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Effects of Ultraviolet-B Radiation on Growth and Photosynthesis in Sunflower Seedlings

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1. Introduction

Photosynthetic organisms need sunlight and are thus, inevitably, exposed to UV-B radiation. UV-B radiation is a ubiquitous stress factor for them, dependent on solar radiation. An increase in UV-B induces DNA damage by formation of DNA photo-products (Christie and Jenkins, 1996). In addition to DNA damage, UV-B exposure has been reported to result in growth inhibition and accumulation of UV-screening sub-stances that prevent the occurrence of damage (Burchard et al.,2000). In general, plant reponse to UV-B is highly variable, and is dependent on environmental conditions and plant resource, i.e. species, cultivar(Ambasht and agrawal, 1998). It is reported recently that UV-B irradiation has been shown to induce the production of free radicals on plants (Baradas et al., 1998). In the present study we examined the effect of UV-B irradiation on growth parameters and photosynthetic function in sunflower seedlings.

2. Materials and methods

2.1. Plant material and growth conditions

Seeds of sunflower(*Helianthus annuus* L.) were grown on a mixture of vermiculite, peat moss and perlite in plastic pots (7×11cm). The seedlings were grown in a growth chamber (Eyelatron, FLI-301N, Japan) with 25±1℃, 70±7% RH, 160 μmol m^{-2} s^{-2} PAR, and with a 14 h light period.

2.2. UV-B irradiation

Approximately 15-day-old seedlings were used for the UV-B treatments. Control plants were grown under visible light only, while treated plants were irradiated with supplementary UV-B during the 14 h light periods. UV-B was provided by two fluo-rescent UV-lamps (VL-6, Vilber lourmat France sunlamp), suspended 43 cm above the plant seedlings. The UV-B fluence rate, at the height of seedlings, was measured using a UV spectroradiometer (Li-1800, Lycosa).

2.3. Growth measurements

Primary leaves were harvested and cut at daily intervals during the 7 d. They were weighed and dried for 3 days at 80℃ for dry weight determination.

2.4. Chlorophyll measurements

The concentrations of chlorophylls were determined from the samples before the plant material was dried. Leaf disks were excised from the second fully grown leaf of each sample, placed in 5 mL of N,N-dimethylformamide and stored in the dark at 4℃ until they were analysed. The absorbance of the extract was measured at 647 nm and 664 nm and the concentrations of chlorophyll a, b and total chlorophyll were calculated according to Inskeep and Bloom(1985).

2.5. Chlorophyll fluorescence

The quantum yield of PS II electron transport was assessed by measuring the chlorophyll fluorescence (Fv/Fm) with a pulse amplitude modulation fluorometer (PAM 2000; Heinz Walz GmbH, Germany). Leaves were dark adapted for 15 min prior to measurement.

3. Results and Discussion

In response to UV-B irradiation, a growth inhibition of sunflower seedlings was observed from about 5 d after start of UV-B treatment (34 % decrease compared with controls). However, visible injury, such as chlorosis, which seems to mediated by the generation of free radicals, was not observed throughout the 15 d of UV-B treatment.

Elongation of UV-B-induced leaves lagged significantly, compared to that of controls during the 7 d, but final leaf length on day 7 d did not differ between treatments. Fresh weight was significantly greater for UV-B-induced leaves than for controls at most developmental stage. With UV-B radiation, dry weight slightly more, than for controls, but the differences were not statistically significant.

To investigate the effect of UV-B on the electron transport of photosystem, the Fv/Fm ratio of sunflower first leaves was measured during the 7 d. The Fv/Fm ratio decreased by 13 % compared to the control after 2 d, and was kept to be lower than the control level until 5 d. Our data support that the elevated UV-B induced decrease in photosynthetic fuction, especially in PS II photochemistry.

4. Abstract

The effects of UV-B irradiation on the growth and photosynthetic activity were investigated in seedlings of sunflower(*Helianthus annuus* L.). The first leaves irradiated with UV-B were retarded in growth but simultaneously acquired a remarkably de-

creased chlorophyll fluorescence ratio compared with the non-irradiated leaves. The Fv/Fm ratio decreased by 13 % compared to the control after 2 d, and was kept to be lower than the control level until 5 d. From the results it is suggested that UV-B radiation may induce reduced biomass production and decrease in photosynthetic rate in sunflower plants.

References

Ambasht, N. K. and M. Agrawal, 1998. physiological and biochemical responses of S*orghum vulgare* to supplemental UV-B radiation. Can J. Bot. 76, 1290-1294.

Baradas, K. N., Szegletes, Z, Pestenacz, A., Fulop, K. and Erodai, L., 1998. Effect of excess UV-B irradiation on the antioxidant defence mechanisms in wheat (*Triticum aestivum* L.) seedlings. J. Plant Physiol., 153, 146-153

Burchard, P., W. Bilger and G. Weissenboeck, 2000. Contribution of hydroxycinnamates and flavonords to epidermal shieldring of UV-A and UV-B radiation in developing rye primary leaves as assessed by ultraviolet-induced chlorophyll fluorescence measurements. Plant Cell Environ. 23, 1373-1380.

Christie, J. and G. Jenkins, 1996. Distinct UV-B and UV-A/blue light signal transduction pathways induce chalcone synthase gene expression in *Arabidopsis* cells. Plant Cell, 8, 1555-1567.

Liu, L., D.C. Gitz and J.W. McClure, 1995. Effects of UV-B on flavonoids, ferulic acid, growth and photosynthesis in barley primary leaves. Physiol. Planta. 93, 725-733.