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Effect of Cytokinin-Type Compounds On The Self-Regulation Of Plant Water Status Under Conditions of Adverse Humidity Variation And Repeated Water Stress

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Abstract

The effect of cytokinin, thiourea, and complex chemical Polyel + F on the ability of water status self-regulation, photosynthesis, and on the efficiency of water use by plants under conditions of humidity fluctuations and repeated drought was studied. Glycine max (Merr) L. plants of 'Nadejda', 'Moldovitsa' and 'Magia' cultivars grown in the Mitcherlih vegetation pots with a volume of 40 kg soil and exposed to the drought stress at the phases "first trifoliate leaf" and "flowering – pod formation" were used in the study. The studied compounds' property to increase the plant resistance to unfavorable humidity fluctuations and conditions of repeated moderate drought has been established. Plants that have endured a moderate drought in the early stages of ontogenesis become more tolerant to moderate water stress during flowering and pod formation. The effect of tolerance inducing in plants pre-treated with respective compounds is manifested by increasing the water retention capacity, keeping the internal aqueous medium at a comparatively higher level. After restoring optimal moisture conditions, the plants pre-treated with thiourea and Polyel+F restore their functional processes more integrally. The research data suggest that changes occurring at the cellular level in the early stages of development, caused by moderate moisture deficiency and conferring resistance, are initiated when the water content decreases and can be consolidated when water loss is not too drastic.

***Keywords** - plants, water stress, water homeostasis, water retention capacity, photosynthesis*

I. INTRODUCTION

Climate change on Earth and global warming have led to an increase not only in the intensity but also in the frequency of extreme natural phenomena. The negative impact of climate change on Earth, over time repeated drought, accompanied by heat, hail and temperature drops, extreme fluctuations in rainfall, nutrient imbalance, is often catastrophic for plant productivity. Under field conditions, due to the negative impact produced by repeated drought, coupled with intense heat, hail, rain, and temperature drops, crop yield reaches an average of only 50% of its potential [2]. Lately, special attention is given to elucidating the mechanisms involved in plant response reactions and tolerance to repeated stress in order to optimize the plant adaptability to fluctuations of environmental conditions and streamline the use of water and nutrients in the production process.

Recent bibliographic data show that plant responses to repeated cycles of ecological stress differ from those that suffer single stress incidents [4; 8; 11; 17; 18]. Based on our own investigations [11; 12], it was argued that a moderate short-term drought in the early stages of development triggers mechanisms that increase tolerance to extreme fluctuations in environmental conditions – the repeated occurrence of insufficient humidity, hypo-, and/or hyperthermic stress. These findings are accordant with [7] by the correlation between hydrostatic pressure changes, stomata closure, and plant tolerance to the reduction of water potential in soil works carried out, especially on plant species of spontaneous flora. When humidity changes and the osmotic pressure of the soil solution increases, the plants react almost instantly by changing the water status in the organism with repercussions on metabolic processes, growth, and productivity. Under drought conditions, disturbance of the internal aqueous medium, inhibition of metabolic reactions and biosynthesis is the main cause of disruption of functional processes [3; 9; 11; 14; 15]. Dehydration conditions the reduction of phytohormone levels not only by inhibiting their transport but also by blocking their synthesis. Decreased tissue hydration activates auxinoxidase and cytokinin oxidase, which leads to a sudden decrease in auxin and cytokinin and reduces water absorption by the roots and conductivity of the stomata, and, as a result, reduced leaf perspiration [21]. Under moderate moisture deficiency in the soil, when water potential in the shoot is not yet affected, and the auxin production is not inhibited, their transport in the roots continues to condition the acceleration / or stabilization of their growth to wetter soil layers, thus ensuring a way for water absorption and its delivery to the shoot. Along with the water flow from roots to the shoot, the transfer of cytokinins takes place through which is regulated the state of stomata and, consequently, water consumption, the process of assimilation of carbon dioxide and formation of the foliar apparatus, as well as cell growth. At the same time, cytokinins increase the potential of water dragging to leaves and growing organs. Their dragging action is explained by the property of the phytohormone, on the one hand, to open the osteoles of the stomata and to intensify perspiration, on the other hand – to stimulate growth processes and biosynthesis in cells. The intensification of perspiration increases the suction force due to the cohesion of water molecules, and the intensification of biosynthesis conditions the molar concentration increase of photoassimilates in leaves, which leads to the decrease of the osmotic potential and to the osmotic absorption of water.

