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GROWTH PERFORMANCE DURING THE IMMATURE PHASE OF A FEW RUBBER (*HEVEA BRASILIENSIS*) CLONES IN ORISSA

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Growth response during the immature phase of ten *Hevea* clones to prolonged soil moisture stress, high wind speed and high summer temperature in Orissa, a non-traditional area for rubber, was studied. The plants wintered by the end of February or first week of March. From April onwards, severe chlorosis, leaf margin drying and partial defoliation were observed. The variations of the clones in terms of six morphological characters were assessed from June 1996 to July 1998 and correlations worked out. Significant positive correlation of girth with the other four morphological traits (plant height, canopy height, canopy breadth and number of branches) were noticed. Higher growth indices were recorded in the clones RRIM 600, SCATC 93-114, RRII 208 and RRII 5 than the general mean indicating better adaptability to the stress situations. In general, RRIM 600 maintained relatively higher growth during the immature phase.

Key words : Abiotic stress, Clonal variation, Girth, Growth index, *Hevea*, Immature phase, Non-traditional region.

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INTRODUCTION

Rubber (*Hevea brasiliensis*) is traditionally cultivated in humid tropics within 10° North and South of the equator, where the quantity and distribution of rainfall and the ambient temperature are suited for its growth. In India, the traditional rubber growing area extends up to 13° N on the South West Coast. Attempts are now being made to extend rubber cultivation to the non-traditional regions of India, where near tropical climatic conditions exist (Sethuraj *et al.*, 1991). One such region identified is Orissa in Eastern India (20° N and 85° E). Prolonged severe soil moisture stress, high ambient day temperature during the summer months, moderate winter temperature and high wind velocity are the major agroclimatic constraints in this region that may affect growth and productivity of rubber (Sethuraj *et al.*, 1991; Chandrashekar *et al.*, 1996; Meenattoor *et al.*, 2000).

Very limited information is available on suitability of *H. brasiliensis* clones and the cultural practices to be adopted under prolonged drought conditions (Pushparajah, 1993; Sethuraj, 1986), crop performance under high temperature stress (of more than 40°C) and on the combined effect of low and high temperature and drought on growth and yield (Sethuraj *et al.*, 1991; Vijayakumar *et al.*, 1988).

It is known that the annual growth rate determines the length of the immaturity period and girth is the parameter used for evaluating the maturity of a rubber plantation (Sethuraj and George, 1980; Paardekooper, 1989). Growth performance analysis can also provide useful information on the clonal differences in growth (Chandrashekar *et al.*, 1998).

At present there is no information on the growth performance of *Hevea* in Orissa. The objective of the present study was to assess the early growth of ten *Hevea* clones using a

growth index. This is the first report of the performance of these clones in Orissa.

MATERIALS AND METHODS

A clone trial was established in 1990 at the experimental farm of the Regional Research Station of the Rubber Research Institute of India, at Kadalipal (20° 49' 40" North, 85° 30' 45" East at an altitude of 100 m above msl) in the Dhenkanal district of Orissa State. Two primary clones and eight secondary clones evolved in India, Malaysia, China and Indonesia were included in this study (Table 1). These clones were selected based on their performance in the traditional region. The experiment was laid out in randomized block design with three replications. The tree spacing adopted was 4.6 m x 4.6 m with square plots comprising of 25 plants as the site was almost flat and uniform. The soil was of sandy loam type with pH 5.6 and was lateritic in nature. It had 49.9 per cent coarse sand, 25 per cent fine sand, 17.5 per cent silt and 6.6 per cent clay. The initial fertility status showed that soils were low in organic carbon (0.2%) and available phosphorus (0.31 mg/100 g of soil). The available potassium (6.5 mg/100 g of soil) was in medium range, while the available magnesium (3.87 mg/100 g) was of high. The recommended cultural practices (Rubber Board, 1990) were followed.

During the summer period (March-May) the plants were maintained under life-saving irrigation. The quantity of irrigation fixed was arbitrary and varied from10 L per plant in the first year to 60 L per plant in the fourth year given at weekly intervals. From the fifth year, for the rest of the immature phase, irrigation at the rate of 100 L per plant on fortnightly basis was given during summer. White washing, mulching plant bases, weeding and manuring were part of the agronomic management practices employed to protect the plants. The casualties were replaced in the second year. The mean weather parameters recorded for the period 1996 to 1998 are presented in Table 2.

