Studia Universitatis "Vasile Goldiş", Seria Ştiinţele Vieţii
Vol. 23, issue 1, 2013, pp. 85-89

INFLUENCE OF TYPE UV-B RADIATIONS OF DIFFERENT WAVELENGTHS REGARDING THE PHOTOSYNTHETIC ACTIVITY DURING PLANT DEVELOPMENT OF *ZEA MAYS L.*

Maria ORODAN*, Violeta TURCUŞ, Gongyi OSSER, Aurel ARDELEAN
"Vasile Goldis" Western University Arad, Romania

ABSTRACT. In general, UV-B radiation causes a net inhibition of photosynthesis for a wide range of plants (Tevini, 1993). From laboratory studies, this inhibition appears to result from a malfunction in the photosynthetic cycle including PSII reaction centers perturbation (Stride *et al.*, 1992). Stomatitis function, and thus gas exchange at the leaf level is also affected (Teramura, 1990; Tevini and Teramura, 1989). In our experiments we sought to answer the question whether treatment with UV-B radiation type, of different wavelengths of 280-310 nm, has a stressful effect on plants by the appearance of changes in photosynthetic activity, and if there are differences in this regard between controlled and treated plants. All measurements were performed on days 1, 3 and 4 of treatment, at young plants; samples were consisting of leaves taken from plants in which the 3rd leaf was fully developed.

Keywords: photosynthetic activity, UV-B radiation, photosynthetic system, PSII protein complex

INTRODUCTION

We analysed the effect on photosynthesis in relation to certain wavelengths through measurements of fluorescence induction rate, photosynthetic activity, the intracellular concentration of carbon dioxide. All analyses were performed on days 1, 3 and 4 of the treatment, at the level of young plants at the 3-leaf developed.

During measurement of chlorophyll fluorescence photosynthesis system property is used by which the pigment that absorbs light energy and traps it leaves in three different ways. One of the ways is recovering energy of photochemical reactions, during which the photon energy is absorbed by chlorophyll and release electrons, which are transferred into the protein complex of PS II photochemical (photosystem II) and then in PS I (photosystem I) (Leipner J., 1998).

Energy "surplus" of light trapped inside, ie energy remaining after closing the reaction centres is dissipated out in two ways: through heat that is less quantifiable, through luminescence which is easier to put out. The wavelength of this light is always greater than the wavelength of light absorbed (Li X.P. *et al.*, 2000).

The difference between the wavelength of light captured and of light released facilitates the quantification despite the fact that pigment chlorophyll fluorescence value compared to light irradiance is relatively small. Knowing the values of irradiating light, fluorescence emitted by plant its characterizing well the function of photosynthesis. This is a simple and effective method by which we can understand the photosynthetic apparatus inside, functionality of electron transport chain, the ratio between closed and open reaction centres, and other features of the photosynthetic system.

MATERIALS AND METHODS

During the test, after turning his head sample reading and exposed in the dark is collected a level of minimal fluorescence (F0), then with a high intensity flashing light are closed the reaction centres, and in this way measured a value (fm) fluorescence maximum. In the next 5 minutes, the device releases photosynthetic active light on the sample and from time to time use also high intensity flashing light (flash type), thus determining the amount Fm. Even before downloading lights can measure the value Ft.

PS II efficiency can be calculated by the following formula: **jPSII = (F m - Ft) / F m**

The factor (jPSII) is the value of light absorption of chlorophylls and energy balance of the energy used in photochemical reactions in the PSII, with reference to the value of linear electron transport (J), more precisely to the functioning of photosynthesis. Because of all these properties, (j) PS II is used to calculate photosynthetic capacity.

Determination of molar absorption photochemical (qP) is based on the following formula:

qP = (F m - Ft)/(F m - F o) the value of qP refers to the ratio of reaction centres open.

Frequently, the parameter Fv/Fm characterized the actual performance of PSII, while all reactions are open. The formula is:

Fv/Fm = (Fm - Fo)/Fm = JPS II/qP

Modifying the Fv/Fm is due to the change in molar absorption efficiency of non-photochemical elimination. Maximum quantum efficiency of PSII is defined by parameter Fv/Fm.

RESULTS AND DISCUSSIONS

According to the results it can be stated that for most small wavelength values were measured lowest values of the ratio Fv/Fm, to the group of plants controlled throughout the treatment interval. Under the effect of the treatment this parameter has increased significantly compared with the controled group, for all

**Correspondence:* Maria Orodan, "Vasile Goldis" Western University, Arad, 91-93 Liviu Rebreanu St., Arad, Romania, Tel./Fax +40-(257)-228622, email: rosu.marcel-ar@ansvsa.ro
Article received: December 2012; published: February 2013

three days of measurements. For day 3 and 4, at a wavelength of 287nm were obtained values of Fv / Fm significantly higher at treated plants compared to the control group. All this suggests that the chemical modification provides protection for the second operation photochemical system at this wavelength compared to its harmful effects.

