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BRIEF COMMUNICATION

Gas exchange in *Hardwickia binata* after water stress and rewatering

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Abstract

The net photosynthetic rate (P_N), stomatal conductance (g_s) and transpiration (E) of *Hardwickia binata* Roxb. leaves were reduced due to decrease in the leaf water potential (ψ_w) from -2.0 to - 5.7 MPa. P_N partially recovered in the treated plants upon rewatering. Decrease in g_s due to water stress may be the main factor for reduction of P_N.

Additional key words: photosynthetic rate, stomatal conductance, transpiration rate, water potential.

Although it is well established that water stress impairs numerous metabolic and physiological processes in plants, the response of photosynthesis to water deficits has gained special attention (Breda *et al.* 1993, Maier and Teskey 1992). However, the effects of water stress on photosynthesis of tropical tree species have been studied rarely.

Hence the present study focusses on *Hardwickia binata* Roxb., a tropical tree species which has been introduced in semi-arid region in the southern part of India and aims to determine the gas exchange characteristics in response to water deficits and during recovery after rewatering.

The study was conducted in the Biomass Research Centre, Madurai Kamaraj University, Madurai (10°00'N latitude, 78°10'E longitude and at an altitude of 186 m). *H. binata* seedlings were grown in pots (diameter 27 cm at top and 14 cm at the bottom) filled with soil and farmyard manure (ratio 3:1). The plants were grown singly in pots and kept at 0.5 m × 0.5 m spacing so that the plants did not shade each other. The photosynthetically active radiation available at the soil surface was around 1750 μmol m^{-2} s^{-1}. All plants were watered daily. After 5 months seven different

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rates of soil drying were created by imposing different levels of irrigation for 15 d (control and T_1, T_2, T_3, T_4, T_5, T_6, T_7).

On the 16th day net photosynthetic rate (P_N), stomatal conductance (g_s) and leaf temperature (T_l) were measured on the third fully expanded leaf using *LI-6200 Portable Photosynthesis System* (*Li-COR*, Lincoln, USA). The chamber position after inserting the leaves was identical to the natural position of the leaf. The leaves were exposed under natural day light. The leaf temperature varied from 33 to 35 °C during the measurement. Water potential (ψ_w) was determined by a pressure chamber (*PMS Instrument Co.*, Corvallis, USA). Transpiration rate (E) was measured with a steady state porometer (*LI-1600, Li-COR*, Lincoln, USA). All measurements were taken between 10.00 and 12.30.

Then all pots were irrigated for 5 d with sufficient water to bring back the soil to field capacity. The recovery of plants was monitored on the 6th day after watering.

Simple linear regression between the measured variables and one way analysis of variance (*ANOVA*) among the treatments were made using *SPSS* packages.

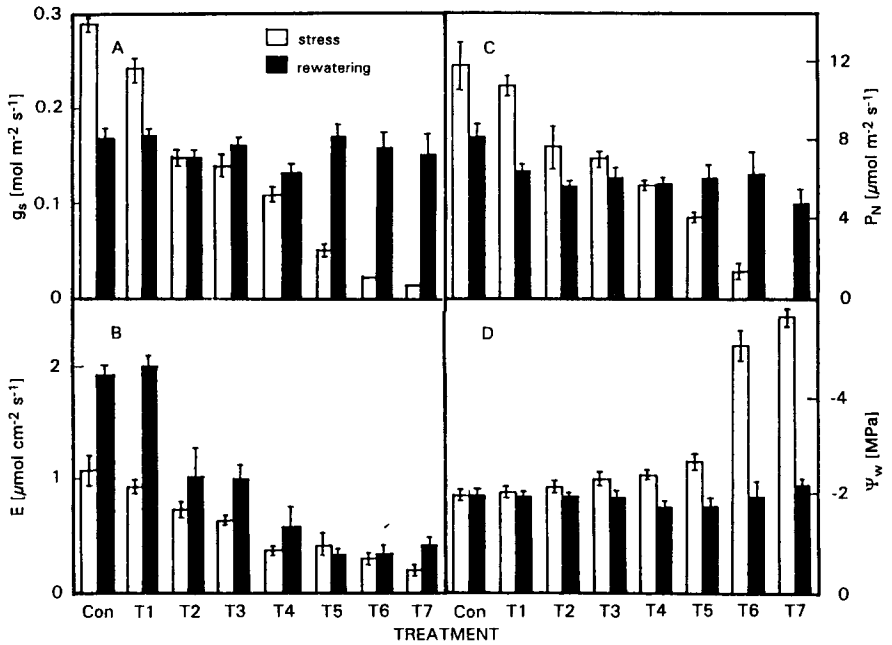

Fig. 1. Stomatal conductance, g_S (*a*), transpiration rate, E (*b*), net photosynthetic rate, P_N (*c*) and leaf water potential, ψ_w (*d*) after water stress (created by different levels of irrigation - T_1 to T_7) and rewatering of *Hardwickia binata* plants. Each column is a mean of 4 plants, bars represent S.D.

The maximum P_N ranged between 8 and 12 μmol m^{-2} s^{-1} in control plants (daily watered) and was within the range reported for evergreen trees (for review see Ceulemans and Saugier 1991). P_N, g_s and E decreased when the leaf ψ_w decreased. At ψ_w -5.7 MPa P_N was completely inhibited but the plants were alive. So critical ψ_w

at which the plant did not survive even if water was supplied was less than -5.7 MPa. The parallel decrease in P_N and E indicated that stomatal closure might be the main cause in the water stress mediated reduction of P_N. In addition, significant correlation was observed between P_N and g_s ($r = 0.99$) or g_s and E ($r = 0.97$).

After rewatering, P_N in all stressed plants did not recover fully, and was lower than that in control (non-stressed) plants. P_N in the rehydrated plants was 80, 70, 76, 71, 75, 78 and 58 % of control, respectively. If the number of days of rewatering was more than 5, the recovery of P_N was better.

The pattern of P_N and g_S was similar at different treatments (Fig. 1). This might show again stomatal regulation of photosynthesis. But E recovered only slightly in the differently treated plants (Fig. 1).

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