

Influence of herbicides on indexes of yield of hybrid of corn Orzhitsa 237 MV

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The purpose. To study properties of grain of hybrid of corn Orzhitsa 237 MV and action of ferments anti-oxidant protection for detection of aftereffects of treatment of sowings with selective herbicides Kharnes, Proponit, Master and Stellar. **Methods.** Activity of superoxide scavenger (SOD; KF 1.15.1.1) was determined according to the level of retardation of regenerative process of nitrosine tetrazolium at presence of nicotinamide nucleotide and phenazine methasulphate. Catalase activity was determined by titrometric method with solution of potassium permanganate after incubation of supernatant during 30 minutes at 25°C with hydrogen superoxide and it was expressed in mM of H₂O₂/min g of crude mass. Content of GSH and activity of glutathione-S-transferase was determined according to practical standard. **Results.** After-effect of herbicidal treatment on the dead-ripe grain of hybrid of corn Orzhitsa 237 MV is probed. Lower mass of seeds and content of water-soluble proteins depending on individual properties of herbicides is fixed. There were also determined different direction changes in activity of anti-oxidant ferments. **Conclusions.** The determined morphological and metabolic changes can be evaluated as development of after-effect of herbicides: aberration from control indexes of seeds, caused by action of herbicides, points out to aggravation of yield of probed hybrid. Results of investigation specify expediency of testing perspective hybrids also on responsivity to herbicides with different mechanisms of action.

Key words: hybrid of corn, after-effect of herbicides, anti-oxidant ferments, rebuilt glutathione, activity of glutathione-S-transferase.

One of the topical problems of agricultural production in Ukraine is the fight against weeds, which limit the yield of cultivated plants by intensive use of nutrients and moisture. Increasing the flow of water through its evaporation with different types of weeds reaches 3000 m³. In some cases, the losses caused by weeds can be 20-50% of the possible level of yield for continuous crops and 40-80% for crop rotation [1].

To regulate the growth and reproduction of undesired vegetation, herbicides of various spectrum of action are widely used [2]. Cultivated plants do not belong to the target objects of their action, but under conditions of agrocenoses, they undergo the phytotoxic influence of these substances, which is accompanied by reorganization of linear growth and development of plants, manifestation of chlorosis, variously directed violations of physiological and biochemical functions, changes in the structure of crop and grain quality [3].

Herbicide treatment of crops is a leading place among the methods of controlling weeds in the modern agricultural sector of Ukraine. Costs associated with the use of herbicides can reach 15-20% of the cost of cultivating crops. Despite the long period of use of herbicides, the issue of environmental safety has not yet received a unambiguous assessment [4, 5].

The need for herbicide treatment is dictated by the fact that the degree of contamination of 80% of the crop area in Ukraine by weed seeds reaches 1.14 - 1.47 billion pp./ha. On the other hand, the herbicidal method of weed control is often not sufficiently effective. For example, it has been established [6] that in the steppe Dnieper region, against the backdrop of annual application of herbicides in the period 1991-2001, the general littering of the ground arable layer by seeds of weeds increased by 1.5 and the amygdala of polynomial (*Ambrosia artemisiifolia* L.) - 2.4 times.

The negative impact of herbicides on the ontogenesis of cultivated plants is also possible, despite the fact that companies producing herbicides consistently confirm the absence of their toxic effects on various plant species. In particular, in recent years, a significant number of studies have revealed the negative effects of some herbicides: 2,4-D (50% vr.) - d.r. 2,4-dichlorophenoxyacetic acid amine salt, Atrazine (50% cf.) - d.r.

derivative of sim-triazine, Achenite (85% CU) - d.r. acetohlor, a derivative of chloroethanalide, etc., which were widely used in the previous period [6].

Under these conditions, there was a decrease in the height, the surface area of the leaves and the productivity of corn grain, increased sterility of pollen of sorghum [7], accumulation of residual herbicide and their metabolites in cultivated plants [8].

We studied some of the properties of corn grain and the functioning of antioxidant protection enzymes in order to detect after the treatment of crops with standard and new selective herbicides: Harnes, 90% of k.e. - (acetohlor) - 2.5 l / ha; Offer 96% of k.e. - (propyosochlor) - 2,0 l / ha; Master, 62% - (foramussulfuron + iodossulfuron-methyl sodium + carbazon-methyl + antidote isoxadifenethyl) - 150 g / ha + Bio-Power adherent - 1,25 l / ha; Stellaar, 21% yr - (топрамезон + дикамба) - 1,25 l / ha + metolat adherent - 1,25 g / l.