Assessment of photosynthetic capacity at maize plants under the influence of different UV-B wavelengths

Table 1. Maximum quantum efficiency of PSII changes given by parameter of induction of fluorescence (Fv / Fm) at Helga hybrid

Corn plants	Wavelength UV-B	Parameter (Fv/Fm)			Period of time (day 1)	Period of time (day 3)	Period of time (day 4)
		Day 1	Day 3	Day 4			
control	280nm	0,7	0,6	0,75			
Helga	280nm	0.75	0.65	0.70			
control	287nm	0,75	0,65	0,72			
Helga	287nm	***0,77***	***0,65***	***0,79***	***	**	*
control	290nm	0,7	0,7	0,75			
Helga	290nm	***0,75***	***0,75***	***0,77***	**	**	*
control	295nm	0,65	0,65	0,65			
Helga	295nm	0,7	0,7	0,7			
control	300nm	0,6	0,6	0,6			
Helga	300nm	0,65	0,65	0,65			
control	310nm	0,6	0,6	0,55			
Helga	310nm	0,65	0,65	0,65			

* significant values compared with the control group at P <0.05, 0.01 and 0.001 to corn plants, HELGA

Table 2. Maximum quantum efficiency of PSII changes given by parameter of induction of fluorescence (Fv / Fm) hybrid ZP471

Corn plants	Wavelength UV-B	Parameter (Fv/Fm)			Period of time (day 1))	Period of time (day 3)	Period of time (day 4)
		Day 1	Day 3	Day 4			
control	280nm	0,6	0,60	0,50			
ZP471	280nm	0.65	0.60	0.50			
control	287nm	0,65	0,62	0,60			
ZP471	287nm	***0,65***	***0,62***	***0,65***	**	**	**
control	290nm	0,7	0,61	0,60			
ZP471	290nm	***0,75***	***0,65***	***0,63***	*	*	*
control	295nm	0,65	0,65	0,6			
ZP471	295nm	0,7	0,65	0,6			
control	300nm	0,6	0,6	0,55			
ZP471	300nm	0,65	0,6	0,5			
control	310nm	0,6	0,6	0,5			
ZP471	310nm	0,65	0,6	0,55			

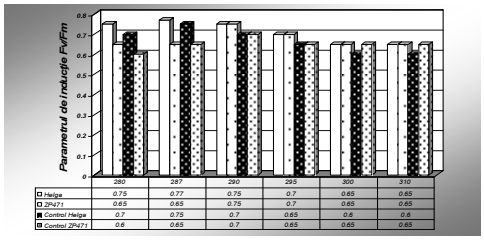
* significant values compared with the control group at P <0.05, 0.01 and 0.001 to corn plants, ZP471

Helga hybrid photosynthetic capacity is significantly increased (***) 287nm UV-B and distinctly significant (**) at 290nm (Table 1). Also hybrid ZP471 is not notice the difference too much compared to Helga (Table 2). No statistically significant differences observed to the other experimental variants.

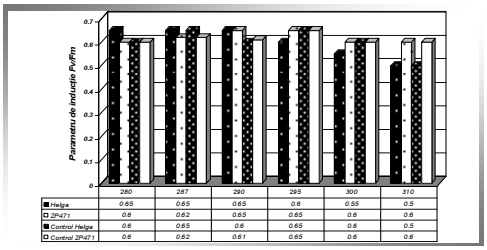
Photosynthetic capacity of plants under the influence of different UVB wavelength does not change dramatically after the 3rd day of treatment influence the wavelength of 287nm or 290nm (Fig. 1 c). Although both wavelengths have a clear influence on the photosynthetic apparatus it can be observed the different reaction of the two hybrids. Although in the first day of treatment (Fig. 1.a, b) hybrid ZP471 has a lower photosynthetic capacity that is activated on day 3 signs that plants are beginning to adapt to the new conditions. A lower photosynthetic capacity may be due to low stomatitis conductivity or to low capacity of CO2 assimilation in leaves. Under the treatment this parameter has increased significantly in the groups treated versus control group. Value of the report Fv / Fm obtained on the 3rd and 4th at the wavelength of

287nm were significantly increased in treated plants compared to control group (Fig. 1).