The possibility of adjusting the adaptive reactions using exogenous phytohormone has been demonstrated in many investigations [10; 11].

Based on the mentioned above, the current research objective was to elucidate the effect of cytokinin-type compounds on the ability of self-regulation of the plant water status under humidity fluctuations and episodic repeated drought.

II. MATERIALS AND METHODS

Plants of *Glycine max* L. (Merr) 'Nadejda' variety, obtained in IGFPP (author Ph.D. Budac Alexandru), were used as objects of study. Testing the effect of tolerance inducers under conditions of controlled fluctuating humidity and repeated water stress was performed in vegetation trials with plants grown in Mitcherlih containers with a capacity of 40 kg of absolute dry soil. A new complex compound, conventionally called Polyel, which contains macro-and microelements in the form of salts and coordination complexes, as well as vitamins – components necessary for normal plant development was obtained and tested. It is a solid beige mixture of coordination complexes of iron(III), cobalt(III), micro-and macroelements, vitamins, NO_3^- ions, substances that optimize the chemical composition of the compound and make it effective for plant growth and development. It does not contain substances that would be harmful to the environment.

Scheme of trials at the phase "I trifoliate leaf":

1. Control – plants under permanent humidity of 70% TWC (total water capacity of the soil);
2. Plants under humidity of 40% TWC (moderate drought);
3. Plants pre-treated with cytokinin solution and exposed to moderate drought (40% TWC);
4. Plants pre-treated with thiourea solution and exposed to moderate drought (40% TWC);
5. Plants pre-treated with the solution of Polyel + phytohormones (AIA, Gb, CK) and exposed to moderate drought (40% TWC);

Scheme of trials at the phase "flowering – pod formation":

1. Control, humidity 70% TWC;
2. Plants exposed for the first time to moderate drought, 70-40% TWC (first cycle of drought);
3. Plants repeatedly exposed to drought, the humidity of 70-40-70-40% TWC (2 drought cycles);
4. Plants pre-treated with CK and exposed to the humidity of 70-40-70-40% TWC (2 cycles of drought);
5. Plants treated with thiourea and exposed to the humidity of 70-40-70-40% TWC (2 cycles of drought);
6. Plants treated with Polyel + F complex and exposed to the humidity of 70-40-70-40% TWC (2 cycles of drought).

In the trials, the plants were exposed to consecutive cycles of water deficit, each cycle followed by a recovery period, and in each cycle, new, fully developed leaves formed under the corresponding stress conditions were analyzed. Analysis of water status parameters was performed after each drought cycle (on the seventh day of water stress) and after 7 days of recovery in the post-stress period by classical methods [16]; transpiration intensity (E), photosynthesis intensity (A), stomatal conductivity (Gs) – by using the portable gas analyzer LCpro-SD (ADC biotech-scientific Limited, UK). The net rate of photosynthesis, stomatal conductance, and transpiration were determined according to the scheme of experiments on active photosynthetic radiation (PAR) from 1000 $\mu mol \cdot m^{-2} \cdot s^{-1}$ photon flux density, while leaf temperature, air humidity, and CO_2 concentration – according to their content in the environment. Measurements were performed from 8 am to 11 am. The results were statistically analyzed using the "Statistics 7" software package for PC. The parameters of water content, saturation deficit, tissue water retention capacity, as well as photosynthesis intensity, and water use efficiency were used as indicators to quantify plant stress intensity and tolerance to repeated moisture fluctuation and moderate drought over time.

III. RESULTS AND DISCUSSIONS

Due to the fact that plant organism as an open biological system keeps close connection with the environment, and plant water is a continuum of soil water, the lack of moisture reflects primarily on plant water status, and tissue dehydration is a direct consequence of the external factors' action [5; 6]. At the same time, due to self-regulation abilities, plants can ensure a certain autonomy of metabolic processes regardless of the conditions of the external environment [22], and the higher is the stability of functional processes, the greater manifests the resistance of these plants.

Water stress conditioned by the reduction of the water supply of the plants in the "I trifoliate leaf" phase naturally caused a reduction of the hydration degree of the leaf tissues and increased saturation deficit (Table 1).