Materials and methods of research

Field experiments were carried out at the sites of the Institute of grain crops of NAAS (Dnipro, Ukraine), the soil cover of which is represented by conventional black soil with 4-5% humus. The object of the study was to reach the seeds of corn hybrid Orzhitsa 237 MB. Herbicides were used in the recommended standards, in particular Harnes - 2.5 l / ha, Master and Stella - 1.25 l / ha and Proponit - 2.0 l / ha.

The activity of the enzyme superoxide dismutase (SOD, KF 1.15.1.1) was evaluated by the level of inhibition of the nitrosine tetrazolium (NST) reduction process in the presence of nicotinamide dummies (NADH) and phenazinemethylsulphate (FMS) [9]. The reaction mixture contained 1.2 ml of Na-phosphate buffer, 0.1 ml of FMS solution, 0.3 ml of NST and 0.3 ml of supernatant. The reaction was initiated by the addition of 0.2 ml NADH and stopped with 1 ml of acetic acid. To determine the activity of the enzyme benzidine peroxidase (PO; KF 1.11.1.7) [10] in the reaction mixture containing 0.2 ml of a supernatant and 0.8 ml of acetate buffer, 1 ml of a 0.1 M solution of benzidine was added. The changes in optical density were recorded at wavelengths of 470 nm, and the activity of the enzyme was expressed in units of optical density / min × g of crude mass.

The activity of the enzyme Catalase (CF 1.1.1.6) was investigated by the titrimetric method [11] with potassium permanganate solution after incubation of the supernatant for 30 minutes at 25 ° C with hydrogen peroxide and expressed in mmol H₂O₂ / min × g of crude mass.

One of the effective components of metabolic protection is a glutathione system, the activity of which is induced in response to the influence of various stressors and is determined by the content of reducing glutathione (GSH) in plant cells. GSH content and glutathione-S-transferase activity (GST) were determined according to the generally accepted method [12].

The statistical processing of the results is done using the Statistica 6.0 package.

Results and discussion

As a result of the study, we found a reduction in the mass of 1000 corn grains, as well as a decrease in protein content in grain (Table 1). The least reduction in the weight of seeds (2.4% below control) and protein content (7.6%) were detected by the action of herbicide Harnes, and the greatest decrease (correspondingly, 4.2% and 13.1%) - due to herbicide action Master . The obtained results are consistent with the known data on the negative effects of herbicides, including glyphosate, which leads to a decrease in the similarity and mass of pea seedlings, as well as to the damage to the growth and conservation of micronutrients in soybeans [13, 14].

Table 1. Influence of herbicide treatment of crops on reaching grain of maize hybrid Orzhitsa 237 MB

Herbicides	Weight 1000 grains, g (M ± SD)	P	Water soluble protein content, g / 100 g (M ± SD)	P
CONTROL	205.6±2.6	-	1.72±0.01	-
Harnes	200.8±2.4	0.435	1.58±0.01	0.010
Master	197.1±2.5	0.002	1.49±0.01	0.002
Stellaar	198.3±2.4	0.006	1.58±0.01	0.006
Propose	199.3±2.4	0.010	1.57±0.01	0.003

Support for oxidative-reducing homeostasis of plant organisms due to environmental factors, including herbicides, is provided by an antioxidant defense system. Adaptive ability of plants to the action of an abiotic stressor can be realized provided the coordinated functioning of protective enzyme systems, including SOD, peroxidase and catalase. In corn seeds from herbicide-treated plants, SOD activity exceeded control in 2.0-5.6 times (Table 2), which is accompanied by accumulation of excess hydrogen peroxide in plant cells [15].

At the same time, the activity of enzymes that can reduce the content of toxic metabolites, significantly ($P < 0.05$ in all cases) decreased compared with control: peroxidase activity was lower in 1,3-2,3 times, and the activity of catalase in 2, 4-2.9 times.

