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PHOTOSYNTHETIC RATE AND ITS RELATION WITH LEAF CHARACTERISTICS IN SEEDLINGS OF *HEVEA BRASILIENSIS*

Selection of genotypes with high leaf carbon dioxide exchange rate (CER) is important for improving crop yield. In view of this, several workers have attempted to relate CER with yield of crop and select plants for high CER to improve yield. A poor and sometimes negative relationship of CER with yield of crop has been reported by Evans (1975) and Ozbun (1978). However, relationship of CER with yield of *Hevea* was reported to be positive, though the correlation was weak (Samsuddin *et al.*, 1987). Various physiological, biochemical and anatomical characteristics are related to variations in CER. Evidence suggests that leaf area index, leaf angle, leaf duration and other factors influence radiation harvesting process. The relation of leaf area, number and thickness with CER which has not been studied to date is also important for *Hevea* productivty. The objective of the present study is to examine the relationship of CER with a few leaf characters such as leaf area, length, breadth, number and thickness.

The experiment was conducted at the Rubber Research Institute of India, Kottayam. Eighteen month old polyclonal seedlings of *Hevea brasiliensis* were used for the study. These seedlings were grown in pots under well watered conditions by following standard cultural practices. Seventy seedlings were selected for the experiment. Carbon dioxide exchange rate was measured by a closed system of infrared gas analyser (Portable photosynthesis system, LI 6200 LICOR, USA). Fully expanded mature leaf was inserted into the chamber as identical to natural position and exposed to sunlight for measurement. All measurements were done between 08.30 and 09.30 hrs. in the second half of January. The ambient temperature was 27 ± 2°C, relative humidity approximately 60% and light intensity 1000 ± 200 μ mol m^{-2} s^{-1}. After gas exchange measurements, leaves were detached from each plant and the area was recorded using leaf area meter (LI 3000, LICOR, USA). Leaves were later dried in an Oven for 72 hours at 80°C and dry weights were recorded. Girth at 5 cm above the ground, leaf length, leaf breadth and leaf number per plant were also recorded.

Frequency distribution of CER in the polyclonal population of seventy seedlings is presented in Figure 1. Values of CER ranged from 4.1 to 14.3 μ mol m^{-2} s^{-1} with mean of 8.8 μ mol m^{-2} s^{-1} and 24.7 per cent coefficient of variation (Table 1). Considerable variation in CER is indicated by the high coefficient of variation. (More than 20% CV is considered as significant according to Guzhov Yu, 1989) . Earlier workers also have reported considerable variation in CER (36% CV) in *Hevea* genotypes (Samsuddin, 1986; Samsuddin and Impens, 1978; 1979; Ceulemans *et al.*, 1984).

Correlation coefficients of CER and other leaf characters are presented in Table 2. An inverse significant correlation of CER with single leaf area was observed. Significant negative correlation is well documented in literature between CER and leaf area in

Table 1. Mean, range and covariance in CER, other leaf traits and girth in a population of polyclonal seedlings of *Hevea*

Variables	Mean	SE(±)	CV	Range
CER (μ moles $m^{-2}s^{-1}$)	8.8	0.26	24.7	4.1-14.3
Leaf area (cm^2)	111.2	4.33	32.5	52.7-252.0
Leaf length (cm)	22.3	0.44	16.7	15.7-37.8
Leaf breadth (cm)	7.6	0.16	17.2	4.9-12.3
SLW (mg cm^2)	6.2	0.08	11.4	4.3-8.5
No. of leaves	43.0	2.08	40.6	15.0-99.0
Total leaf area (dm^2)	135.7	6.82	38.0	50.6-299.4
Girth (cm)	3.7	0.08	18.2	2.2-4.7

genotypes of soybean (Hesketh *et al*., 1981), barley (Berdahl *et al*., 1972) and rice (Dey *et al*., 1989). High variation was observed in individual leaf area which ranged from 52.7 to 252 cm^2 with a mean of 111.2 cm^2 and a CV of 32.5 per cent. Other parameters such as leaf length, leaf breadth and thickness showed moderate CV of 16.7, 17.2 and 11.4 per cent respectively. The mean of total leaf number per plant was 43 and ranged from 15 to 99. Leaf number per plant exhibited the highest CV (40.7%) among the measured parameters. Total leaf area per plant

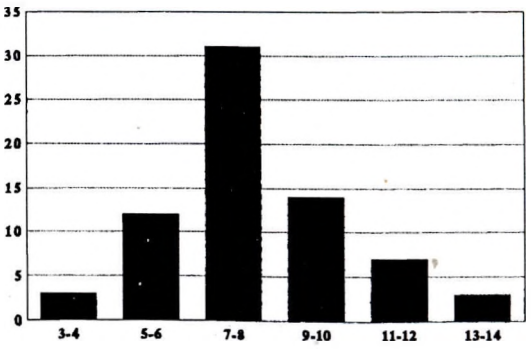

Fig. 1. Frequency distribution of CER among the polyclonal seeding population of *Hevea*

Table 2. **Correlation coefficient of CER with leaf traits and girth**

	Leaf area	Leaf length	Leaf breadth	SLW	No. of leaves	Total leaf area	Girth
CER	-0.431**	-0.353**	-0.479**	0.252*	0.183	-0.199	-0.219
Leaf area		0.879**	0.877**	-0.095	-0.375**	0.326*	0.372**
Leaf length			0.715**	-0.077	-0.378**	0.245*	0.220
Leaf breadth				0.057	0.283*	-0.373**	0.407**
SLW					-0.094	-0.120	-0.039
No. of leaves						0.709**	0.216
Total leaf area							0.510**

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

showed a large variation of nearly six times (50 to 299 cm^2) and girth of the seedlings ranged from 2.2 to 4.7 cm.

Photosynthesis (CER x total leaf area) per plant showed positive relation with total leaf area (r = 0.806**) and girth (r=0.350**) of the plant. This indicates that total photosynthesis can be increased either by increasing CER or total leaf area. Further, total leaf area may be increased by increasing leaf number per plant and mean area per leaf. Leaf number per plant showed significant negative correlation (r = -0.375)** with single leaf size which indicates that increase of leaf size will result in decrease of leaf number, ultimately reducing the total leaf area. Therefore, leaf number and leaf size seem to be mutually complementary. There are several instances, where variation in size of leaf does not reflect on yield (Berdahl *et al.*, 1972; Mandl and Buss, 1981). Negative correlation between leaf area and CER may be one of the causes for lack of consistent relation between CER and yield. Hence leaf area and leaf orientation in the canopy are important for optimising photosynthesis. Leaf length and breadth, the traits contributing to leaf area, also showed negative correlation with CER. Total leaf area per plant is negatively correlated with CER and positively with girth. Leaf thickness indicated by specific leaf weight showed significant positive correlation with CER. The relationship of SLW with CER is not consistent as surveyed by Bhagsari and Brown (1986) in several crops. In our observations there is a positive relation between SLW and CER which indicates that thick leaves have higher CER. Lack of relationship between leaf area and SLW suggests that genotypes could have high SLW with higher area per leaf. This further signifies the possibility of identifying genotypes with higher leaf area and higher SLW. Such types may possess high growth by virtue of high assimilation rate. Leaf size, angle and position on stem often greatly influence natural shading in the canopy. Further studies are needed to postulate an ideal canopy architecture taking into consideration leaf size, orientation and leaf area index at different layers of the canopy for optimum productivity.

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