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CLONAL DIFFERENCES IN GROWTH PARAMETERS OF YOUNG *HEVEA* BUDDINGS AND THEIR RELATION TO FIELD PERFORMANCE

by

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SUMMARY

Hevea *trees when tapped exhibits a depression of girth increment and canopy growth. Hence a high growth rate is required to maintain the growth whilst giving a high yield. Growth parameters of 5* Hevea *clonal buddings were determined after different growth intervals viz., 3, 6, 9, and 12 months to study the correlation they show with the field performance of the same clones. Clonal differences were significant, but did not necessarily correlate with the field performance. Growth rates gradually increased with age during the period of investigation. The possibility of using growth parameters together with gas exchange capacities determined in earlier studies in predicting later field performance are discussed.*

INTRODUCTION

The major yield components of *Hevea brasiliensis* are the initial flow rate per unit length of tapping cut, length of the tapping cut, percentage rubber content and plugging index (Sethuraj, 1981). Therefore a high unit leaf rate for growth and a high ratio of the partitioning of assimilates into rubber for yield are physiological requirements of a high producing tree. Tapping is associated with decreased growth rate of the tree envinced by reduced girthing rate. This could be due to competition between the shoot and latex sinks for limiting supply of assimilates (Simmonds, 1982) or due to competition for vital growth factors which are lost in the serum at tapping (Templeton, 1969).

Plant growth analysis have been primarily designed to describe in quantitative terms, the plants and stands as productive systems. From a practical point of view growth characteristics are also useful as indices of yield capacity. Growth characteristics of 2 *Hevea* clones under plantation conditions have been monitered by

Templeton (1968) for 7 years after planting. The Relative Growth Rates (R) and Unit Leaf Rates (E) had declined with age and Leaf Area Ratio (F) and Leaf Weight-Ratio (LWR) remained constant for the first 3 years and then started to decline there after. The changes in dry matter production paralleled those of Leaf Area Index (LAI). Later studies have shown tapping to reduce shoot dry weight increment and also the growth of the canopy in high yielding clones (Templeton, 1969).

In this study growth parameters of 5 *Hevea* clones, having different yield potentials were studied. The period of study was restricted to I year because the standard growth analysis becomes difficult to apply when trees get beyond a certain size and also to enable us to find whether growth parameters at this early stage of growth are correlated with the later field performance. Earlier studies have shown that gas exchange capacities of young *Hevea* buddings could be used to predict the later field performance (Nugawela and Aluthhewage, 1987). The possibility of using growth parameters to further improve this predictive ability were examined.

MATERIALS AND METHODS

Plant material: Green buddings of 5 clones *viz*., RRIC 45, RRIC 100, RRIC 103, PB 86 and IAN 710 were grown in cement pots (diameter 14") filled with top soil mixed with a basal dose of manure. Each clone was replicated 20 times. Pots were distributed randomly in the open. They were kept on pillars of about a meter in height to prevent root growth into the ground. The plants were watered and manured regularly.

Sampling plants for growth analysis: Four plants selected at random were sampled from each clone at 3 month intervals from the day of planting upto a year. Each plant sampled was divided into its morphological units roots, shoots, petioles and leaves. Fresh weights of different morpholcgical units and leaf areas (LI-COR, Model LI-3000 Area Meter) were determined separately for each plant. Dry weights were recorded in the same manner after drying in an oven (maintaind at 80°C) to constant weight. Fresh and dry weights of budded stumps used for planting (4 per each clone) were determined initially.

Calculation of growth parameters: Relative Growth Rates (R), Unit Leaf Rates (E), Leaf Area Ratio (LAR), Leaf Weight Ratio (LWR) and Specific Leaf Area (SLA) were calculated as described by Hunt (1978). These growth parameters were calculated for each clone after 3, 6, 9 and 12 months growth.

The average of each growth parameter determined after 3, 6, 9 and 12 months was taken as the mean for that clone for the entire growth period *i.e.* one year.

RESULTS

The Relative Growth Rates (R) determined after 3, 6 and 9 months of growth showed significant clonal differences. R calculated after 12 months growth did not show clonal differences (Table 1).