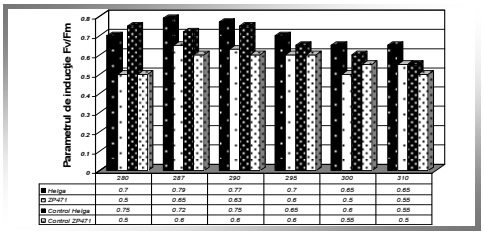
In our experiments, as part of the research, we examined how the wavelength affects photosynthetic activity of plants in relation to intracellular accumulation of CO2. Below are presented the results. Corn plants treated with 287nm wavelength in many cases have shown a significant increase in photosynthetic activity compared with the control group during the 3 days of complete measurements.



a.



b.



c.

Fig. 1. Change in induction of photosynthesis compared to the two hybrids included in the study after 24 h, 72 h and 96 h of exposure

Table 3. Changing at hybrid Helga photosynthetic activity

Corn plants	Wavelength UV-B	The photosynthetic activity A(µmol CO_2mÕ²sÕ¹)			**Period Day**		
		Day 1 1 1	Day 3	Day 4	1	3	4
Control	280nm	5	4, 5	4, 5			
Helga	280nm	6	5	4,5			
Control	287nm	3,4	4,4	2,4			
Helga	287nm	4,9	2,9	2,1	***	****	***
Control	290nm	3,5	3,9	2,9			
Helga	290nm	4,7	3,2	2,6	**	**	**
Control	295nm	3,4	4	2,4			
Helga	295nm	4,2	4,0	2,4			
Control	300nm	3,2	4,2	2,2			
Helga	300nm	3,8	4,8	2,8			
Control	310nm	3,0	4,80	2,8			
Helga	310nm	3,5	4,5	3,5			

* significant values from control at P <0.05, 0.01 and 0.001.

Table 4. Changing photosynthetic activity at hybrid ZP471

Corn plants	Wavelength UV-B	The photosynthetic activity A (µmol CO_2mÕ²sÕ¹)			**Period Day**		
		Day 1	Day 3	Day 4	1	3	4
Control	280nm	4,5	3,5	3,5			
ZP471	280nm	5	3,5	3,6			
Control	287nm	3,8	2,8	2,5			
ZP471	287nm	3,9	2,3	2,0	*	**	**
Control	290nm	3,7	3	2,8			
ZP471	290nm	3,8	2,9	2,6	*	*	*
Control	295nm	3,6	3,2	3,0			
ZP471	295nm	3,6	3,2	3,0			
Control	300nm	3,5	3,15	3,1			
ZP471	300nm	3,55	3,05	3,0			
Control	310nm	3,45	3,00	3,0			
ZP471	310nm	3,55	3,00	3,0			

* significant values from control at P <0.05, 0.01 and 0.001

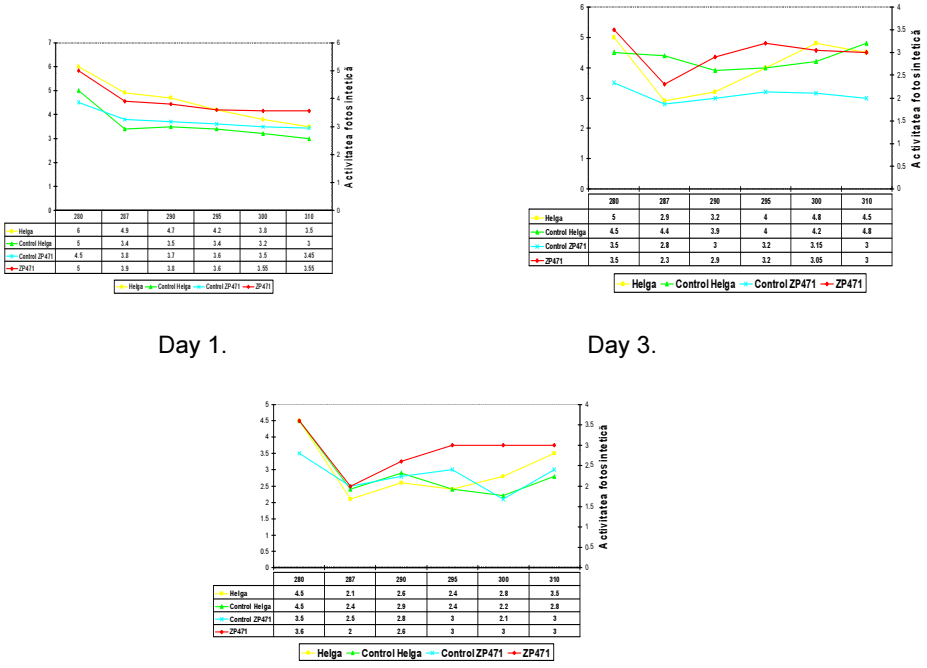


Fig.3. Changes photosynthetic activity (mole CO2m ō ō ¹ ² s) under the influence of UVB at corn hybrids Helga and ZP471 after 1, 3 and 4 days of treatment

