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PERFORMANCE OF INDIGENOUS AND EXOTIC CLONES OF *HEVEA BRASILIENSIS* I. EARLY GROWTH PERFORMANCE OF 13 CLONES

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ABSTRACT

Thirteen rubber clones of Indian, Malaysian and Chinese origin were evaluated for early growth performance for a period of four years. Clonal variation was studied, correlations worked out and components of variance, heritability and genetic advance estimated. The growth parameters revealed highly significant clonal difference indicating the existence of genetic variability among clones. On the basis of growth indices computed at 16 and 28 months of growth, RRII 118 is the most vigorous clone, followed by RRII 208, RRIM 600 and SCATC 88-13, in that order. Annual girth and annual girth increment were also the highest for RRII 118 and annual summer girth increment over three years was the highest in the chinese clone Haiken 1, followed by SCATC 93- 114 and RRII 118.

INTRODUCTION

One of the main impediments in the cultivation of rubber *(Hevea brasiliensis)* is the long gestation period of six to seven years. Over the years, many attempts have been made to reduce this long unproductive phase by adopting various agricultural practices. In this context, selection of vigorous clones which attain tappable size earlier results in reduction of immaturity period. Therefore, knowledge on the early growth performance of clones assume special significance. Good immature vigour is one of the important attributes associated with early opening and good early yield in rubber (Tan, 1987; Simmonds, 1989). However, reports on comparative performance of popular clones at immature phase are rather limited. The effect of environmental constraints on early growth of certain clones in non-traditional areas has been reported by Sethuraj *et al.* (1991) and Nazeer *et al.* (1992). In the present investigation selected clones of indigenous and exotic origin have been subjected to evaluation of growth performance at the immature phase, over a period of four years.

MATERIALS AND METHODS

The experimental materials comprised two primary clones (RRII 5 and Haiken 1) and 11 hybrid clones (RRII 105, RRII 118, RRII 208, RRII 300, RRII 308, RRIM 600, RRIM 703, PCK 1, PCK 2, SCATC 88-13 and SCATC 93-114) of *H. brasiliensis.* Ten months old polybag plants of these clones were planted in the field employing Randomized Block Design (RBD) with seven replications and seven plants per plot, at the experiment station of the Rubber Research Institute of India, Kottayam during June 1989. Plant height, girth at 20 cm from the bud union, number of leaf flushes and total number of leaves were recorded at 16 months' growth (Dec. 1989). At 28 months growth (Dec. 1990), plant height, girth at 150 cm from the bud union, bark thickness, number of branches and branching height were recorded. Monthly girth was recorded from 1990 onwards and used for calculating annual girth increment an summer girth increment. The data were subjected to analysis of variance (Panse and Sukhatme, 1967). Growth index (Gr. In.) for each of the 13 clones at 16 months growth (Dec. 1989) was computed considering the variables plant height

(X_1, girth (X_2), total number of leaf flushes (X_3) and total number of leaves (X_4) as follows:

$$Gr.\ In. = X_1W_1 + X_2W_2 + X_3W_3 + X_4W_4$$ where

X_1, X_2, X_3 and X_4 = Mean values of each of the four traits pertaining to each clone. and W_1 W_2, W_3 and W_4 $= \frac{1}{\sigma^2_{e_1}}\ \frac{1}{\sigma^2_{e_2}}\ \frac{1}{\sigma^2_{e_3}}$ and $\frac{1}{\sigma^2_{e_4}}$ = the weights attached to each of the four traits under study (Mydin *et. al.* (1990). Similarly, the variables plant height, girth at 150 cm height, canopy density and annual girth increment were used for computing growth index at 28 months. Correlation coefficients between different parameters were worked out and only those having significant positive correlation with girth were considered for computation of growth index. Data on weather parameters recorded at the station during the period of study (1989 to 1992) were also taken in to consideration. Phenotypic Coefficient of Variation (PCV), Genotypic Coefficient of Variation (GCV), Heritability in the broad sense (H^2) and Genetic Advance (GA) were estimated according to Johnson *et. al.* (1955) and Burton and Devane (1953).

