CLONAL VARIATION IN LEAF EPICUTICULAR WAXES AND REFLECTANCE: POSSIBLE ROLE IN DROUGHT TOLERANCE IN *HEVEA*

Soil and atmospheric drought and high temperature are major environmental factors limiting growth and yield in *Hevea* in traditional and non-traditional regions. Identification and breeding of clones tolerant to these stresses are important. Stress tolerant clones are of special importance for successful cultivation of *Hevea* in the non-traditional regions under rainfed conditions. Early evaluation of stress resistant traits will be highly useful in this context. Amount of epicuticular wax on the leaf surface is reported to be an important parameter associated with drought and heat tolerance (Levitt, 1972; Bengtson *et al*, 1978; Rajagopal *et al*, 1988). Presence of epicuticular wax helps in reducing cuticular transpiration (Bengtson *et al*, 1978; Rao *et al*, 1981; Reddy *et al*, 1982; Gururaja Rao, 1983) and stomatal transpiration (Ehleringer *et al*, 1976; Ehleringer, 1981) and promotes reflection of radiant energy by canopies (Eller and Willi, 1981; Lee and Graham, 1986). This paper presents observations made on clonal variations in leaf epicuticular wax and optical properties in young *Hevea* plants. Possible use of these parameters for screening for drought tolerance in *Hevea* is discussed.

Fully expanded and physiologically mature sun leaves (second leaf from the bottom in the second flush in a branch) collected from three year old rubber plants, belonging to six clones *viz*., Gl 1, RRII 308, RRII 105, RRIM 623, RRII 43 and Tjir 1 during the dry season of 1988 were used for estimation of epicuticular wax and spectral properties. Six plants were selected at random from a complete random planting of various clones and three sun leaves were collected from each plant. Leaf epicuticular waxes were extracted using chloroform. The extract was evaporated and the wax contents were determined gravimetrically (Ebercon *et al*, 1977). For studying optical properties, leaves were collected in polythene bags to avoid transpirational water loss and to minimise errors. The leaves were analysed for diffuse reflectance and diffuse transmittance allowing calculation of absorptance from the abaxial surfaces. For optical analysis, a Li-Cor 1800–12 Integrating Sphere attached by a Fibre Optic cable to a LI-1800 Spectroradiometer was used in all measurements. The leaf sample was placed against an outside port of the sphere and diffuse transmittance and reflectance were compared with those of a barium sulphate standard. The experimental setup provided a spectral range of 350–1100 nm at scanning intervals of 2 nm. Programmes in the instrument's microcomputer were made use of in the calculation of diffuse reflectance, diffuse transmittance, absorptance of each leaf and the ratio of reflectance to transmittance.

The absorptance was calculated using the equation:

Absorptance = 1 – (reflectance + transmittance).

Regression equation was developed using the mean values of epicuticular wax and reflectance for individual plant. The data collected were statistically analysed.

Data on leaf epicuticular waxes and optical properties are given in Table 1. Highly significant clonal variations were found in the levels of epicuticular wax in the young

Table 1. Leaf epicuticular wax content and optical properties in clones of *Hevea brasiliensis*

Clone	Wax** (μg cm^{-2})	Optical properties			
		Absorptance*	Diffuse Reflectance** (R)	Diffuse Transmittance* (T)	R/T*
Gl 1	120.36	0.830	0.106	0.063	1.480
RRII 308	93.12	0.855	0.095	0.056	1.269
RRII 105	87.81	0.867	0.087	0.044	1.256
RRIM 623	39.72	0.883	0.063	0.056	1.010
RRII 43	37.72	0.883	0.063	0.056	1.125
Tjir 1	35.79	0.883	0.055	0.054	1.020
C. D. $_{0.05}$	7.35	0.021	0.011	0.008	0.102

** Significant at 1 % level. * Significant at 5 % level.

Note: For optical properties, the instrument calculates by taking 1 as 100 per cent.

Hevea plants studied. Among the clones, maximum epicuticular wax was noticed in Gl 1 followed by RRII 308, RRII 105, RRIM 623, RRII 43 and Tjir 1 in order. Clonal differences in diffuse reflectance were found to be highly significant. Though clonal variations in absorptance and transmittance were found statistically significant, the difference in these characters between clones was not as high as the variation in reflectance values. Of all the clones, diffuse reflectance was found to be the highest in Gl 1. Much of the reflectance was in the 750–1100 nm region (Figs. 1 and 2). In the near infra-red region, around fifty per cent of the light was reflected, whereas in the visible region (400-700 nm), the reflectance was only around 8 per cent. *Hevea* clones were found to absorb very little radiant energy in the region of 750–1100 nm. The amount of epicuticular wax in these clones was correlated with high reflectance values (r = 0.9630**).