Table 2. Influence of herbicidal treatment of crops on antioxidant activity ($M \pm SD$) in corn hybrid of corn Orzhitsa 237 ww

Herbicides	SOD activity mind / min \times g	Activity of catalase, mM H ₂ O ₂ / min \times g	Activity of peroxidase, mind / min \times g
CONTROL	3.7 \pm 0.09	3.4 \pm 0.01	2.6 \pm 0.01
Harnes	9.7 \pm 0.05	1.3 \pm 0.06	1.9 \pm 0.01
Master	7.3 \pm 0.03	1.4 \pm 0.01	2.1 \pm 0.01
Stellaar	20.8 \pm 0.29	1.2 \pm 0.01	1.2 \pm 0.01
Propose	7.3 \pm 0.07	1.4 \pm 0.03	1.2 \pm 0.01

The results are in agreement with the data of other authors who have revealed different-directional changes in the activity of antioxidant enzymes in maize leaves due to the influence of Norflurazon herbicide, as well as in 8-day wheat sprouts after treatment with Paraquat herbicide. Significant disturbances in the functioning of the antioxidant system of maize seeds can cause the weakening of the protective properties of the grain and deterioration of its quality through herbicidal treatment of the parent form [citation. for 16].

Plants of the species *Zea mays* are capable of biodegradation, penetrated into herbicide cells, by activating the glutathione-dependent enzyme system. Therefore, the level of activity of this protective system in grain reflects the degree of detoxification of herbicides in corn plants during the formation of seeds [14].

In our studies, a significant reduction in the efficiency of the glutathione-dependent system, which functions in the seeds of corn plants, for the treatment of herbicides (Table 3).

In comparison with the control parameters, the content of reduced glutathione in seeds of herbicide-treated plants was reduced by 1.4-1.7 times, and the activity of glutathione-S-transferase was reduced by 1.2-1.7 times, indicating a significant deviation in the functioning of the glutathione-dependent system of plant protection.

Table 3. Influence of herbicide treatment of corn crops on GSH content and GST activity in the seed of hybrid Orzhitsa 237 MB

Herbicides	Вміст GSH, нМ / г ($M \pm SD$)	P	Активність GST, нкат / г ($M \pm SD$)	P
CONTROL	863.2 \pm 36.3	-	5.3 \pm 0.05	-
Harnes	505.4 \pm 48.1	0.015	3.5 \pm 0.11	0.001
Master	605.3 \pm 20.8	0.029	4.5 \pm 0.11	0.026
Stellaar	635.9 \pm 12.4	0.042	3.1 \pm 0.02	0.003
Propose	545.3 \pm 83.6	0.043	4.2 \pm 0.10	0.021

The greatest reduction in the content of reduced glutathione was caused by the effect of soil herbicides (up to 59% of the control level) and Proponita (up to 63% of the control level). As for glutathione-S-transferase, the activity of the enzyme was reduced mainly due to the effects of Harnes herbicide (up to 66% of the reference level) and Stellaur (up to 58% of the reference level). Accordingly, the glutathion-dependent

system responsible for the biodegradation of toxic components of different origins was inhibited in maize grain cells due to the action of herbicides on parent plants.

Reducing the pool of reduced glutathione may be due to its conjugation with herbicides, as well as to violations of its biosynthesis. In any case, the decrease in the content of this thiol compound leads to a decrease in the oxidative-reducing status of plant cells and a weakening of the resistance of plants to stress factors [1, 17].

The results of the studies showed that the effects of herbicide treatment of maize crops were observed in changes in the properties of the seeds, which confirms the sensitivity of the 237 MB Orzhits corn hybrid to the phytotoxic action of herbicides.

CONCLUSIONS

In the State Register of Varieties of Plants, suitable for distribution in Ukraine, the hybrid of corn Orzhitsa 237 MW was registered in 2010. It is characterized by high yield and quality of grain and resistance to cold, drought and pests. It is assumed that the quality of the grain of this hybrid must fully meet the standards.

Herbicide treatment of crops led to a decrease in the mass of seeds, the content of water soluble proteins, and increased activity of antioxidant enzymes in the reached seed of hybrid maize Orzhitsa 237 MB depending on the individual properties of herbicides. The amount of reducing glutathione in the seeds treated with herbicides was higher, the activity of the enzyme glutathione-S-transferase was lower than in the control.

Detected morphological and metabolic alterations can be estimated as a manifestation of aftereffects of herbicides. In particular, deviations from the control parameters of the seeds, indicating a deterioration in the quality of the herbicide yield, indicate a deterioration in the yield of the studied hybrid maize. Thus, testing of promising corn hybrids for sensitivity to herbicides with different mechanisms of action has been established.

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