RESULTS AND DISCUSSION

Among the thirteen clones evaluated for early growth, two are primary clones (RRII 5 and Haiken 1) and all others are resultant of hybridization and selection programmes in different countries. During the period under report, monthly rainfall ranged from 3.95 mm in February to 898.33 mm in June with a total annual precipitation of 3370 mm (mean over four years, 1989-1992). Temperature ranged from 21.35°C in January to 34.35°C in March (Table I).

General growth, in terms of growth indices at 16 month's age (six months after field planting) ranged between 38.34 and 50.47 (Table II). At both the growth period of 16 and 28 months, RRII 118, RRIM 600 and SCATC 88-13 recorded high growth indices and the trend was generally comparable. Relatively high growth indices for RRII 118 and RRIM 600 have earlier been reported (Varghese *et. al.,* 1993). PCK 1 was the least vigorous clone in both the early growth stages (Table II). RRII 118 and RRIM 600 are reported to exhibit superior growth in non-traditional areas also (Sethuraj *et. al.*, 1991).

Table 1. Average rainfall and temperature (1989-1992)

Months	Rainfall (mm)	Temperature ° C	
		Maximum	Minimum
January	10.58	32.43	21.33
February	3.95	33.55	22.48
March	30.18	34.65	23.83
April	131.85	34.35	24.43
May	302.80	32.60	24.28
June	898.33	29.55	23.18
July	742.05	29.13	22.58
August	401.90	29.28	22.93
September	208.35	30.28	23.05
October	415.78	30.63	22.85
November	217.88	31.48	22.58
December	13.35	32.50	21.50
Total	3370.00	Mean 31.70	22.92

Table II. Growth indices of clones at two growth stages

Clones	16 months	28 months
RRII 5	40.20	23.74
RRII 105	45.60	23.69
RRII 118	50.47	28.03
RRII 208	50.40	26.18
RRII 300	46.25	23.92
RRII 308	47.64	22.34
RRIM 600	50.42	25.18
RRIM 703	47.87	23.12
PCK 1	38.34	20.53
PCK 2	43.38	22.02
SCATC 88-13	48.95	25.09
SCATC 93-114	48.73	23.73
Haiken 1	45.53	25.02
GM	46.14	24.05

Table III. Performance of clones at 16 months growth

Clones	Parameters			
	Height (cm)	Girth (cm)	Flushes (no.)	Leaves (no.)
RRII 5	209.98	7.41	5.18	27.19
RRII 105	250.08	7.42	6.33	38.59
RRII 118	243.31	8.08	7.28	46.96
RRII 208	265.82	7.74	7.16	45.57
RRII 300	237.16	7.58	6.57	44.61
RRII 308	257.79	7.21	6.86	40.85
RRIM 600	284.81	7.53	6.84	47.43
RRIM 703	252.88	7.39	6.59	46.10
PCK 1	186.36	6.48	5.33	33.34
PCK 2	223.68	6.89	6.19	37.18
SCATC 88-13	284.37	7.21	7.03	38.33
SCATC 93-114	280.57	8.10	6.38	35.47
Haiken	245.02	7.16	6.43	37.55
GM	247.83	7.40	6.48	39.94
CD	22.69	0.53	0.48	7.96
VR	13.49**	5.64**	14.02**	4.54**

