PHYSIOLOGICAL PROCESSES ASSOCIATED WITH THE RESISTANCE OF *GLYCINE MAX* (MERR., L.) PLANTS TO REPEATED WATER STRESS

PROCESE FIZIOLOGICE, ASOCIATE CU REZISTENȚA PLANTELOR DE *GLYCINE MAX* (MERR., L.) LA STRESUL HIDRIC REPETAT ÎN TIMP

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Abstract. *The experimental data were obtained on the reasoning behind the meaning of water homeostasis significance and antioxidant protection in the event of potential resistance of Glycine max L.(Merr) plants to the hydric and oxidative stresses, conditioned by in time repeated drought. It was established that the primary reaction of soybean plants to drought action is changing the parameters of the water status and tissue dehydration, coupled with the formation of reactive oxygen species (ROS), an increase of malonic dialdehid (DAM) and peroxide oxidation of lipids. Dehydration and ROS formation causes destruction of chloroplasts and diminish fund assimilating pigments in the leaves of both cultivars, especially in sensitive plants.Water stress caused closure of the stomata, the inhibition of carbon dioxide assimilation, with the negative consequences on the of water use efficiency in the production process. The plants, which have suffered a moderate drought at the initial stages of ontogenesis, exhibit a greater tolerance to repeated drought during critical period.*
Key words: plants, drought, oxidative stress, photosynthesis, assimilating pigments, tolerance.

Rezumat: *Au fost obținute date experimentale privind argumentarea semnificației capacității de homeostatare a apei și protecției antioxidante în manifestarea potențialului de rezistență a plantelor de Glycine max,L.(Merr) la stresul hidric și oxidativ, condiționat de seceta repetată în timp. S-a stabilit, că reacția primară a plantelor de soia la acțiunea secetei este modificarea parametrilor status-ului apei și deshidratarea țesuturilor, cuplată cu formarea speciilor reactive de oxigen (SRO), majorarea di-aldehidei malonice (DAM) și oxidarea peroxidică a lipidelor. Deshidratarea și generarea SRO, provoacă destrucția cloroplastelor și diminuarea fondului de pigmenți asimilatori în frunzele ambelor cultivare, cu precădere la plantele sensibile. Stresul hidric a condiționat închiderea stomatelor, inhibarea asimilării dioxidului de carbon, cu urmări negative asupra eficienței utilizării apei în procesul de producție. Plantele, care au suportat o secetă moderată la etapele inițiale ale ontogenezei manifestă o toleranță sporită la apariția repetată a secetei în perioada critică.*
Cuvinte cheie: plante, secetă, stress oxidative, fotosinteză, asimilare, pigmenți, toleranță.

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INTRODUCTION

The adverse conditions, repeated over time, can cause the damage cell structures, the discordance of the key physiological processes and morphological changes with severe consequences on productivity. Recent research assume that plants that have suffered a moderate stress at the beginning of vegetation can form so-called "stress memory" - the ability to react adequately to the repeated stress over time (Davies and Zhang , 1991; Kalapa *et al.,* 1996; Beck *et al.,* 2007; Bartol *et al.,* 2013). Recent literature in this field misses the data on the impact of environmental stress repeatedly on the functional processes of the most valuable crop plants. In this context the purpose of the work was to assess the significance homeostation water capacity and antioxidant protection in the event of property plant *Glycine max*, L. (Merr) to react adequately to droughts in time.

