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THE EFFECT OF SALT SOLUTIONS ON THE DMDH ENZYME ACTIVITY IN THE *Hordeum vulgare* PRIMARY INCUBATION

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ВЛИЯНИЕ СОЛЕВЫХ РАСТВОРОВ НА АКТИВНОСТЬ ФЕРМЕНТА ДМДГ ПРИ ПЕРВИЧНОЙ ИНКУБАЦИИ *Hordeum vulgare*

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Abstract. Plants are subjected to a wide range of environmental stresses which reduces and limits the productivity of agricultural crops. Two types of environmental stresses are encountered to plants which can be categorized as abiotic stress and biotic stress. The abiotic stress causes the loss of major crop plants worldwide and includes radiation, soil salinization, floods, drought, extremes in temperature, heavy metals, etc. Abiotic stresses such as drought (water stress), excessive watering (water logging), extreme temperatures (cold, frost and heat), soil salinization and mineral toxicity negatively impact growth, development, yield and seed quality of crop and other plants. In future it is predicted that freshwater scarcity will increase and ultimately intensity of abiotic stresses will increase.

Аннотация. Растения подвергаются широкому спектру экологических стрессов, что снижает и ограничивает продуктивность сельскохозяйственных культур. Растения подвергаются двум типам экологических стрессов, которые можно разделить на абиотические стрессы и биотические стрессы. Абиотический стресс вызывает гибель основных сельскохозяйственных культур во всем мире и включает радиацию, засоление почвы, наводнения, засуху, экстремальные температуры, тяжелые металлы и т. д. Абиотические стрессы, такие как засуха (водный стресс), чрезмерный полив (заболачивание), экстремальные температуры (холод, мороз и жара), засоление почвы и минеральная токсичность отрицательно сказываются на росте, развитии, урожайности и качестве семян сельскохозяйственных и других растений. В будущем прогнозируется увеличение дефицита пресной воды и, в конечном счете, увеличение интенсивности абиотических стрессов.

Keywords: Hordeum vulgare, osmotic stress, abiotic stress, plants, soil salinization.

Ключевые слова: ячмень обыкновенный, осмотический стресс, абиотический стресс, растения, засоление почвы.

Introduction

Stress in plants refers to external conditions that adversely affect growth, development or productivity of plants. Stresses trigger a wide range of plant responses like altered gene expression, cellular metabolism, changes in growth rates, crop yields, etc. A plant stress usually reflects some sudden changes in environmental condition. However, in stress tolerant plant species, exposure to a particular stress led to acclimation to that specific stress in a time time-dependent manner [6, 8]. Plant stress can be divided into two primary categories namely abiotic stress and biotic stress. Abiotic stress imposed on plants by environment may be either physical or chemical, while as biotic stress exposed to the crop plants is a biological unit like diseases, insects, etc. Some stresses to the plants injured them as such that plants exhibit several metabolic dysfunctions. The plants can be recovered from injuries if the stress is mild or of short term as the effect is temporary while as severe stresses lead to death of crop plants by preventing flowering, seed formation and induce senescence. Such plants will be considered to be stress susceptible. However, several plants like desert plants (Ephemerals) can escape the stress altogether [1, 3].

Salinity in water or soil is another abiotic factor that can limit crop production specifically in arid or semi-arid regions. According to an estimate published in 2011, over 800 million hectares of world land are affected by high levels of salinity [4, 7]. Similarly, the same study reported that about 17 million hectares of agricultural land will be affected by salinity by 2050. The adverse effects of salinity on plants are associated with the low osmotic potential of soil, nutritional imbalance, specific ion effect, or a combination of all these factors. These factors have severe effects on plant growth and development at various levels. General effects include reducing the growth rate, smaller and fewer leaves, and reduction in root length. The osmotic effect of salinity contributes to changes in leaf color and developmental aspects such as root/shoot ratio and maturity rate [1, 2, 5]. As with other abiotic stresses, the effects of salinity on plants and their response towards it depends on the duration and severity of the stress. Generally, salinity has short term effects (such as ion-independent growth reduction) that take place within minutes to hours or days after perception of the stimuli, close stomata and inhibition of cell expansion which is shoot specific and long-term effects which can occur over days or even weeks (such as building up cytotoxic ion levels, slowing down the metabolic activities and causing early senescence and ultimately cell death).

Material and Methods

Salinity and associated salt stress have a sharp impact on the growth and development dynamics of plants, and even their morphological characteristics. At the heart of these processes, of course, are changes in the metabolism of stressed plants, which, on the one hand, are reflected in the morphology of plants, on the other hand, give plants a chance to adapt to adverse environmental conditions.

Salt stress can create a water deficit even in well-supplied soils by reducing the osmotic potential in the soil solution, complicating the process of water absorption from the environment by the root system of plants. In addition, salt stress causes artificial ion deficits in plant tissues by affecting the intracellular compartmentalization of ions (J. Krasensky, C. Jonak). As a result, the growth and development of plants is difficult, and when changes in metabolism are sharp, the stress factor leads to the destruction of the plant [2, 7].