** Significant at $P < 0.01$

Table IV. Performance of clones at 28 months growth

Clones	Parameters			
	Height (cm)	Girth (cm)	Branching height (cm)	Canopy density (%)
RRII 5	423.55	12.01	257.95	68.16
RRII 105	435.43	11.95	263.72	68.37
RRII 118	437.31	13.79	257.99	67.95
RRII 208	459.43	12.93	262.94	65.71
RRII 300	401.77	12.01	254.02	63.67
RRII 308	409.67	11.15	247.26	59.18
RRIM 600	461.26	12.78	265.27	65.10
RRIM 703	440.49	11.98	248.33	63.74
PCK 1	355.41	10.95	264.31	38.98
PCK 2	391.94	11.16	259.71	52.44
SCATC 88-13	439.85	12.06	269.06	60.03
SCATC 93-114	473.97	12.48	306.69	49.18
Haiken 1	373.20	12.47	236.80	60.37
GM	423.33	12.13	260.85	60.22
CD	30.90	1.07	16.15	10.55
VR	10.36**	4.21**	8.04**	5.38**

** Significant at $P < 0.01$

Table V. Girth (cm) and girth increment (cm)

Clones	Girth		Annual girth increment
	40 months	52 months	40-52 months
RRII 5	21.34	29.86	8.52
RRII 105	20.33	28.30	7.97
RRII 118	24.22	33.78	9.57
RRII 208	22.02	29.52	7.51
RRII 300	20.61	29.30	8.68
RRII 308	20.31	28.75	8.44
RRIM 600	20.71	26.95	6.24
RRII 703	19.90	27.75	7.85
PCK 1	18.41	26.64	8.23
PCK 2	19.57	28.71	9.14
SCATC 88-13	20.44	26.99	6.55
SCATC 93-114	19.07	25.04	5.96
Haiken	20.46	27.23	6.76
GM	20.57	28.37	7.80
CD	1.66	1.83	0.87
VR	5.88**	10.65**	13.20**

**Significant at $P < 0.01$

Table VI. Mean growth during first three years.

Clones	Mean annual	
	Girth increment (cm)summer	Summer girth increment (cm)
RRII 5	8.84	2.02
RRII 105	8.20	2.01
RRII 118	10.02	2.22
RRII 208	8.66	2.14
RRII 300	8.64	2.21
RRII 308	8.42	1.94
RRII 600	7.84	2.09
RRII 703	8.07	2.06
PCK 1	7.79	1.96
PCK 2	8.47	1.93
SCATC 88-13	8.14	1.94
SCATC 93-114	6.92	2.24
Haiken 1	8.06	2.26
GM	8.31	2.08
CD	0.59	0.20
VR	11.28**	3.08**

** Significant at $P < 0.01$

Analysis of variance of the difference growth parameters, both at 16 and 28 months revealed highly significant clonal differences indicating the existence of genetic variability among the clones evaluated (Tables III and IV). At 16 months growth (Table III) plant height was the highest in RRIM 600 (284.81 cm), followed by the Chinese clones SCATC 8-13 (284.37 c m) and SCATC 93-114 (280.57 cm) and girth the highest in SCATC 93-14 (8.10 cm), followed by RRII 118 (8.08 cm). Number of flushes were the highest in RRII 118 and number of leaves in RRIM 600.

At the more advanced growth phase of 28 months (table IV), SCATC 93-114 recorded the highest value for plant height (473.97 cm), followed by RRIM 600 (461.6 cm); girth was the highest in RRII 118 (13.79 cm), followed by RRII 208 (12.93 cm) and RRim 600 (12.78 cm) and the lowest in PCK 1 (10.95 cm). The high

Table VII. Correlations

A.	At 16 months growth stage	
	Girth Vs.	
	- Height	= 0.5789**
	- Number of flushes	= 0.665**
	- Number of leaves	= 0.4328**
B.	At 28 months growth stage girth Vs.	
	- Height	= 0.5727**
	- Bark thickness	= 0.4703**
	- No. of branches	= 0.0109
	- Branching height	= -0.178
	- Canopy	= 0.5754**
	- Annual girth increment	= 0.9439**

