DIFFERENCES IN RESPONSES OF SOME CEREALS TO UV IRRADIATION

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Abstract

The responses of plants to UV irradiation include physiological, biochemical, morphological and anatomical changes. In general UV radiation deleteriously affects plant growth, reducing leaf size and limiting the area available for solar energy capture. These findings have been achieved mainly through studies in greenhouses and exposure to artificial sources of ultraviolet radiation; extrapolation to changes on crop yield as a result of increases in terrestrial solar UV radiation is difficult. In this work the effects of UV radiation on plant growth for the most useful cereals in our country: corn and wheat. Corn and wheat seeds were irradiated during 20 minutes and 40 minutes respectively, using a UV laboratory source. After that they were putted to germinate in laboratory conditions, using Petri dishes on double filter paper. The dynamic of germination and the growth in length of the roots and the sheets of the plantlets was monitorized during the first phenophase. UV radiation modified the germinative potential determining a delay of seed germination especially for higher time of exposure. Our results also show that a negative correlation exists between the root length and the sheet length of the plantlets and the time of irradiation.

Key words: global climate change, UV source, plantlets

Surface-level ultraviolet (UV) radiation and ozone (O_3) are components of the global climate change and any increases in their levels can lead to adverse effects on crop growth. Possible increases in surface UV radiation are attributed to the depletion of the beneficial stratospheric O_3 layer. Actually increases in surface-level O_3 that in many regions are largely the result of photochemical oxidant pollution, are also part of the general increase in the concentrations of the so-called „greenhouse" gases. The responses of plants to UV irradiation include physiological, biochemical, morphological and anatomical changes. This response is controversial yet. In general UV radiation deleteriously affects plant growth, reducing leaf size and limiting the area available for solar energy capture Zuk-Golaszewska K., et al., 2003). On the other hand the results of Zancan et al (2006) showed that UV-B radiation had no significant effect on plant growth. In addition, exposure of plant to UV-B radiation increased both chlorophyl content and root and leaf iron content.

These findings have been achieved mainly through studies in greenhouses and exposure to artificial sources of ultraviolet radiation; extrapolation to changes on crop yield as a result of increases in terrestrial solar UV radiation is difficult (Yao, Y., 2006). In this work the effects of UV radiation on plant growth for the most useful cereals in our country: corn and wheat. The dynamic of germination and the growth in length of the roots and the sheets of the plantlets was monitorized during the first phenophase. Germination rate and root elongation, as a rapid phytotoxicity test method, possess several advantages, such as sensitivity, simplicity, low cost and suitability for unstable chemicals or samples. These advantages made them suitable for developing a large-scale phytotoxicity database and to study mechanisms of phytotoxicity (Wang, X. et. al., 2001).

MATERIAL AND METHOD

The experiments were conducted in the Biophysics Department Laboratory of the University of Agronomy from Iasi (Foca N., 2007; Oancea S., 2005). As a biological material we used corn (*Zea mays*) and wheat (*Triticum aestivum*) the most widely used cereal in our country. To study the effect UV radiation on plant growth, corn and wheat seeds were irradiated, using a UV laboratory source of 125W. The seeds were irradiated during 20 minutes and 40 minutes keeping 10cm between source and seeds. We prepared the following variants:

1. control;
2. 20 minutes of irradiation;
3. 40 minutes of irradiation. 20 irradiated seeds of corn and 20 irradiated seeds of wheat were putted to germinated into Petri dishes on

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double filter paper with distilled water in laboratory conditions. The seeds were kept in dark at the optimal temperature (23^{0}C) for 5 days. The dynamic of germination and the growth has been monitorized during the first phenophase of growth.

RESULTS AND DISCUSSIONS

Figure 1 shows the corn seed germination after UV irradiation.

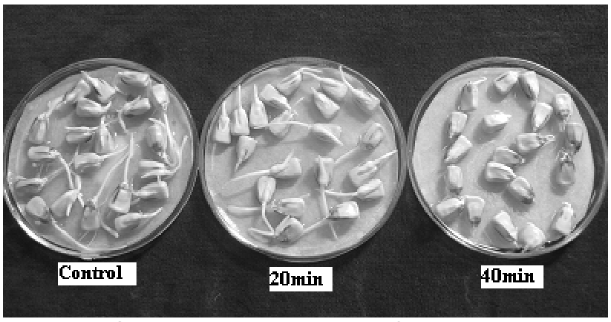

Figure 1 **Corn seed germination after UV irradiation**

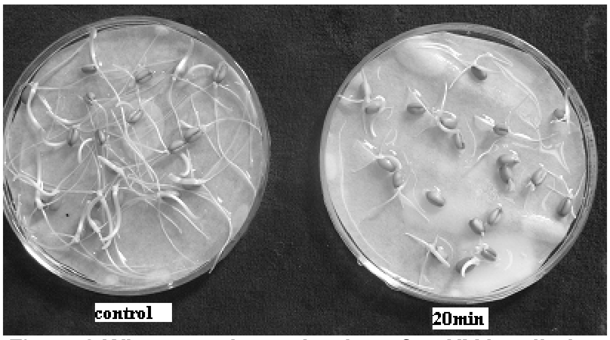

Figure 2 **Wheat seed germination after UV irradiation**

Germination dynamics of corn seeds is given in figure 3 and of wheat seeds in figure 4.

