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THE EFFECT OF UVB STRESS ON PHOTOSYNTHESIS IN *ERUCA SATIVA*

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ABSTRACT Climate changes can determine an interruption in normal functioning of ecosystems, an increased risk of affection or even the extinction of some species. Temperature, excessive light and CO_2concentration are the main abiotic stress factors in plants that affect directly the process of photosynthesis.Thedamages produced by UVB radiations are: CO_2 deficiency, low levels of chlorophylls, damages on PS I and PS II etc. Using chlorophyll fluorescence for studying photosynthesis is one of the efficient methods used by physiologists and ecophysiologists. With the modern fluorimeters chlorophyll fluorescence measurements can be done, even in the laboratory or in the field. The measurements of chlorophyll fluorescence on *Eruca sativa,* under normal or UVB stress conditions were done with the MONI PAM fluorimeter. Reported on the control samples, the plants treated with high intensities of UVB radiations, can't induce the reparatory mechanisms for a normal photosynthesis, which fact conduces to the death of the plants. The samples treated with low intensities of UVB radiations could induce these reparatory mechanisms and plants were growing normally.

Keywords: photosynthesis, climate change, chlorophyll fluorescence, PS II, *Eruca sativa*.

INTRODUCTION

The study of UVB radiations impact on photosynthesis is important due to the modification of climate parameters, mainly because of the human activity. The global greenhouse gas emissions have increased in the last 50 years, with a significant increasing in the last 15 years, without precedent on the recent Earth past. Among the main gaseswith greenhouse effect which riches concerning levels are: nitrous oxides, methane emissions, fluorinated gases, CO_2emissions. The last one has increased with 31% in 2005 comparing with 1990, representing ¾th of total global emissions (World Resources Institute,2012). The increasing levels of these gases determine the degradation of the ozone layer and thereforethe increasing levels of UVB radiations reaching at the Earth surface. There is a direct relation between UVB radiation, terrestrial life and the diminishing of the ozone layer. The effects of UVB stress in plants determine: CO_2 deficiency [Jones L.W., 1966; Allen D.J. et al., 1998; Teramura A.H. et al.,1980; Desai T.S., 1990], stomata closure (Allen et al., 1997; Teramura A.H et al., 1983; Nogues S. et al., 1999), diminishing of chlorophyll level, damage of PS I and PS II, sugar decline [Frederick J.E., 1993; Kerr J.B. et al., 1993]. It is well known that the light energy reaching the leaf surface can undergo one of three possible ways: it can be absorbed and used in photochemistry, can be dissipated like heat or re-emitted like fluorescence [fig.1].

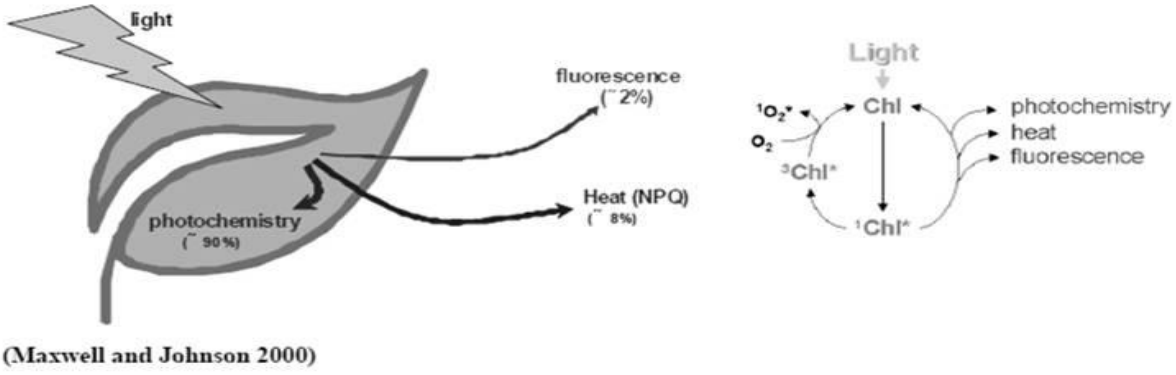

Fig.1 Light energy absorbed by chlorophyll molecules in a leaf can undergo one of three possible fates

In photosynthetic membranes between 2 and 10% of absorbed quanta are emitted as photosystem II fluorescence. Highly sensitive and fast fluorimeters were developed in the last 50 years witch contributed substantially to the elucidation of the basic mechanisms involved in the complex process of