Selected plants are widespread in nature and are of great agricultural importance. The experiments were carried out during the first 7 days of seedling development. It is known that during this period of development, plants become more sensitive to adverse environmental conditions, including salt stress, and it is easier to monitor their responses to it.

Results and Discussion

Table 1 below shows the effect of different concentrations of NaCl, Na_2SO_4, $NaHCO_3$ and Na_2CO_3 salts on the dynamics of cytoplasmic DMDH enzyme activity of barley seed roots over 24 hours.

As can be seen from the figures presented in the table, there is virtually no significant change in the activity of the control variant DMDH enzyme during the 24-hour incubation period. Apparently, this stability is due to the nature of the demand for its catalytic activity in the early stages of development of barley seedlings.

Although osmotic stress stimulates the activity of the DMDH enzyme in all cases, the changes observed in its dynamics are different depending on the type, concentration and duration of exposure to the salt used to create the stress state. At relatively low concentrations of NaCl salt (25 and 50 mM) there is a direct correlation between the degree of stimulation of the enzyme activity and the salt concentration and duration of action. The maximum stimulation of the enzyme activity occurs 24 hours after incubation at a concentration of 50 mM of NaCl salt. During this period, its activity is 44.7% higher than the similar activity in the control variant (Table).

Table

SHORT-LIVED BARLEY SEEDLINGS IN Na-ISOQUATED SALT SOLUTIONS EFFECT OF INCUBATION ON DMDH ENZYME ACTIVITY

Variants	*Incubation period (hours)*			
	6	*12*	*18*	*24*
Control	75±1.5	77±1.6	76±1.8	76±1.2
		NaCl		
25 mM	78±1.3	90±1.9	96±1.3	98±1.7
50 mM	84±1.5	97±1.7	107±1.5	110±1.1
75 mM	88±1.6	108±1.5	99±1.7	87±1.4
100 mM	91±1.4	105±1.8	85±1.5	70±1.6
		Na_2SO_4		
25 mM	77±1.3	96±1.5	102±1.5	86±1.8
50 mM	82±1.5	88±1.4	90±1.3	73±1.3
75 mM	86±1.7	90±1.2	85±1.5	64±1.7
100 mM	84±0.9	86±1.5	60±1.8	30±1.4
		$NaHCO_3$		
25 mM	85±1.6	105±1.5	122±1.5	116±1.5
50 mM	89±1.4	114±1.6	139±1.6	151±1.7
75 mM	97±1.15	116±1.4	125±1.4	123±1.5
100 mM	104±1.6	96±1.6	73±1.6	59±1.7
		Na_2CO_3		
25 mM	80±1.3	92±1.2	96±1.3	100±1.8
50 mM	85±1.5	104±1.3	113±1.5	126±1.3
75 mM	91±1.4	108±1.4	97±1.6	91±1.5
100 mM	96±1.9	88±1.1	76±1.4	68±1.5

At high concentrations of salt, the activity of the enzyme is inhibited. It seems that overcoming the stress situation at low concentrations of NaCl salt requires the intensification of the DMDH enzyme in the root system of barley seedlings, while at high concentrations the normal functioning of the enzyme itself is disrupted.

The nature of the stress caused by the short-term effects of the Na_2SO_4 salt on the dynamics of the activity of the enzyme DMDH is significantly different from that of the NaCl salt. The time required for maximum stimulation of the enzyme activity under the influence of Na_2SO_4 salt is shorter than that of NaCl salt, but its stimulating effect is weaker than that of NaCl salt. This emphasizes that the inhibitory effect of Na_2SO_4 salt is stronger than that of NaCl salt.

It is not known how these differences relate to the effect of salts. In fact, these differences are due to the absorption of salts by the cells of barley sprouts, the expression and translation of the gene encoding the enzyme protein, the direct effect of salts on the enzyme molecule, and so on. can occur at the level of.

The effect of stress generated by the Na_2CO_3 salt on the dynamics of DMDH enzyme activity is similar to the effect on the NaCl salt variant.

Among salts, $NaHCO_3$ salt has the strongest effect on the activity of the enzyme. At a concentration of 25-50 mM, its stimulating effect varied in direct proportion to time and viscosity, and the maximum effect was observed after a 24-hour incubation period at 50 mM. As in all variants, in this case, the high concentrations of salt had an inhibitory effect on the activity of the enzyme DMDH. Thus, different concentrations of NaCl, Na_2SO_4, $NaHCO_3$ and Na_2CO_3 salts have different effects on the activity dynamics of the cytoplasmic DMDH enzyme in the root system of barley seedlings even during short-term incubation. At relatively low concentrations of salts, the activity of the enzyme is significantly increased, while at higher concentrations, on the contrary, it is inhibited. It seems that the induction of the activity of the enzyme DMDH during salinity stress is associated with the protective reaction of seedlings and is carried out at the level of enzyme expression. The effect of high concentrations of salts is probably non-specific and is due to the direct effect of salts on the catalytic activity of the enzyme.

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