The values of water status components, as indicators of stress, in plants grown from seeds pre-treated with cytokinin-type compounds change under the influence of moisture deficit differently. Moderate drought at the "I trifoliate leaf" stage induces leaf dehydration and decrease of water content by 12.8% in untreated plants and by 9.8-11.7% – in plants grown from seeds pre-treated with compounds with cytokinin action. In plants pre-treated with thiourea, but especially in those pre-treated with Polyel + F complex, the degree of hydration is maintained at a higher true level.

Table 1. Modification of water status in the leaves of soybean plants in the "I trifoliate leaf" stage under the influence of cytokinin-type compounds and moderate drought.

Trial group, humidity % TWC	WC, g · 100 g f.m.		SD, % from full saturation		WRC retained water, % of initial content	
	M ± m	Δ, %*	M ± m	Δ, %	M ± m	Δ, %
Control, 70	77,87 ± 0,51		11,23 ± 0,30		50,06 ± 0,56	
Drought, 70-40	67,88 ± 0,85		28,56 ± 0,56		50,29 ± 0,69	
CK, 70-40	68,72 ± 0,58	1,24	27,35 ± 0,33	-4,32	52,85 ± 0,43	5,09
Tiouree, 70-40	69,34 ± 0,48	2,15	26,80 ± 0,27	-6,16	53,36 ± 0,35	6,10
Polyel + F, 70-40	70,22 ± 0,55	3,45	25,51 ± 0,21	-10,68	55,74 ± 0,33	10,84

* compared with untreated plants exposed to the same drought conditions.

Moderate soil moisture deficiency caused a considerably lower increase in saturation deficit in pre-treated plants with the studied compounds compared to the impact produced on untreated plants. As a result, leaf turgidity in untreated plants decreased by 19.5-20.5% compared to plants in the trial group well supplied with moisture, and in plants pre-treated with Polyel + F, the impact of drought was 15.0-16.0% from control plants.

One of the internal factors regulating water homeostasis is the ability to retain water. It has been established that soybeans leave under optimal moisture background after 2 hours of experimental wilting retain in the tissues about 50.0% of the initial water content; plants exposed to moderate drought conditions – 50.3% and plants pre-treated with CK, thiourea, and Polyel + F retain respectively 52.9%, 53.41% and 55.8% of the initial water reserve in the tissues. The leaves of the plants from the "Polyel + F" group, under conditions of moderate humidity insufficiency (70-40% TWC), are characterized by maximum values of water retention capacity.

It is known that the nature of the change in water status parameters – relative water content, water retention capacity in tissues, can be used as test criteria for assessing plant tolerance or sensitivity to drought [13]. Plants pre-treated with thiourea and, in particular, with Polyel + F under conditions of moderate humidity (40% TWC) are characterized by the property of keeping the tissue hydration at a relatively stable level. Therefore, these data lead to the conclusion that the compounds used for the treatment of seed before sowing and foliar apparatus during growth increase plant resistance to drought. Obtained results coincide with those stated by Argueso C.T. and coauthors [1] and by Vesselov D.D. and coauthors [19]. When humidity conditions improve, the plants, preventively treated with compounds with cytokinin action, restore their internal aqueous medium faster and more thoroughly (Table 2).

Table 2. Degree of water status restoring in soybean leaves, preventively exposed to water stress, under improvement of humidity conditions

Trial group, humidity % TWC	WC, g · 100 g f.m.		SD, % from full saturation		WRC retained water, % of initial content	
	M ± m	Δ, %*	M ± m	Δ, %	M ± m	Δ, %
Control, 70	76,51 ± 0,36		10,20 ± 0,08		49,58 ± 0,52	
Drought, 70-40-70	72,01 ± 0,23		12,65 ± 0,27		49,54 ± 0,29	
CK, 70-40-70	73,99 ± 0,65	2,75	11,75 ± 0,05	-7,11	50,55 ± 0,60	2,04
Tiouree, 70-40-70	74,68 ± 0,52	3,71	11,11 ± 0,22	-12,17	54,25 ± 0,45	9,50
Polyel + F, 70-40-70	76,62 ± 0,34	6,40	10,55 ± 0,18	-16,60	57,56 ± 0,37	16,19

* compared with untreated plants exposed to the same drought conditions.

Plants pre-treated with thiourea and Polyel + F restore more thoroughly their hydration grade. They are distinguished by higher values of leaf relative turgidity because the plants preventively treated with cytokinin-type compounds keep at a level higher water retention capacity in tissues and after optimizing soil moisture (Table 2). Plants pre-treated with thiourea and Polyel + F in the post-stress period retain by 10.1 and 16.1% respectively more water compared with control plants and by 9.5 and 16.2% more water compared with plants untreated and preventively exposed to the action of moderate drought.

