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The effects of UV radiation on photosynthesis estimated as chlorophyll fluorescence in *Zygnemopsis decussata* (Chlorophyta) growing in a high mountain lake (Sierra Nevada, Southern Spain)

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ABSTRACT

The effect of increased UV radiation on photosynthesis estimated as in vivo chlorophyll fluorescence i.e. optimal quantum yield (F_v/F_m*) and electron transport rate (ETR) in the green filamentous alga* Zygnemopsis decussata *(Streptophyta, Zygnematales) growing in the high mountain lake "La Caldera" (Sierra Nevada, Spain) at 3050 m altitude was evaluated. Two sets of* in situ *experiments were conducted: (1) On July 2006,* F_v/F_m *was measured throughout the day at different depths (0.1, 0.25, 0.5 and 1 m) and in the afternoon, ETR and phenolic compounds were determined. In addition, in order to analyze the effect of UV radiation,* F_v/F_m *was determined in algae incubated for 3 days at 0.5m under three different light treatments: PAR+UVA+UVB (PAB), PAR+UVA (PA) and PAR (P). (2) On August 2007,* F_v/F_m *was determined under PAB, PA and P treatments and desiccation/rehydration conditions.* F_v/F_m *decreased in algae growing in surface waters (0.1 m) but also at 1 m depth compared to that at 0.5 m depth. The decrease of* F_v/F_m *at noon due to photoinhibition was small (less than 10%) except in algae growing at 1 m depth (44%). The maximal electron transport rate was 3.5-5 times higher in algae growing at 0.25-0.5 m respectively than that at 0.1 and 1 m depth. These results are related to the accumulation of phenolic compounds: i.e. the algae at 0.25-0.5 m presented respectively about a 3-5 times higher concentration of phenolic compounds than that of algae at 0.1-1 m depth. The protection mechanisms seem to be stimulated by UVB radiation, since* F_v/F_m *was higher in the presence of UVB (PAB treatment) compared to PA or P treatments. UVA exerts the main photoinhibitory effect, not only at midday, but also in the afternoon. UVB radiation also had a protective effect in algae grown under desiccation conditions for three days. During re-hydration, the rapid increase of* F_v/F_m *(after 1 h) was higher in the UVB-grown algae than in algae grown under UVA radiation. After 5 h,* F_v/F_m *values were similar in algae submitted to desiccation/rehydration under PAB and P treatments as they were in the control (submerged algae). The combined effect of desiccation and UVA produced the greatest decrease of photosynthesis in* Z. decussata*. Thus UVB, in contrast to other species, may support the recovery process.* Z. decussata *can acclimate to severe stress conditions in this high mountain lake by the photoprotection mechanism induced by UVB radiation through dynamic photoinhibition and the accumulation of phenolic compounds (UV screen and antioxidant substances).*

Key words: chlorophyll fluorescence, high mountain lake, phenols, photosynthesis, UV radiation, Zygnemopsis decussata