

In the study of the course of peroxide processes, MDA content in the phase of milk ripeness of the grain under the effect of seed treaters was 11.8-27.9% less than in the control variant. The combination of treaters with AKM growth regulator had a positive effect and contributed to a decrease in MDA content by 17.9-35.4% relative to the control variant.

Thus, the decrease in the level of MDA in the tissues of plants had a beneficial effect on the process of formation and ripening of grain. This is confirmed by the inverse correlation which was established between the mass of 1000 seeds and MDA content in the leaves of plants in the period of milk ripeness of the grain (r = – 0.61 ÷ – 0.99).

The statistical analysis of the obtained data shows that seed treater (factor A) had a significant impact on the formation of productivity elements of Shestopalivka winter wheat variety, with the share of influence of 77.6-90.3%. Plant growth regulator (factor B) also had a significant effect on the indicated parameters and amounted to 8.4-16.0%.

Conclusions

In stress conditions caused by pathogenic microflora, pests, and unstable weather conditions in the years of research, selected fungicidal and fungicide-insecticidal treatments, as well as their combination with AKM PGR did not have a negative impact on plant growth and development and formation of the yield structure elements.

The best indices of the yield structure elements and yield were formed by the plants when using Lamarrdor + Gaucho and Lamarrdor + Gaucho + AKM presowing treatments, which allowed to realize the genetic potential of productivity by 47 and 51%, respectively.

The positive effect of presowing seed treatment by multi-component tank mixtures on plant development is attributed to a decrease in the activity of peroxidation processes, which was manifested in the decrease in MDA content by 6.2-30.3% on average during plants vegetation, depending on the treatment variant compared with the control.

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