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Comparative Study of Catalase, Superoxide Dismutase and Lipid Peroxidation Products in Wheat Plant Exposed to Salt Stress and to Presowing Gamma Irradiation

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Abstract

The effect of presowing gamma irradiation on the activity of antioxidant system of wheat seeds exposed to salt stress was studied. The treatment of wheat seeds with various dozes of gamma irradiation significant reduction in processes initiated by salt stress. A positive effect of small dozes gamma irradiation on the amount of malon dialdehyde, catalase, superoxide dismutase in salt stress exposed wheat seedlings was revealed.

Keywords: wheat, salt stress, γ-irradiation, catalase, superoxide dismutase, lipid peroxidation, malondialdehyde

Introduction

20 % of the worlds irrigated agricultural lands are adversely affected by soil salinization [1]. Providing the world's population with food products is one of the most global problems of humanity. On Earth, drought stress and increasing soil salinization, which occur against the background of global warming, are serious sources of abiotic stress that reduce plant productivity. All these negative effects and the limitation of suitable and productive land areas for agriculture in the future pose a serious threat to meeting people's food needs [2]. According to the information of the "World Resources" and "Environment and Development" international institutes, currently 25% of the arable land on earth has been subjected to salinization to one degree or another. High salt concentrations that increase the amounts of reactive oxygen species (ROS), such as singlet oxygen-1O2, superoxide anion radical - O2 ·-, hydrogen peroxide H2O2, and hydroxyl radical - OH· cause oxidative stress [3]. Salt stress adversely affects plant growth and development, whereas plants have evolved regulatory mechanisms that allow them to adapt to these adverse conditions. For instance, plant growth is inhibited by salt stress due to decreased photosynthesis [4]**.** High doses of gamma irradiation acts similarly, but it is known that small dozes of gamma irradiation accelerates the growth and development of plants and improves their productivity. Organisms are able to protect themselves from the damaging effects of free radicals due to highly active antioxidant system that includes low and high molecular substances capable inhibiting of free radical processes [5].

Examined the effect of low dose γ- radiation on improving the drought resistance of a local Iranian rice variety. The results showed that under stressful conditions, preliminary treatment of seeds with γ-irradiation cause a significant increase in callus growth compared to those of controls [6]. The effect of different radiation doses was investigated. The results showed that irradiated seeds had increased seed germination percentage, seedling dry matter content in the leaves of seedlings [7].

The obtained results show that gamma irradiation at dose rate 5 Gy gave the best results of plant gamma irradiation at dose rate 2.5 and 10 Gy and also higher photosynthetic pigments such as chlorophyll a, b, a+b and carotenoids than un-irradiated tubers. Regarding chemical constituents of tubers it was observed that gamma irradiation at dose 5 Gy scored higher percentage of nitrogen, phosphorus, potassium, total carbohydrates and inulin than other doses. [8].

The main purpose of the presented work was a comparative study of the effects of various NaCl concentrations on antioxidant enzymes activity and on lipid peroxidation of wheat plant grown from seeds exposed to small dozes of ionizing irradiation.

Materials and method

The objects of research were triticum durum wheat seeds of the “Girmizi gul” variety. Wheat seeds were treated with solutions of hydrogen peroxide for sterilization.

Than the seeds were irradiated with a dose of 15 Gy using the URİ (K-25 gamma irradiation source) device. Experiments to study the effect of various NaCl concentrations on the dynamics of growth and development of seedlings were also carried out after irradiation of seeds. Experiments were carried out in 5 repetitions.

To determine the product of lipid peroxidation, malonic dialdehyde, 1 g of fresh weight of seedlings was homogenized in a porcelain mortar with a small amount of the reaction mixture consisting of a 0,25% solution of thiobarbituric acid (TBA). The homogenate was transferred into a glass tube in small portions of the reaction mixture. The samples were mixed and placed in a water bath heated to 950 C for 30 min. Then the contents of the samples were transferred into centrifuge tubes and centrifuged for 10 min at 10,000 g. Optical density was measured on a spectrophotometer Multiscan GO, Germany [9].

Activities of CAT [10], SOD were determined using spectrophotometric methods [11].