MATERIAL AND METHOD

As subjects of study were used the plants *Glycine max* (Merr., L.) cultivars (cv.) Indra and Enigma grown in containers Mitcerlih with the capacity of 30 kg absolutely dry soil in humidity conditions controlled in the Complex of vegetation IGFPP ASM. The scheme included: - I variant - witness, humidity 70% of the total capacity for soil water (CTA); II variant - 70-35% CTA, stress phase "button formation - beginning of flowering" III variant - 70- 35-70 - 35% CTA, plants exposed to water stress phase "first trifoliate leaf" and repeated in the phase of "button formation - beginning of flowering." The duration of water stress - 7 days. Status of the water parameters were determined by classical methods (Vasseu and Sharkey, 1989), the intensity of CO2 uptake, transpiration, stomatal conductance and water use efficiency were investigated using portable gas analyzer LCA-4. Malone di-aldehyde content DAM -. The activity of key enzymes of antioxidant protection was investigated by the spectrophotometric method: SOD – according; GR - by reducing oxidized glutathione in the presence of NADP · H, λ 340 nm (Schad and Bassham, 1977). The differences between the variants were documented by statistical analysis using the set of programs "Statistica 7" - ANOVA.

RESULTS AND DISCUSSIONS

The experimental data have shown a reaction and a different degree of parameter change of the status of the water plant *Glycine max* (Merr., L.) to drought conditions (Table. 1). The lack of humidity caused the decrease of the moisture of plant (CA) to both varieties, but especially to the variety Enigma. As a result of dehydration in leaf tissues was created a deficit of saturation (DS) significantly higher compared with control plants, unexposed to drought action: with + 4.47% Indra variety and +16,90% - Enigma plants. To the repeated occurrence of drought conditions in phase of "button formation - beginning of flowering" were found a different reaction to the plant that suffered a moderate water stress in the phase of "first trifoliate leaf" (Tab. 1).

Table 1

The influence of repeated drought in time to "button formation - beginning of flowering" stage on the parameters of water leaves of plants *Glycine max* (Merr., L.)

cultivation	Soil mosture, % CTA	CA, g·100g m.p.		CRA, % water lost from the original content		DS, % of full saturation	
		M ± m	Δ, % control	M ± m	Δ, % control	M ± m	Δ, % control
Indra	Control plants, 70	73,8±1,5		18,6±0,8		12,5±0,6	
	Drought , 70-35-70-35	73,1±1,5	-1,03	15,6±0,5	-15,94	12,8±0,5	+2,24
	Drought, 70 -35	72,3±1,9	-2,02	15,9±0,3	-14,44	13,1±0,4	+4,47
Enigma	Control plants, 70	77,6±1,4		24,4±0,9		11,5±0,3	
	Drought , 70-35-70-35	74,9±1,0	-3,48	16,3±0,6	-21,81	12,5±0,2	+8,40
	Drought , 70 -35	73,7±2,0	-4,89	19,0±0,8	-25,75	13,5±0,2	+16,90

The representatives cv. Enigma, the adaptation effect is less pronounced as a result of the weaker autoregulation property of the status of the water. In plant tissues exposed first to drought stress was formed a deficit of saturation respectively with 4.47 and 16.9% higher compared to control plants and 2.18 and 7.92 higher than plants that they have supported a moderate water stress at the first stage of trifoliate leaves. Water retention capacity values (CRA) in the leaves of plants adapted are higher than the plants exposed for the first time to drought. A hydric suboptional regime in the youthful phase of development makes insufficient the adaptation to the moisture by forming a plant xerophit guy (Brînză, 2005). This phenotype of plants has a better assimilation of homeostatare water in tissues. Therefore, to the molecular level, the stress memory and tolerance to drought is associated with the property's stabilization of domestic water status by increasing its retention capacity by the macromolecules.

One of the first consequences of the stressogenic factors action is intensifying the appearance in the cells of the reactive oxygen species, oxidative stress and the damage cell structures. The data obtained in this paper (Tab. 2) showed that the degree of increase of SRO formation induced by insufficient humidity during the button formation and flowering of plants, is significantly lower in plants that have suffered a moderate water stress in the first trifoliate leaf

stage, compared to plants exposed to the first cycle of drought during the critical period.

Table 2.

