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Irradiance influences contents of photosynthetic pigments and proteins in tropical grasses and legumes

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Abstract

Three tropical range grasses (*Cenchrus ciliaris*, *Dichanthium annulatum*, and *Panicum antidotale*) and two range legumes [*Macroptilium atropurpureum* (siratro) and *Stylosanthes hamata* (stylo)] were grown under four irradiances, *i.e.* 100 (I_{100}, control), 75 (I_{75}), 50 (I_{50}), and 25 (I_{25}) % of full sunlight. Accumulation of chlorophyll (Chl) *b* increased but that of Chl *a* decreased under low irradiances. The greater accumulation of Chl (*a*+*b*) in grasses (particularly in *D. annulatum* and *P. antidotale*) under shade predicted their shade adaptability. Among legumes *Stylosanthes* was more adaptive to the shade than *Macroptilium* due to its higher accumulation of Chl (*a*+*b*). Significant difference in the accumulation of carotenoids under I_{25} over I_{100} was observed in all the species, which shows the increase in quality of the fodder under limited irradiance. There was a significant decrease in soluble protein content in *C. ciliaris* under I_{75}, however, no significant difference in protein content was observed under I_{50} and I_{25}, which was also reflected in the SDS pattern with the reduction in content of polypeptides at I_{75} and following increase at I_{50} and I_{25}. This was possibly due to reduction of light-induced protein at I_{75} and then expression of the stress-induced protein at further reduction of irradiance. Peroxidase activity in *C. ciliaris* increased with the decrease in irradiance and its isozyme pattern showed differences among all treatments, which indicated the role of different peroxidase isoforms at different irradiances.

Additional key words: carotenoids; *Cenchrus*; chlorophyll; *Dichantium*; *Macroptilium*; *Panicum*; polyacrylamide gel electrophoresis; *Stylosanthes*.

Introduction

Morphological development of plants, leaves, and chloroplasts largely depends on the irradiance under which the plants are grown (Boardman *et al.* 1975, Lichtenthaler 1979, 1981). This development greatly depends on the amount of photons available during growth. Under high growth irradiance plants react with a strong growth response and under low growth irradiance with a weak growth response (Lichtenthaler 1981). The shade-type chloroplasts of shade leaves, low-irradiance leaves, and shade plants are characterized by much larger grana stacks and higher stacking degree (Anderson *et al.* 1973, Guillot-Salomon *et al*. 1978, Lichtenthaler *et al.* 1981) than the sun-type chloroplasts, which have much less chloroplast lamellae. High-irradiance chloroplasts are represented by higher ratio of chlorophyll (Chl) *a/b* and lower ratios of xanthophylls/carotene (x/c) and Chl *a*/prenylquinones (Lichtenthaler 1979, Lichtenthaler *et al*. 1981).

The characteristics of photosynthetic reactions differ between shade tolerant species grown in shade and shade-intolerant species acclimated to higher irradiance (Björkman 1981): acclimation responses occur among genetically uniform plants grown at different irradiances and among leaves of individual plants acclimated to different irradiance. Bond *et al.* (1999) determined the acclimation of foliage physiology along the canopy irradiance gradient in conifers of varying shade tolerance. Photon-saturated net photosynthetic rate (P_{Nmax}) and Chl *a/b* ratios were higher in foliage of canopy positions exposed to higher irradiance as compared to shaded crown layers. The shade tolerant species showed relative shade-type characteristics at a given radiation environment, both P_{Nmax} and Chl *a/b* ratio were lower in needles of the shade tolerant species. In higher plants, the amount of incident solar radiation available during growth produces distinct differences in the composition, function, and structure of chloroplasts (Leong and Anderson 1984, Lechowicz *et al*. 1986).

We tried to define typical differences in the accumulation of photosynthetic pigments, SDS protein profiles, and isozymes between sun-type and shade-type leaves of some tropical grass and legume species.

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