Therefore, the studied compounds have the property to increase plant resistance to conditions of moderate drought. The effect of tolerance inducing is manifested by increasing the capacity of water retention, keeping the internal aqueous medium at a comparatively higher level, which ensures a better course of vital processes.

In the current investigations, new arguments, which confirm the formation of "stress-memory" in plants pre-exposed to the action of moderate water stress in the juvenile phase were obtained (Table 3). Mild dehydration caused by moderate water stress (40% TWC, 7 days) in the initial development phases (phase "I trifoliate leaves") results in the increased plant tolerance to repeated drought Plants, which have undergone mild water stress at "first trifoliate leaf" phase, manifested an adequate response under the occurrence of repeated drought conditions at "flowering – pod forming" phase. Plants that have undergone a moderate drought in the early stages of ontogenesis are more tolerant to moderate water stress during flowering and pod formation. This implies that changes occurring at the cellular level in the early stages of development under moderate moisture deficiency and conferring resistance are initiated by a decrement in water content and can be consolidated when water loss is not too fast. At the same time, there was a co-activating effect of the potential for stress-memory formation under repeated drought of *Glycine max* (Merr), L. plants by using cytokinin, thiourea, and, in particular, the Polyel + F complex.

Table 3. Parameters of water status in soybean leaves of 'Nadejda' under conditions of repeated drought at the stage of "flowering – pod formation."

Trial group, humidity % TWC	WC, g · 100 g f.m.		SD, % from full saturation		WRC retained water, % of initial content	
	M ± m	Δ, %*	M ± m	Δ, %	M ± m	Δ, %
Control,70	71,16 ± 0,46		12,95 ± 0,28		55,75 ± 0,41	
Drought, I cycle 70 - 40	66,42 ± 0,08		31,65 ± 0,63		56,30 ± 0,13	
Drought, II cycle, 70-40-70-40	67,30 ± 0,33	1,32	30,67 ± 0,57	-3,09	56,95 ± 0,28	1,15
CK, drought, II cycle 70-40-70-40	67,87 ± 0,41	2,18	29,25 ± 0,09	-7,64	57,24 ± 0,41	1,67
Thiourea, drought, II cycle, 70-40-70-40	68,08 ± 0,36	2,50	27,52 ± 0,27	-13,05	58,06 ± 0,35	3,12
Polyel + F, drought, II cycle, 70-40-70-40	68,77 ± 0,29	3,54	26,03 ± 0,48	-17,75	58,78 ± 0,28	4,40

* compared with untreated plants exposed to the same drought conditions.

Plants pre-treated with the respective compounds are distinguished by significantly higher maintenance of water homeostasis capacity compared to untreated plants. Thus, the saturation deficit of untreated plants under repeated drought conditions is 3.09% lower compared to the value of the saturation deficit of plants exposed for the first time to drought conditions, while the saturation deficit value of plants pre-treated with thiourea and Polyel + F is lower by 13.05 and 17.75% respectively (Table 3). These compounds condition a significant co-activation of stress-memory under conditions of repeated drought with 10.27 and 15.13% compared with stress-memory of the untreated plants. Symptoms of disturbance of functional activity in these plants are significantly weaker under the occurrence of repeated drought compared to untreated plants, and especially with those exposed for the first time to the action of water stress – unadapted plants. In plants pre-treated with cytokinin-type compounds, the stress-memory effect is more pronounced as a result of self-regulation of water status by increasing the water retention capacity of the cells. The obtained data (Table 3) show that water retention capacity in the leaf tissues under repeated drought is higher compared to plants exposed for the first time to stress. The values of water retention capacity in the leaves of pre-treated plants under repeated drought are higher compared to untreated plants. The investigations confirmed the existence in plants of memory about the incidents caused by the previous stress and that the response reaction of soybean plants pre-treated with cytokinin-type compounds and exposed to the action of repeated stress is more adequate compared to untreated plants. In the formation of stress memory, an important role belongs to the potential of self-regulation of water status by activating the mechanisms of stabilization/increase of water retention capacity, keeping turgidity and hydration at the level necessary for the normal course of vital processes.