Table 1. *Relative growth rates (R) gg^{-1} wk^{-1}, of the selected* Hevea *clones determined after different growth periods.*

Clone		Growth period (months) 3	6	9	12
RRIC 45	...	0.0044	0.0277	0.0318	0.0272
RRIC 100	...	0.0176	0.0059	0.0155	0.0220
RRIC 103	...	0.0165	0.0314	0.0180	0.0270
PB 86	...	0.0107	0.0243	0.0228	0.0264
IAN 710	...	-0.0259	0.0014	0.0182	0.0231
Significance of clonal differences		***	***	**	n.s.
L.S.D.	...	0.0129	0.0063	0.0051	—

n.s. = Not significant
** = Significant at $P < 0.01$
*** = Significant at $p < 0.001$

Unit leaf rate (E) determined after 3, 6, 9 and 12 months of growth showed significant clonal differences (Table 2).

Table 2. *Unit leaf rates (E) gg^{-1} wk^{-1}, of the selected* Hevea *clones determined after different growth periods*

Clone		Growth period (months) 3	6	9	12
RRIC 45	...	0.0084	0.0132	0.0111	0.0097
RRIC 100	...	0.0194	0.0040	0.0056	0.0066
RRIC 103	...	0.0176	0.0190	0.0086	0.0209
PB 86	...	0.0106	0.0147	0.0107	0.0122
IAN 710	...	-0.0254	-0.0013	0.0102	0.0080
Significance of clonal differences		***	***	*	**
L.S.D.	...	0.0140	0.0058	0.0025	0.0053

* = Significant at $P < 0.05$
** = Significant at $P < 0.01$
*** = Significant at $P < 0.001$

Except for Specific Leaf Area ($\overline{SLA}$), clonal differences in the other growth parameters, the mean for the entire growth period, were significantly different (Table 3).

Table 3. *Relative growth rate ($\overline{R}$) gg^{-1} wk^{-1}, unit leaf rate ($\overline{E}$) gg^{-1} wk^{-1}, leaf area ratio ($\overline{F}$) cm^2 g^{-1}, leaf weight ratio ($\overline{LWR}$) and specific leaf area ($\overline{SLA}$) cm^2 g^{-1} of the selected Hevea clones (Each value is the mean of that parameter determined after 3, 6, 9 and 12 months growth)*

Clone	Growth parameter $\overline{R}$	$\overline{E}$	$\overline{F}$	$\overline{LWR}$	$\overline{SLA}$
RRIC 45 ...	0.0228	0.0122	8.46	0.110	148.1
RRIC 100 ...	0.0153	0.0106	10.20	0.139	144.4
RRIC 103 ...	0.0223	0.0164	6.62	0.089	152.7
PB 86 ...	0.0211	0.0121	7.78	0.113	143.0
IAN 710 ...	0.0043	0.0038	8.46	0.115	140.3
Significance of treatment differences	***	***	**	***	n.s.
L.S.D. ...	0.0036	0.0031	1.18	0.015	—

n.s. = Not significant at $P < 0.05$
** = Significant at $P < 0.01$
*** = Significant at $P < 0.001$

R, F, LWR and SLA determined after different growth periods were significantly different. R, F and LWR showed a gradual increase while SLA declined. E did not differ significantly with age of plant (Table 4).

Table 4. *Relative growth rates (R) gg^{-1} wk^{-1}, unit leaf rates (E) gg^{-1} wk^{-1}, leaf area ratio (F) cm^2 g^{-1}, leaf weight ratio (LWR) and specific leaf area (SLA) cm^2 g^{-1}, determined after different periods (in months) of growth (each value is the mean of 5 clones)*

Growth period	Growth parameter R	E	F	LWR	SLA
3 ...	0.0047	0.0061	4.56	0.053	167.0
6 ...	0.0182	0.0099	8.06	0.112	146.0
9 ...	0.0213	0.0092	10.40	0.114	148.0
12 ...	0.0251	0.0115	10.20	0.146	136.0
Significance of treatment differences ...	***	n.s.	***	***	**
L.S.D. ...	0.0033	—	1.05	0.013	12.3

n.s. = Not significant at $P < 0.05$
** = Significant at $P < 0.01$
*** = Significant at $P < 0.001$

Increase in R with age of plant paralleled to that of F (Fig. 1).