Table 1. **Rubber clones evaluated in Orissa**

Clone	Parentage	Country of origin
RRII 5	Primary clone	India
RRII 208	Mil 3 / 2 x AVROS 255	India
RRII 300	Tjir 1 x PR 107	India
RRIM 600	Tjir 1 x PB 86	Malaysia
RRIM 701	RRIM 501 x 44 / 553	Malaysia
PB 310	PB 5/51 x RRIM 600	Malaysia
SCATC 88-13	RRIM 600 x Pil B 84	China
SCATC 93-114	TR 31-45 x Heck 3-11	China
Hai Ken 1	Primary clone	China
PR 255	Tjir 1 x PR 107	Indonesia

The girth was measured in July during the sixth and eighth years after planting. Observations on plant height, canopy height, canopy breadth, number of branches and branching height (crotch height) were recorded during the eighth year of planting only. Girth was measured from all the 16 trees selected in each plot at a height of 125 cm from the bud union, while other morphological characters were recorded from 10 trees per plot selected at random. The data were subjected to the analysis of variance (Panse and Sukhatme, 1954). Simple correlation coefficients among all characters were computed. These characters were simultaneously considered for computation of a growth index (Mydin *et al.*, 1990). The clones were ranked on the basis of growth index.

RESULTS AND DISCUSSION

The Dhenkanal region of Orissa experiences a warm dry sub humid climate. This region received a mean annual rainfall of 989 mm with only 71 rainy days, during the study period (Table 2). The rainfall was almost confined to June to September with July recording the maximum rainfall (305.6 mm). The dry period extended from the middle of October to the middle of May (except for a few showers in March and April). The highest mean maximum temperature of

Table 2. **Weather during the experimental period at Kadalipal, Dhenkanal (1996-1998)**

Month	Air temperature °C		Relative humidity (%)		Rainfall	No. of rainy
	Max.	Min.	0710 h	1410 h	(mm)	days
January	26.2	15.1	88	78	3.5	1
February	29.6	17.7	90	64	3.4	1
March	35.9	21.2	89	61	24.9	2
April	36.9	22.9	89	65	58.8	5
May	39.8	26.3	83	48	17.4	2
June	36.5 *	26.1	87	65	133.4	14
July	31.9	24.9	90	76	305.6	16
August	31.2	24.9	90	77	202.9	14
September	31.2	24.0	91	77	167.2	9
October	28.9	22.5	90	74	34.2	5
November	27.5	19.7	88	67	18.6	1
December	26.1	12.2 **	88	63	19.1	1

* 47.7°C on 01.06.1998 ** 6.5°C on 30.12.1998

39.8°C (with peak of 47°C on 1st June 1998) was recorded during the month of May. In general, during March to mid-June, the mean maximum temperature was higher than 35.9°C and in other months it was below 32°C. The lowest mean minimum temperature of 12.2°C was recorded in December (with lowest temperature of 6.5°C recorded on 30th December 1998). December to February is the winter and the summer is from March to May. The summer months exhibited severe soil moisture stress conditions. The lowest relative humidity was observed during the month of May, especially during the afternoon hours. Environmental constraints such as soil moisture deficit, high summer and moderate winter temperatures may limit the growth of rubber in these regions (Chandrshekar *et al.*, 1998).

Table 3. **Girth and girth increment of clones**

Clone	Girth (cm)		Annual girth increment during 6 to 8 YAP	
	6 YAP* (1996)	8 YAP (1998)	(cm)	(%)
RRII 5	26.80	42.27	7.73	57.7
RRII 208	27.20	41.27	7.03	51.7
RRII 300	25.80	41.43	7.82	60.6
RRIM 600	29.40	43.83	7.22	49.1
RRIM 701	23.13	36.43	6.65	57.5
PB 310	26.10	39.67	6.78	52.0
SCATC 88-13	22.93	34.30	5.68	49.6
SCATC 93-114	28.20	44.73	8.27	58.6
Hai Ken 1	24.83	38.27	6.72	54.1
PR 255	26.53	42.37	7.92	59.7
General mean	26.09	40.46	7.18	55.1
SE	2.48	3.27	0.4	31.9

* YAP = Years after planting

The girth at the sixth and eighth years of planting and mean girth increment from 1996 to 1998 are presented in Table 3. The clones showed only very limited variation in girth and the mean girth increment. The maximum girth at the sixth year of planting was observed in RRIM 600 (29.4 cm) and at the eighth year of planting in SCATC 93-114 (44.73 cm), closely followed by RRIM 600 (43.83 cm). During both the years, minimum girth was recorded for SCATC 88-13 (22.93 cm and 34.30 cm).

