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PHOTOSYNTHETIC RESPONSES AT LOW TEMPERATURE IN YOUNG PLANTS OF *HEVEA BRASILIENSIS*: ROLE OF PARTIAL SHADE TO REDUCE PHOTOINHIBITORY EFFECTS

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The effect of low winter temperature on CO_2 assimilation and associated gas exchange parameters and growth under agro-climatic conditions of Tripura in North-East India was studied in five different *Hevea* clones grown in polybags. The study was conducted in three different periods *viz.*, pre-winter, winter and post-winter. There was about 50% reduction in net CO_2 assimilation rate in winter compared to the pre-winter and post-winter periods. There was a clear low temperature-induced photoinhibition of photosynthesis in winter indicating the harmful effects of high photosynthetic photon flux densities (PPFD) in the stress period. Such photoinhibitory effects on the young plants could be reduced by partial shading. Apparent quantum yield (ϕ_c) of CO_2 assimilation was also lower in winter than in the pre- and post-winter periods. However, under cold stress, ϕ_c was relatively high in partial shade with values similar to the post-winter period. Overall growth was more in the plants grown under partial shade and this has been found to be due to the maintenance of photosynthesis for longer duration than in open conditions in the winter period. Differential capacities in net photosynthetic rates under prevailing low temperature conditions were noticed among the clones.

Key words: Cold stress, Excess excitation energy, *Hevea brasiliensis*, Low temperature, Photoinhibition, Photosynthesis, Quantum yield

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INTRODUCTION

Deterioration in environmental conditions leads to rapid decrease in photosynthesis resulting either from reduced CO_2 uptake due to stomatal limitation or from inhibition of primary and secondary processes in the chloroplasts (Larcher, 1995). Decreasing temperatures lead to a reduction in the irradiance required to saturate photosynthesis (Berry and Bjorkman, 1980). Under such stress conditions, light absorbed by the leaves is highly in excess of their capacity to utilize it for photochemical reactions, leading to photoinhibition of photosynthesis (Barber and Anderson, 1992; Fryer *et al.*, 1998).

Low temperature affects growth and yield of *Hevea brasiliensis* in a large part of the non-traditional rubber growing areas of the North-East India (Sethuraj *et al.*, 1989; Alam *et al.*, 1998) and in China (Zongdao and Yanquing, 1992). Tripura is a major rubber growing area in India. The winter temperature in this region can be as low as 5°C (Meenattoor *et al.*, 1989). Characteristics of the winter in this area are cold nights, with the coolness being retained in early part of the day with bright sunlight, and relatively warm afternoons (Jacob *et al.*, 1999). Thus a combination of low temperature and high sunlight occurs with a high possibility of photoinhibitory effects on photosynthesis and growth (Baker *et al.*, 1994). However, detailed studies on low temperature induced photoinhibition in *Hevea* for this region have not been carried out so far. It was also felt necessary to test whether partial reduction of incident light on the young plants during winter can decrease the photoinhibitory effects.