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photosynthesis (Krause G.H., Weis E., 1991). The Moni Da fluorimeter used in the experiment is a performing tool for measuring chlorophyll fluorescence, a non-invasive method for *in vivo* study of photosynthesis. These studies make possible the evaluation of photosynthetic capacity in plants and also the evaluation of photochemical activity in leaves. Pam fluorimeters are used for short or long monitoring of the efficiency of PS II in the laboratory or field conditions. It can measure up to 18 photosynthetic parameters such as: photosynthetic active radiation (PAR), photosynthetic photons flux density (PPFD), efficiency of PS II (YII), electron transport rate (ETR) etc. and can monitor the same leaf area for long periods of time. The plant used in this greenhouse study is *Eruca sativa*, from Brassicaceae family, known like arugula, or rucola, from Mediterranean zone. It is a well-knownstudied plant, with spicy and medicinal properties and it have a short period of vegetation (about 90 days); for this reason the experiment could be repeated twice per year, in spring and autumn. The plants were monitored in vegetation period, before flowering and the greenhouse conditions were similar to the field ones: low temperatures in the night (8-10°C) and moderate temperature during the day (13-20°C).

MATERIALS AND METHODS

The rucola culture was monitored in the greenhouse for 6 days with 3 devices on 3 different plants: control, the first 3 days, in normal conditions, the next 3 days treatments were applied with two different intensities of UVB radiations: 0.04mW/cm^2 and 0.8mW/cm^2. The first value corresponds to a normal spring day; the 0.8mW/cm^{2}value representsanincreasing intensity of UVB radiation with 20%. This intensity was chosenbecause it is known that plants resist to UVB stress and maintain their physiologic activity until a value increased to approx. 30%. The UVB stress was applied for two hours every day, between 12-14 a.m.

Fig. 2 Plants treated with low intensities of UVB (0.04mW/cm^2) grows normally

Fig. 3 Increasing levels of UVB radiations (0.8mW/cm^2) induces death of plants

RESULTS AND DISCUSSIONS

The control samples andthose treated with low intensities of UVB radiations didn't show any changes in the photosynthetic activity, but they showed growth stimulation at phenotypic level (fig.2).The increasing about 20% of the UVB radiationinducesdeath of plants. The reparatory mechanisms, like photoreactivation or reparatory recombination, didn't succeed to recover the photosynthetic process (fig.3).

The experiment was realized in the greenhouse of Biological Research Centre Jibou, in the same conditions: short day, medium temperature 10ºC, in spring and repeated in autumn.The graphic below explain the reaction mode of *Eruca sativa* at different intensities of UVB radiations (Fig. 4). The first 3 days of control *Eruca sativa* plants have normal values of Y (II), between 0.74-0.80 relative units, which show a total recovery overnight. From day 3 to day 6 there are visible changes in photochemical yield: the more the intensity of UVB radiations increase, even the recovery decrease. High values of UVB radiations (0,8mW/cm^2) determine irreversible damage of PSII and consequently, inhibition of photosynthesis.

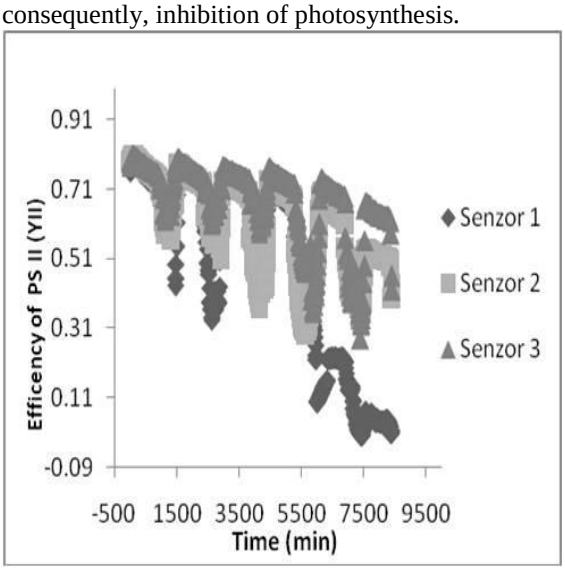

Fig. 4 The effect of different intensities of UVB radiation on the activity of PS II in *Eruca sativa*

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CONCLUSIONS

At low intensities of UVB radiations, rucola has the ability to trigger photosynthetic repair mechanisms and to conduct a normal photosynthetic process, at phenotypic level is noticeable even growth stimulation. The reparatory mechanisms used by plants to stop the cytotoxic effect of UVB radiation consists in: photoreactivity, excision of damaged DNA, reparatory recombination, processes that are light dependent. The most efficient protective mechanism is the biosynthesis of flavonoids and other phenolic compounds that are capable to absorb UVB radiation. Increased intensity of UVB radiations, as a consequence of the drastic decrease in the value of Y (II), demonstrates a strong inhibitory effect on photosynthetic apparatus, an effect that could not be offset by repair mechanisms in plants..

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