DISCUSSION

The mean of the Relative Growth Rates ($\bar{R}$) and Unit Leaf Rates ($\bar{E}$), determined after 3, 6, 9 and 12 months growth of clones RRIC 45, RRIC 100, RRIC 103, PB 86 and IAN 710 were significantly different (Table 3). They were highest for RRIC 103, a high yielding and a vigorously growing clone. Though a moderatley high yielder, clone IAN 710 had the lowest mean $\bar{R}$ and $\bar{E}$. The Relative Growth Rate (R) and Net Assimilation Rate (E) determined after 3 months of growth were negative in this clone. This shows that there had been no net dry matter production during that period. Anyhow these parameters were comparable with that of other clones when determined after 9 and 12 months of growth. The correlation coefficient of the growth parameters with yield potentials (Jayasekera, 1987) of clones studied are given in Table 5. The R determined after a years growth showed a better correlation with yield potential (Table 5) than the mean R($\bar{R}$) for the entire growth period.

E gives the mean rate of CO_2 uptake integrated over the period of measurement less total plant respiratory losses. This, determined using year old *Hevea* buddings, is more closely correlated to yield than the maximum leaf CO_2 assimilation rate of the clone, determined under optimum conditions using newly expanded leaves (Table 5). Gas exchange rates and related anatomical features of the *Hevea* clones used for this study were investigated earlier using clonal buddings of similar age (Nugawela and Aluthhewage, 1987). The mean net CO_2 assimilation capacity of a single leaf whorl in a clone showed a significant correlation with its yield potential (Nugawela and Aluthhewage, 1987). This correlation can be further improved by substituting maximum leaf CO_2 assimilation rate (A) and photorespiration rate (Rp) with E, to calculate the above (Table 5). Anyhow E. La is only slightly better in predicting yield than ($A-R_p$). La which is based entirely on non-destructive measurements and thus could be used with seedlings.

Table 5. *Growth and gas exchange parameters of clones RRIC 45, RRIC 100, RRIC 103, PB 86 and IAN 710 and their correlation coefficient (r) with yield potential.*

Parameter		Correlation coefficient	Significance
R	...	0.3229	n.s.
(After 12 months growth)			
$\bar{R}$	...	0.3085	n.s.
E	...	0.4921	n.s.
(After 12 months growth)			
$\bar{E}$	...	0.0555	n.s.
F	...	0.8389	*
A	...	0.0754	n.s.
$(A—R_p)$ La	...	0.9083	*
$\bar{E}$.La	...	0.9395	*

n.s. = Not significant at $P > 0.05$
* = Significant at $P > 0.05$

Differences in Relative Growth Rates (R) could be due to differences in Unit Leaf Rate (E) or Leaf Area Ratio (F). It seems that the clonal differences in R are brought about by both. But the increase in R with age of the plant could be due to parallel increases in F. The E did not change significantly with age (Fig. 1).

Leaf Area Ratio (F) and Leaf Weight Ratio (LWR) are both estimates of leafiness of the plant. F, determined at this stage, could give an indication of the potential leafiness of the canopy in mature plants of the same clones. F correlates negatively with the yield potential (r = 0.8389). In *Hevea* CO_2 assimilation rate per unit leaf area tends to be low when the leaf size is large (Nugawela and Aluthhewage, 1987). If the leaf size and the number of leaves of a particular clone is high, E could drop due to mutual shading of leaves. Though the total leaf area is less, if they are efficient in CO_2 assimilation, that could lead to a higher CO_2 assimilation capacity of the canopy. In the 5 *Hevea* clones studied F increased significantly with age suggesting an increase in partitioning of assimilates towards producing assimilatory material.

Specific Leaf Area (SLA), a measure of the relative thickness of the leaf does not show clonal differences. But SLA seems to decline with age of the plant (Table 3). This could help in increasing assimilatory area with the available dry matter.

CLONAL DIFFERENCES IN GROWTH PARAMETERS

A high growth rate is a requirement of a high yielding tree. Anyhow the growth parameters of young *Hevea* clonal buddings did not show a significant correlation with the field performance *viz.*, yield and growth vigour. The growth rates studied were varying with age of plants in all 5 clones through-out the period of the study. These growth parameters determined at a latter stage of development may show a better correlation with the field performance.

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