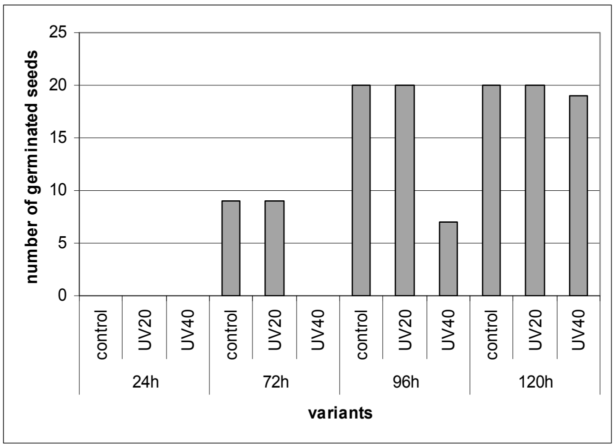

Figure 3 **Corn seed germination dynamics after UV irradiation**

Figure 3 shows that the control corn seeds germinated faster that the irradiated seeds.

Figure 4 shows that, for 40 minutes of UV irradiation, the wheat seeds were not germinated at all. That is the reason that this variant have been not presented in figure 2.

The plantlets root dimensions are given in figure 5 and 6.

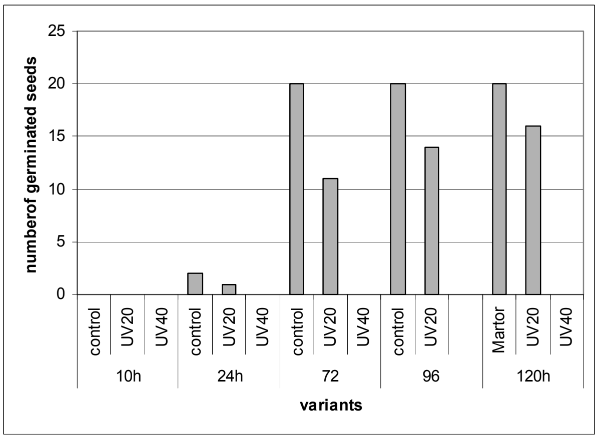

Figure 4 **Vheat seed germination dynamics after UV irradiation**

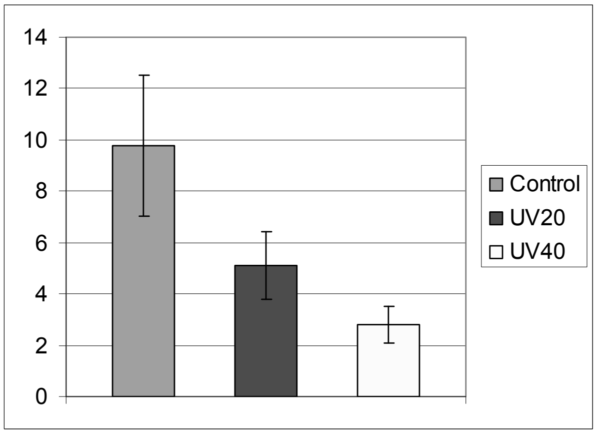

Figure 5 **Corn root dimensions (cm) after 5 days of UV irradiation. Error bars are 95% confidence intervals (n=20) (5)**

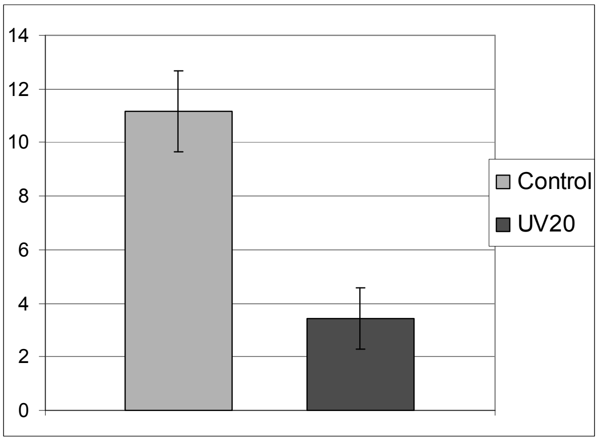

Figure 6 **Total wheat root dimensions (cm) after 5 days of UV irradiation. Error bars are 95% confidence intervals (n=20)**

From figures 5 and 6 we can see that the corn and wheat root of the control plants are much better developed than the irradiated plants. In these figures the errors bars didn't overlap; this means that significat differences between control plants and irradiated plants can be revealed (Cumming G., 2007).

