BRIEF COMMUNICATION

Influence of ultraviolet-B radiation on photosynthetic and biochemical characteristics of a mangrove Rhizophora apiculata

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Abstract

Changes in photosynthesis and biochemical constituents were studied in R. apiculata seedlings grown under solar and solar enhanced UV-B radiation, equivalent to 10, 20, 30, and 40 % stratospheric ozone depletion. The seedlings grown under 10 % UV-B radiation showed an increase of 45 % net photosynthetic rate ($P_N$) and 47 % stomatal conductance, while seedlings grown under 40 % UV-B radiation exhibited a decrease of 59 % $P_N$ with simultaneous elevation of 73 % intercellular CO$_2$ concentration. Effects of UV-B on contents of lipids, saccharides, amino acids, and proteins were significant only at high doses of UV-B radiation. The concentration of anthocyanin was reduced with increasing doses of UV-B. The reverse was true with phenols and flavonoids.

Additional key words: anthocyanins; carotenoids; chlorophyll; flavonoids; intercellular CO$_2$ concentration; net photosynthetic rate; phenols; proteins; saccharides; stomatal conductance.

Ozone (O$_3$) is a principal gas of the atmosphere which absorbs solar UV-radiation at wavelengths shorter than 300 nm (Caldwell and Flint 1994). But, reduction of O$_3$ content due to anthropogenic influence has resulted in an increase of solar UV-B radiation (Caldwell et al. 1989). The UV-B has important photobiological effects, and the effects of solar enhanced UV-B radiation on lower and higher plants have been extensively reviewed (Caldwell 1971, 1977, 1991, Tevini and Teramura 1989,

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Murthy and Rajagopal (1995). The UV-B causes multitude effects on plant physiological responses, especially photosynthesis, targeting on the reaction centre of photosystem 2 (Noorudeen and Kulandaivelu 1982), carboxylating enzymes (Jordan et al. 1991), and polypeptides of thylakoid membranes (Nedunchezhian and Kulandaivelu 1991, Nedunchezhian et al. 1995). Most of the studies report only injurious effects of UV-B on plant growth and photosynthesis, but in some plants UV-B enhances photosynthesis (Beyorsch et al., 1988, Tezuka et al., 1993). Such studies are lacking in mangroves, a tropical coastal marine ecosystem; in marine ecosystems, studies of UV-B effects were primarily concerned with phytoplankton. Although mangrove growth and photosynthesis have been studied in several species, those in response to UV-B have not been done (Kathiresan and Murthy 1993, 1994, Murthy and Kathiresan 1993). The mangroves are prime targets of the tropical coastline for the global climate changes and sea level rise. Therefore, we have quantified, in the present study for the first time, the changes in photosynthesis of R. apiculata grown under solar enhanced UV-B radiation.

Healthy propagules of R. apiculata L. Blume were collected from the Pichavaram mangrove forest (lat. 11°27'N; long. 79°47'E). Propagules 25 ± 2 cm long were used for UV-B treatment. The propagules were placed in 1000 cm³ containers containing 500 cm³ of Arum-Hoagland (1940) nutrient medium with a salinity of 15 kg m⁻³. The nutrient medium was replenished once in 3 d. After sprouting, the propagules were exposed to different UV-B irradiances. The propagules had only two leaves throughout the experimental period.

The UV-B radiation was supplied by Philips sun-lamps (TL 12/20, W. Philips Glolampenfabriken, The Netherlands). The sun-lamps were preburnt and matched for desired spectral irradiance (Teramura et al., 1980) prior to each treatment. Photosynthetically active radiation (400-700 nm) under the lamp was 90%. The radiation was filtered through a 0.13 mm cellulose diacetate (pre-solarised) for transmission below 290 nm for treatment with supplemental UV-B radiation. The UV-B was checked using the generalised plant response action spectrum of Caldwell (1971) normalised at 300 nm. Therefore, the plants kept under UV lamps received supplemental doses of UV-B radiation in addition to ambient solar UV-B. The cumulative radiation (ambient + supplemental) was similar to that which would be received at the study site at Pichavaram mangrove (11°N) with 10, 20, 30, and 40% depletion (marked further as UV-B₁₀, UV-B₂₀, UV-B₃₀, UV-B₄₀, respectively) of atmospheric ozone (Murthy 1996) during a cloudless day on the summer solstice according to Green et al. (1980). Under such conditions the plants were irradiated for 6 h daily (10:00-16:00) for 14 d in an open field environment with the temperature at 28 ± 2 °C. Different UV-B irradiances were induced by altering the distance between the top of plants and the lamp frame. The required irradiance was monitored and maintained once in 7 d.

Pigments were extracted from two leaves and quantified for chlorophylls, Chl (Arnon 1949), carotenoids, Car (Ridley 1977), anthocyanins (Mancinelli 1983), flavonoids (Mirecki and Teramura 1984), and total phenols (Bray and Thorpe 1954). Net photosynthetic rate (Pn), stomatal conductance (gs) and intercellular CO₂ concentration (Ci) were determined in intact leaves by using the Li-Cor 6200 portable

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