The plants preventively exposed to drought stress maintain their water retention capacity at higher levels even after soil moisture level is restored to optimal values (Table 4). After improvement of humidity conditions, the plants retain in tissues a higher amount of water by about 2.0% after

Table 4. Influence of the cytokinin-type compounds on water status parameters in soybean leaves under conditions of soil moisture improvement

Trial group, humidity % TWC	WC, g · 100 g f.m.		SD, % from full saturation		WRC retained water, % of initial content	
	M ± m	Δ, %*	M ± m	Δ, %	M ± m	Δ, %
Control, 70	73,02 ± 0,91		7,63 ± 0,10		58,50 ± 0,66	
Drought, I cycle 70-40-70	72,01 ± 0,66		10,23 ± 0,25		57,16 ± 0,49	
Drought, II cycle, 70-40-70-40-70	72,54 ± 0,07	0,73	7,26 ± 0,14	-29,03	58,02 ± 0,27	1,77
CK, Drought, II cycle, 70-40-70-40-70	72,65 ± 0,20	0,89	7,09 ± 0,11	-30,69	59,20 ± 0,22	3,57
Thiourea, drought II cycle, 70-40-70-40-70	72,70 ± 0,21	0,96	6,80 ± 0,09	-33,52	59,15 ± 0,25	3,48
Polyel + F, drought II cycle,, 70-40-70-40-70	73,41 ± 0,47	1,94	6,45 ± 0,16	-36,95	60,53 ± 0,42	5,89

* compared with untreated plants exposed to same drought conditions.

Repeated drought compared to the plants that endured a single cycle of drought, and the plants treated with cytokinin, thiourea, and Polyel + F continue to retain water in tissues by 3.5-6.0% more than untreated plants. This aspect can explain the ability of plants, preventively exposed to moderate water stress, to withstand repeated drought more easily.

The current paper shows that moderate and short-term drought (40% TWC, 7 days) stress conditions stomata closure and reduction of synthesis processes, including photosynthesis (Table 5). There was a decrease in the opening of stomata of the leaves of 'Moldovitsa,' and 'Magia' plants by 6.45 and 7.72-folds respectively compared to plants well supplied with water. At the same time, the transpiration intensity in these plants decreases 2.4-fold and 2.6-fold, respectively, while the intensity of photosynthesis decreases by 59.4 and 63.8% from the value of process' intensity in plants under optimal humidity. Therefore,

Table 5. Influence of drought at the initial stages of ontogenesis on the intensity of photosynthesis, transpiration and conductivity of stomata in soybean plants

Variety	Trial group, humidity % TWC	Gs, mmol m^{-2} s^{-1}		E, mmol m^{-2} s^{-1}		A, µmol m^{-2} s^{-1}		WUE, mM CO_2/ mM H_2O	
		M ± m	Δ, %	M ± m	Δ, %	M ± m	Δ, %	M± m	Δ, %
Moldovitsa	**Control,70**	0,432 ± 0,013		4,42 ± 0,132		18,48 ± 0,46		4,18	
	Drought, 70-40	0,067± 0,002	-84,49	1,78 ± 0,053	-59,73	7,5 ± 0,18	-59,4	4,21	0,71
Magia	**Control,70**	0,463 ± 0,013		3,64 ± 0,109		20,12 ± 0,62		5,53	
	Drought, 70-40	0,060 ± 0,002	-87,04	1,39 ± 0,042	-62,36	6,81 ± 0,14	-66,2	4,90	-11,39

'Moldovitsa' plants have the ability to maintain the processes of assimilation of carbon and synthesis of compatible osmolytes – soluble carbohydrates, at a relatively higher level as a result of maintaining the conductivity of the stomata and the transpiration intensity. The stomata reaction to environmental and endogenous signals is critical for regulating gas exchange between plants and the atmosphere. In addition, stomata closure is vital for minimizing water loss and preventing lethal embolism during drought [23]. As it was previously stated [11], the decrease of the hydration degree of the tissues under drought conditions is associated with the closing of the stomata, the reduction of perspiration, and the decrease of the carbon dioxide fixation.