** Significant at $P < 0.01$

Table VIII. Genetic parameters for juvenile growth parameters

Character	Coefficient of variation		Heritability	Genetic advance
	PCV	GCV	H2%	GA%
Height	10.71	7.87	54.05	11.92
Girth	10.10	5.67	31.47	6.55
Bark thickness	11.21	3.98	12.60	7.44
No. of branches	30.23	8.20	7.36	4.58
Branching height	8.25	5.84	50.13	8.52
Annual girth	9.87	6.32	41.08	8.36
Annual girth increment	14.35	8.90	38.48	11.37

girthing in SCATC 93-114 at the early phase gradually declines, the possible reason being its late branching habit, less number of branches and relatively small crown (Table IV). This is further evidenced by the relatively poor growth of the clone with respect to girth and annual girth increment in advanced growth stages (Table V). In contrast, the growth rate of RRII 5 has improved substantially during the third and fourth year (Table VI) than that in the first two years. These results indicate that branching height related to early or late branching, number of branches and canopy size have got considerable influence on the rate of growth at immature phase. Annual girth increment over a period of three years (1989-1992) ranged from 6.94 cm to 10.02 cm; the highest in RRII 118, followed by RRII 5, RRII 208, RRII 300 and the lowest in SCATC 93-114 followed by PCK 1. (Table VII).

Drought tolerance in *H. brasiliensis* is manifested in terms of growth as ell as yield during summer months. Data on girth increment during summer months reflect the response of clones to drought condition. Girth increment, during the period Feb-May over three years was the highest in the Chinese wind tolerant clone Haiken 1, followed by SCATC 93-114, RRII 118 and RRII 208 (Table VII). These clones can be ranked as relatively tolerant to drought period with respect to growth. Sethuraj *et al.* 1991 reported relatively, superior growth of RRII 118 and RRII 300 in non-traditional areas. High growth index of RRII 208 in Konkan region has also been reported indicating that the clone is better adapted to stress situation (Nazeer *et. al.*, 1992).

Simple correlations between girth and growth parameters recorded at 16 months showed positive and highly significant correlation with height (r = 0.5789), number of leaf whorls (r = 0.665) and number of leaves (r = 0.4328). Similarly, height, bark thickness, canopy density and annual girth increment with girth at 28 months revealed highly significant positive correlations of r = 0.5727, 0.4703, 0.5754 and 0.9439 respectively. Correlations between girth and branching height was negative and that between girth and number of branches positive but non-significant (Table VII).

Estimates of genetic parameters viz. coefficient of variation phenotypic (PCV) and genotypic (GCV); heritability in the broad sense (H^2%) and expected genetic advance (GA%) for a set of perimeters recorded at 28 months' growth are shown in Table VIII. In general, PCV was greater than GCV for all the characters studied, indicating the influence of environmental effects on these characters. PCV ranged between 8.25 and 30.23 with the maximum value for number of branches (30.23) followed by annual girth increment (14.35) and the minimum for branching height 8.25. The highest estimate of GCV was for annual girth increment (8.90) followed by number of branches and the minimum for bark thickness (3.98). The difference between PCV and GCV was the minimum for plant height, suggesting that among the seven traits this trait is least affected by environment. This is also evident from the highest H^2 value for height (54.05). On the other hand, the difference was maximum for number of branches for which H^2 was the minimum. In the present investigation, H^2, manifested wide variation among the characters (7.36-54.95) (Table VIII).

Among the seven characters, estimates of expected genetic advance was the highest for plant height (11.92) followed by annual girth increment (11.38) and the minimum for number of branches (4.58). Even though, most of the characters showed relatively high degree of heritability, it was not found to be accompanied by high genetic advance.

The present report throws light on the influence of different parameters on growth pattern of clones at immature phase. Growth indices computed for comparison of general vigour of clones takes into account, the extent of environmental influence in the expression of the characters. Among the 13 clones, RRII 118 is the most vigorous clone at all growth stages. Influence of canopy characteristics, on the rate of growth is evident from the change in girthing pattern of clones like RRII 5, PCK 1 and SCATC 93- 114, over the years. Juvenile evaluation in respect of growth parameters facilitate early selection of vigorous clones, the use of which can bring down the immaturity period of rubber.

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