The influence of repeated droughts on the activity of antioxidant enzymes and di-malonate aldehyde content in the leaves of soybean plants

Cultivation	Soil mosture, % CTA	Content DAM, mkM/g. s. p.	SOD un. conv./ g. s. p.	CAT mM/ g. s.p.	APX mM/ g. s. p.	GlPX mM/ g. s. p.	GlRed., mM/ g. s. p.
		M±m	M±m	M±m	M±m	M±m	M±m
Indra	Control plants, 70	40,1±0,9	26,11±0,9	1,2±0,03	2,8±0,1	77,9±2,1	96,8±1,5
	Drought, 70-35-70-35	51,0±1,0	31,17±0,7	1,2±0,02	6,9±0,2	87,0±2,0	150,7±0,9
	Drought, 70 -35	56,4±1,2	28,12±0,6	1,3±0,11	3,3±0,3	81,6±1,9	118,2±2,0
Enigma	Control plants, 70	43,0±0,8	28,84±0,9	1,2±0,20	3,0±0,3	76,6±2,2	111,2±2,5
	Drought, 70-35-70-35	55,3±1,3	32,30±0,9	1,3±0,05	5,2±0,5	80,4±2,6	196,2±2,4
	Drought, 70 -35	62,0±1,5	30,06±0,8	1,1±0,04	3,7±0,3	78,3±2,4	125,6±2,2

Table 3

The influence of repeated water stress on the intensity of photosynthesis (IF), transpiration (IT) and stomatal conductance (SC) of plants *Glycine max* (Merr., L.)

Cultivation	Soil mosture, % CTA	IF, $mmol \cdot m^{-2} \cdot h^{-1}$		IT, $mmol \cdot m^{-2} \cdot h^{-1}$		CS, $mmol \cdot m^{-2} \cdot h^{-1}$		EUA, * mmol CO_2/ mmol H_2O
		M±m	Δ, % control	M±m	Δ, % control	M±m	Δ, % control	M±m
Indra	Control plants 70	9,8±0,3		2,7±0,05		0,14±0,02		3,7±0,2
	Drought, 70-35-70-35	6,7±0,5	-31,5	1,6±0,04	-38,5	0,10±0,01	-28,57	4,1±0,2
	Drought, 70 -35	4,4±0,4	-55,7	1,3±0,09	-52,5	0,08±0,03	-42,85	3,5±0,1
Enigma	Control plants, 70	11,2±1,0		2,4±0,12		0,19±0,05		4,6±0,2
	Drought, 70-35-70-35	7,6±1,0	-32,7	1,3±0,08	-48,7	0,13±0,06	-31,58	6,0±0,3
	Drought, 70 -35	3,7±0,6	-67,2	1,1±0,07	-55,3	0,08±0,04	-57,89	3,4±0,1

It is also remarkable that the same intensity and duration of drought conditions a stronger SO emergence to the plants with less potential for self-regulating status of the water. The degree of increase in content DAM cv. Enigma is higher compared to plants cv. Indra. The action to different types of stress, the tolerance formation is closely linked with the elimination of the SRO by the antioxidant protection systems. SRO cleaving enzyme activity is more pronounced in plants adapted to moderate insufficiency of moisture, especially from representatives cv. Indra. It has been shown that dehydration and SRO eruption had a negative impact on plant photosynthesis (Tab. 3). Water stress conditioned stomatal closure and nearly complete inhibition of uptake of carbon dioxide by leaves, the processes associated with negative consequences on water efficiency in the production process. Stomatal conductance values, carbon assimilation and transpiration plants supposed to repeated water stress is kept to a higher level. So, the data lead to the conclusion that the interrelations of water and SRO form an integrated network which provides under stress conditions the induction of nonspecific protective mechanisms and are part of the plant memory stress.

CONCLUSIONS

1. The primary reaction of soybean plants to drought action is changing of the water parameters status and tissues dehydrating, coupled with the formation of reactive oxygen species (SRO)

2. Water stress had conditioned stomatal closure, the inhibation of carbon dioxide assimilation, with negative consequences on water use efficiency in the production process.

3. The plants which have suffered a moderate drought in the early stages of ontogenesis show an increased tolerance to drought during a repeated criticism.

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