Plants that have undergone moderate water stress during the "first trifoliate leaf" phase, at the onset of a new drought cycle, have a narrower amplitude of changes in the stomatal opening, transpiration intensity, and carbon assimilation processes (Table 6). Plants exposed to a new drought cycle have the property of adapting and maintaining vital processes at a relatively stable level (Table 6). Plants with homeostatic water properties keep vital processes, including photosynthesis, at a higher level under conditions of water stress. Thus, for the 'Moldovița' plants the

Table 6. The effect of drought at the stage of "flower-pod forming" on photosynthesis' intensity, stomata conductance and transpiration of soybean plants

Variety	Trial group, humidity % TWC	Gs, mmol m^{-2} s^{-1}		E, mmol m^{-2} s^{-1}		A, µmol m^{-2} s^{-1}		WUE, mM CO_2/ mM H_2O	
		M ± m	Δ, %	M ± m	Δ, %	M ± m	Δ, %	M± m	Δ, %
Moldovitsa	Control, 70	0,20 ± 0,005		2,99 ± 0,09		14,41 ± 0,4		4,82	
	Drought II cycle, 70-40-70-40	0,09 ± 0,001	55,0	1,68 ± 0,03	43,8	8,86 ± 0,2	-38,5	5,27	9,34
	Drought I cycle 70-40	0,07 ± 0,001	65,0	1,37 ± 0,02	54,2	6,97 ± 0,1	-51,6	5,09	5,60
Magia	Control, 70	0,19 ± 0,004		2,68 ± 0,08		14,06 ± 0,3		5,25	
	Drought II cycle, 70-40-70-40	0,08 ± 0,001	57,9	1,44 ± 0,04	46,3	8,03 ± 0,1	-42,9	5,58	6,29
	Drought I cycle 70-40	0,06 ± 0,001	68,4	1,13 ± 0,02	57,8	6,28 ± 0,1	-55,3	5,08	3,24

Processes of carbon dioxide assimilation under conditions of insufficient moisture at the "flowering-pod formation" phase were reduced by 38.51%, and for the 'Magia' plants, the decrease of photosynthesis was about 43.0% of the value of the process in the control group plants, not exposed to water stress. It should be mentioned that plants, which endured moderate water stress at the "I trifoliate leaf" phase, under the repeated occurrence of drought, have the property to keep the assimilation processes at a higher true level compared to the plants exposed to drought stress for the first time at this stage of ontogenesis. In 'Moldovitsa' plants under the second drought cycle, the intensity of photosynthesis is 27.11% higher than in non-adapted plants and exposed to the first drought cycle. The same differences were recorded in 'Magia' plants. Drought stress gradually decreased CO_2 assimilation rates due to reduced stomatal conductance. In conditions of moderate moisture insufficiency due to decreased stomata opening, water consumption in the process of perspiration is reduced somewhat more significantly compared to the process of carbon assimilation, which led to an increase in water efficiency in the production process. This characteristic is considered one of the biological markers associated with plant drought tolerance.

Therefore, the plants pre-exposed to moderate stress in the early stages of ontogenesis form stress-memory – an ability of plants that undergone stress to manifest appropriate preventive response and easily support new stress. The response memory to environmental incidents is provided by activated protection mechanisms, including changes in the parameters of water status, in particular – hydrostatic pressure and water retention capacity. These results demonstrate the involvement of water status, in particular – water retention capacity and turgor pressure in the formation/manifestation of stress-memory – as a previously unknown mechanism by which water molecules regulate the state of membranes, the formation of ROS and serve as a trigger for the synthesis of compounds with a protective function. Plants subjected to several cycles of dehydration/water recovery retained a relatively higher water content than plants suffering from dehydration stress for the first time. As a result, moderate short-term drought (3-5 days), which repeats periodically, contributes to the increase of plant resistance. Such plants more easily withstand repeated stress compared to plants permanently grown in optimal conditions. Cytokinin-type compounds – thiourea and Polyel + F, condition a significant co-activation of the manifestation of stress-memory under conditions of repeated drought.

CONCLUSIONS

1. The involvement of water status components in the formation, keeping, and activation of plant stress-memory about previously endured stress and its manifestation in conditions of humidity fluctuation and repeated drought has been established.

2. Exogenous activation of the potential for memory formation may be ensured by the exogenous use of agents with a positive impact on non-specific primary plant response to the action of any adverse factor, in particular, unfavorable moisture fluctuation and repeated water stress.

3. Cytokinin-like compounds are proven to be an important factor in mediating plant adaptation and stress-memory formation. Thiourea and Polyel + F conditioned the increase of plant resistance to the repeated occurrence of drought by maintaining the components of water status and photosynthesis at a higher true level.

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