Photosynthetic activity is increased at hybrid Helga after the first day of treatment where the values are statistically highly significant at a wavelength of 287 and 290nm. A more moderate growth of photosynthetic activity recorded at hybrid ZP471 at the same wavelengths indicating a higher tolerance of this genotype at stress imposed (Table 3). Plant response after 3 days of exposure to UVB is enhanced in both hybrids and after 4 days normalize and even diminishes sign that plants adapt to conditions (Table 4). Our data indicate the direct effect of UVB on photosynthetic capacity of plants that can be exploited through selection of genotypes that show high productivity (Fig. 3). Such strategies are currently looking to increase productivity of agricultural plants can have major socio-economic implications especially in poorer areas.

CONCLUSIONS

Our data indicate the direct effect of UVB on photosynthetic capacity of plants that can be exploited through selection of genotypes that show high productivity. Wavelength of 287 and 290nm were increased photosynthetic capacity at hybrid plants Helga mostly analysed.

The results indicate that low levels lengths determined through insignificant changes in photosynthetic capacity of the low of the report Fv/Fm, to control group during treatment plants. Energy produced by photosynthesis is used to synthesize sugars and other nutrient compounds using atmospheric CO2. Capacity and efficiency of photosynthesis is an important link of productivity growth strategies and recent data shows that photosynthesis is able to induce an increase in production when other factors are not limiting during the life cycle of the plant. Even the smallest net growth rate can turn into a significant increase in biomass production since carbon assimilation is integrated throughout the period of plant growth and development.

ACKNOWLEDGEMENTS

This work was co-financed from the European Social Fund through Sectorial Operational Programme Human Resources Development 2007-2013, contract no. POSDRU/107/1.5/S/77082 „PhD Scholarships Complex Training in Bio-Economy and Eco-Economy for Food and Feed Safety and Security in Anthropic Systems”.

REFERENCES

Asada K., 1994, Production and action of active oxygen species in photosynthetic tissues, In: C.Foyer and P. Mullineaux, eds., Photooxidative stresses in plants: causes and amelioration, 77, p.104.

Cachiţă C.D., Ardelean A., 2009, Tratat de biotehnologie vegetală, vol. II, Ed. Dacia, Cluj-Napoca, p. 32 - 116.

Cona A., Rea G., Botta M., Corelli F., Federico R., Angelini R., 2006, Flavin containing polyamine oxidase is a hydrogen peroxide source in the oxidative response to the

protein phosphatase inhibitor cantharidin in *Zea mays* L, Journal of Experimental Botany 57, p. 2277-2289.

Frew J.E., Jones P., Scholes G., 1983, Spectrophotometric determinations of hydrogen peroxide and organic hydroperoxides at low concentrations in aqueous solutions, Analytica Chimica Acta 155: p. 139–150.

Leipner J., 1998, Chiling-induced photooxidative stress and adaptation of defense systems in maize (*Zea mays* L.) leaves, Thesis. Zurich, p. 134-135.

Levine A., Tenhaken R., Dixon R., Lamb C., 1994, H_2O_2 from the oxidative burst orchestrates the plant hypersensitive disease resistance response, Cell 79, p. 583-593.

Li X.P., Björkman O., Shih C., Grossman A.R., Rosenquist M., Jansson S., Niyogi K.K., 2000, A pigment-binding protein essential for regulation of photosynthetic light harvesting, Nature 403, p. 391-395.

Park Y.I., Chow W.S., Anderson J.M., Light inactivation of functional photosystem II in leaves of peas grown in medium light depends on photon exposure, Planta, 196, p. 401-411.

Rao M.V., Paliyath G., Ormrod D.P., 1996, Ultraviolet-B and ozone-induced biochemical changes in antioxidant enzymes of Arabidopsis thaliana, Plant Physiology (Rockville), p. 125-136.

Singh S., Pankaj K., Ashwani K., 2006, Ultraviolet radiation stress: molecular and physiological adaptations in trees in A biotic stress tolerance in plants, Springer Netherlands ed., 1007, p. 4020-4389.

Strid Å., Porra J.R., 1992, Alterations in Pigment Content in Leaves of *Pisum sativum* after Exposure to Supplementary UV-B, Plant Cell Physiol., 33,7, p. 1015-1023.

Teramura A.H., Sullivan J.H., Ziska L.H., 1990, Interaction of elevated ultraviolet-B radiation and CO_2 on productivity and photosynthetic characteristic in wheat, rice, and soybean, Plant Physiology 94, p. 470-475.

Tevini M., Teramura A.H., 1989, UV-B effects on terrestrial plants, Photochemistry Photobiology 50, p. 479-487.