Data analysis and statistical analysis was conducted using Microsoft Excel. Statistical analysis was performed with the aid of the Statgraphics Plus 5.1 statistical package. The means of values were compared by Duncan`s multiple range test (p=0,05)

Results and discussion

At the beginning of the experiments were studied the effects of various NaCl concentrations on the germination of seeds irradiated at a dose of 15 Gy and non-irradiated. The germination rate of seeds that have not been irradiated at a dose 15 Gy has dropped to 62% due to . As a result of salt stress, the germination rate of seeds was reduced by 40% compared to control. The germination rate of wheat seeds irradiated at a dose of 15 Gray was - 82% in the variant exposed to the 50mM Nacl solutions. 78 % in the variant exposed to the 100 mM NaCl solution and 71 % in the variant exposed to the 200 mM NaCl solution.

The study of the dynamics of growth and development of seedlings obtained from gamma-irradiated maize seeds was carried out for 3 weeks. Seedling growth was measured every 4-5 days. The study of the effect of different NaCl solutions on the growth and development of seedlings was carried out without and with presowing irradiation. Table 1 shows the results of experiments on the study of catalase, superoxide dismutase and lipid peroxidation products exposed to presowing gamma irradiation and salt stress.

According to the results from the table, the amount of MDA in 50, 100, 200 mM salt exposed and non-irradiated options increased up to 36% compared to the control option. In variants exsposed to presoving gamma irradiation, this increase was between 10-22% depending on the concentration of the NaCl solution. The amount of H_2O_2 also increased by 17-22% compared to the control version. In the variant obtained from seeds irradiated with a dose of 15 Gy, this figure was between 4-9%. When looking at the activity of catalase and superoxide

dismutase, it was noted that the indicators were closer to the control in the variants exposed to salt after 15 Gy irradiation compared to the variants exposed to 50, 100, 200 mM NaCl. From the obtained results, it can be concluded that presoving irradiating wheat seeds at a dose of 15 Gy before being exposed to NaCl, increases the activity of the antioxidant system in them, causing them to be resistant to the effects of salt in different concentrations.

Table. The effect of various NaCl concentrations on the dynamics of activities of the CAT, SOD enzymes and on the content of the MDA in the leaves of the wheat.

NaCl mM	CAT	SOD	MDA	H_2O_2
First week				
K	0.291±0.17	3.36±1.02	111.0±9.3	162
50	2.387±0.16	4.43±0.56	169.0±20.8	191
100	3.599±1.01	5.23±0.39	172.0±17.8	201
200	3.322±0.39	5.91±0.84	172.0±17.8	199
15Gy+50	0.921±0.42	3.43±0.41	123.0±16.4	169
15GY+100	0.125±0.23	4.51±0.31	134.0±13.4	171
15GY+200	1.31±0.34	4.43±0.28	142.0±12.3	178
Second week				
K	0.301±0.21	2.94±0.76	133±13.7	186
50	2.785±1.01	4.64±0.35	145±12.01	198
100	3.432±0.53	5.36±0.56	147±11.07	203
200	3.17±0.48	5.98±0.98	151±9.05	200
15Gy+50	1.112±0.38	3.92±0.59	139±14.1	184
15GY+100	1.351±0.43	4.78±0.54	142±13.3	188
15GY+200	2.312±36	5.11±0.32	144±9.06	197
Third week				
K	0.305±0.51	2.63±0.56	151±10.04	177
50	2.92±0.39	4.71±0.38	141±11.71	192
100	3.67±0.76	5.55±0.93	143±9.03	196
200	3.43±0.56	5.73±0.37	149±12.08	194
15Gy+50	2.11±0.42	2.94±0.34	133±11.02	188
15GY+100	2.94±0.38	3.22±0.42	144±12.03	191
15GY+200	3.25±0.29	3.44±0.29	142+9.01	189

Gamma irradiation damages initiated by free radicals are enhanced at the expense of reactive oxygen species (ROS) that cause oxidative modification of macromolecules, violation of the integrity of cellular structures. İn lipids, mainly in polyunsaturated fatty acids, ROS cause chain reactions with accumulation of lipid, peroxyl, alkoxyl and other radicals. Organisms are able to protect themselves from the damaging effects of free radicals due to highly active anti-oxidant system that includes low and high molecular substances capable inhibiting

of free radical processes [12].

It was observed that gamma irradiation at dose 5 Gy scored higher percentage of nitrogen, phosphorus, potassium, total carbohydrates and inulin than other doses. The moderate dose of gamma irradiation 5 Gy has a simulative effect on growth of Jerusalem artichoke which reflects on tubers yield and their chemical constituents [13]. Some authors reported that the use of low dose gamma irradiation to improve plant vigor, grain, grain development and yield attributes of wheat [14].

In general, the results showed that irradiation of seeds in doses 15 Gy reducing the effects of salt stress, can partially balance the destructive consequences of excess salt.

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