By comparison with root dimensions, the difference between the stem dimensions of the treated plants and the control one for corn plants is decreased, as the figure 7 shows.

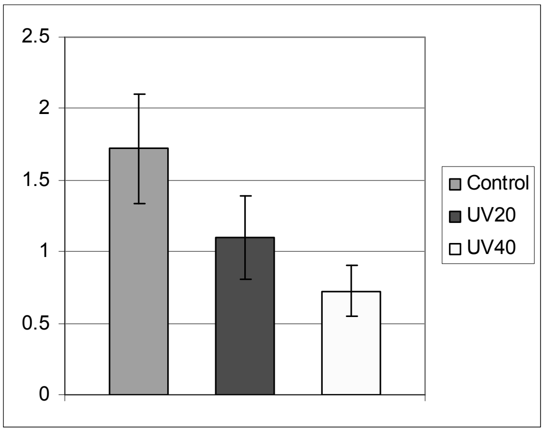

Figure 7 Corn stem dimensions after 5 days of UV irradiation. Error bars are 95% confidence intervals (n=20)

In figure 7 the errors bar overlap; this is the reason we used ANOVA test to establish the effect of UV irradiation (Oancea S., 2007). ANOVA test for corn stem dimensions is given in figure 4.

Anova: Single Factor						
SUMMARY						
Groups	Count	Sum	Average	Variance		
Column 1	20	34.4	1.72	0.664842		
Column 2	20	21.9	1.095	0.386816		
Column 3	20	14.5	0.725	0.146184		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	10.117	2	5.0585	12.66903	2.8E-05	3.158843
Within Groups	22.759	57	0.399281			
Total	32.876	59				

Figure 8 **ANOVA test for corn stem dimensions**

From figure 8 you can see that $F=12.66903>F_{crit}=3.158843$; this inequality demonstrates the significant difference between control and irradiated corn plants. The same evidence stands out from P value which is much smaller from critical value P=0.05.

Our results for wheat stem dimensions are given in figure 9.

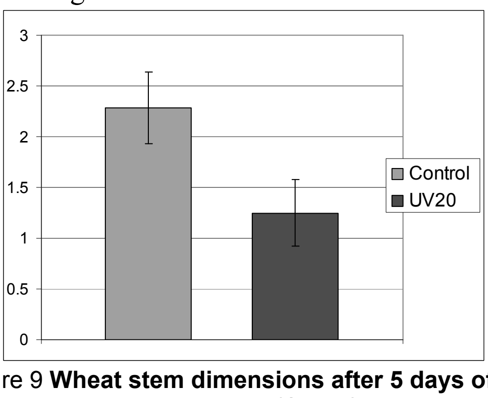

Figure 9 **Wheat stem dimensions after 5 days of UV irradiation. Error bars are 95% confidence intervals (n=20)**

For wheat stem dimensions, as figure 9 shows, the errors bars didn't overlap; this means that there is a significant differences between control plants and irradiated plants.

The content of pigments for irradiated plants is nearly with the control plants; this means that, despite the fact that the control plants germinated faster and they have been grown better than the other plants, the plants have the capacity to revert after irradiation. Mishra et al. (2011), appreciates that the non-enzymatic antioxidants play a significant role in reducing the stress due to UV-B radiations. Both the stresses, pesticides and UV radiations, individually and in combination had resulted in an increase in the electrolyte leakage and lipid peroxidation. However, the increased level of flavonoids might help the organism in preventing the oxidative damage. Salama and coworkers (Salama H.M.H., 2011) suggested that the significant increase in proline content was an important factor for providing higher tolerance to UV radiation treated plant species. In addition, increasing proline content is referred to as protective mechanism due to the generation of reactive oxygen species by UV radiation.

CONCLUSIONS

The results of this work prove that there are significant differences between control plants and irradiated plants. UV radiation modified the germinative potential determining a delay of seed germination especially for higher time of exposure. Moreover, for long time of irradiation wheat seeds didn't germinate. Our measurements also show that a negative correlation exists between the root length and the sheet length of the plantlets and the time of irradiation. The action of the UV irradiation is visible especially for germination and on the plant roots because the UV irradiation is applied on plant seeds.

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