Data on reflectance was regressed over the epicuticular wax levels, using the regression equation:

Reflectance= 0.000598 epicuticular wax + 0.03964.

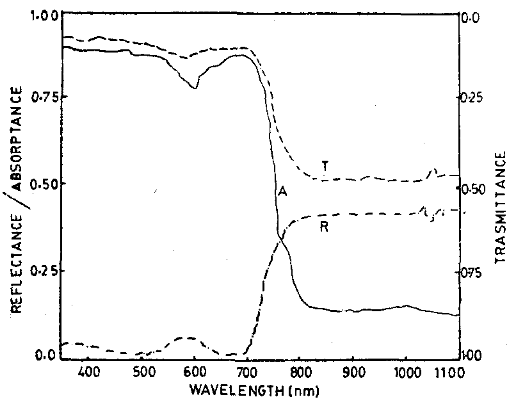

Fig. 1. Optical properties of leaves of *Hevea brasiliensis*. Diffuse reflectance (R) : diffuse transmittance (T) and absorptance (A).

The relation between epicuticular wax and reflectance is depicted in Fig. 3.

Based on the yield drop during summer months, clones like RRII 105, Gl 1 (Raghavendra *et al*, 1984) and RRII 308 (Prema-

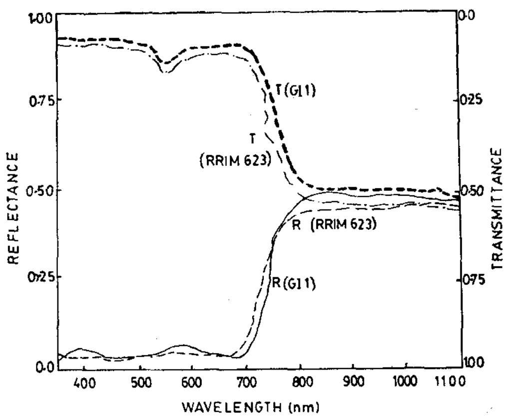

Fig. 2. Comparison of optical properties of leaves of clones GI 1 and RRIM 623. Diffuse reflectance (R) and diffuse transmittance (T).

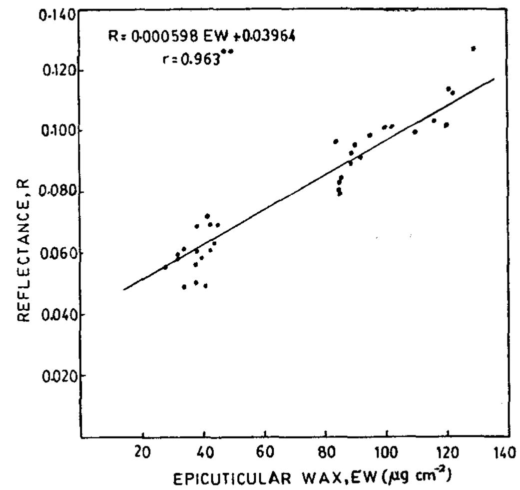

Fig. 3. Relation between epicuticular wax (EW) and reflectance (R) in *Hevea brasiliensis*.

kumari *et al*, 1982) were classified as fairly drought tolerant, while clones like RRIM 623 (Paardekooper, 1965), RRII 43 (Markose, 1984) and Tjir 1 (Sethuraj and George, 1976) were categorised as drought susceptible. High levels of epicuticular wax observed in the tolerant group are associated thus with high reflectance of heat energy and probably reduce transpirational water loss. This can be considered as one of the factors associated with drought resistance in these clones. It is also reported that clone RRII 105 had higher leaf water potentials and lower transpiration rates (Gururaja Rao *et al*, 1988) and a susceptible clone Tjir 1 had very low leaf water potential and very high transpiration rates (Devakumar *et al*, 1988). Higher reflectance of radiant energy will result in lower leaf temperature, thus reducing thermal injury (Loomis, 1965; Eller and Willi, 1981). Accumulation of epicuticular wax resulting in high reflection of radiant energy appears to be an adaptive feature in clones GI 1, RRII 308 and RRII 105.

Results of the present study also indicate that measurements on leaf epicuticular waxes or optical properties can be included as a method of screening for drought tolerance in *Hevea* clones.

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