Higher annual mean girth increment (mean of 2 years) was observed in SCATC 93-114 (8.27 cm) and the lowest in SCATC 88-13 (5.68 cm). Among the clones studied, RRII 300 showed the highest rate in girth increment (60.6%). It is well established that temperature and availability of water are the two major factors influencing growth and yield of rubber plants (Rao *et al.*, 1993). Jiang (1988) reported that the threshold temperature for growth of rubber in southern China is around 20°C. Higher mean girth and girth increment in SCATC 93-114 and RRIM 600 may be due to their wider adaptability to cold (Huason and Shaofu, 1990; Meenattoor *et al.*, 1991; Zongdao and Yanquing, 1992). Induction of deeper and probably denser roots might be responsible for higher plant moisture status

Table 4. **Morphological characters of the clones**

Clone	Plant height (m)	Canopy height (m)	Canopy breadth (m)	Crotch height (m)	No. of branches
RRII 5	9.08	2.70	6.77	2.33	12
RRII 208	8.99	2.80	7.23	2.37	15
RRII 300	8.97	2.67	6.1	2.17	15
RRIM 600	9.57	3.0	7.17	2.58	17
RRIM 701	7.57	2.67	6.13	2.29	13
PB 310	8.33	2.63	6.93	2.23	15
SCATC 88-13	8.57	2.60	6.1	2.33	15
SCATC 93-114	9.13	3.07	7.23	2.43	18
Hai Ken 1	7.97	2.63	5.97	2.23	15
PR 255	8.5	2.67	6.83	2.17	15
General mean	8.67	2.74	6.65	2.31	15
SE	0.62	0.14	0.34	0.09	2
VR	0.93	1.43 *	2.24 *	2.03 *	0.9
CD (P=0.5)	--	0.41	1.01	0.26	--

(Chandrashekar *et al.*, 1990) and good performance in summer. Lower girth and girth increment were observed in SCATC 88-13 during the experimental period. Sethuraj *et al*, (1991) reported that rubber plants attained tappable girth only after eight years of planting in the non-traditional regions. Growth parameters like girth and girth increment did not show any significant clonal variations inferring that this stage is too early for comparison on the basis of these traits as observed by Nazeer *et al.* (1992).

Significant clonal variations were observed in canopy height, canopy breadth and crotch height (Table 4). The clone RRIM 600 recorded the maximum plant height (9.57 m). But there was no significant difference between the clones. With respect to other juvenile traits, SCATC 93-114 recorded maximum canopy height (3.07 m) which was on par with all the clones except SCATC 88-13, PB 310 and Hai Ken 1 and canopy breadth (7.23 m) on par with all other clones except Hai Ken 1, RRII 300 and SCATC 88-13. Higher crotch height of 2.58 m was observed in RRIM 600, which was on par with the clones RRII 5, RRII 208, SCATC 88-13 and SCATC 93-114. Mean number of branches did not show any significant variation among clones. The maximum number of branches was observed for SCATC 93-114 (18) and minimum for RRII 5 (12) with a general mean of 15.

Simple correlations among the juvenile traits under study (Table 5) showed that girth is significantly correlated with plant height, canopy height and canopy breadth. Plant height was positively correlated with canopy height and canopy breadth. Similarly, canopy height was positively correlated with and canopy breadth number of branches and highly correlated with crotch height Significant positive association of girth with other morphological traits such as plant height, canopy height and canopy breadth shows that all these juvenile traits play an important role in early girthing of the plants. Canopy height showed positive correlation

Table 5. **Correlation coefficients among juvenile traits of clones**

Trait	Plant height	Canopy height	Canopy breadth	Crotch height	No. of branches
Canopy height	0.660 *				
Canopy breadth	0.638 *	0.711 *			
Crotch height	0.602	0.798 **	0.562		
No.of branches	0.452	0.709 *	0.437	0.455	
Girth	0.721 *	0.729 *	0.749 *	0.346	0.440

* Significant at 5% ** Significant at 1%

with plant height, indicating that the total height of the plant is influenced by the growth of canopy (Nazeer *et al.*, 1992).

The growth indices are presented in Table 6. The clone RRIM 600 was ranked first in growth index (192.12) followed by SCATC 93-114 (187.02), RRII 208 (179.21) and RRII 5 (174.33) and the values were more than the general mean (173.91). Use of environmental variances as weights attached to each trait in the growth index enables identification of top ranking clones, which show high mean performance for the relatively stable traits (Mydin *et al.*, 1996).

Table 6. **Growth index and rank of clones**

Clone	Growth index	Rank
RRII 5	174.33	4
RRII 208	179.21	3
RRII 300	165.40	10
RRIM 600	192.12	1
RRIM 701	168.95	6
PB 310	168.89	7
SCATC 88-13	170.25	5
SCATC 93-114	187.02	2
Haiken 1	165.86	9
PR 255	167.06	8
General mean	173.91	

The four clones with indices greater than the general mean, were RRIM 600, SCATC 93-114, RRII 208 and RRII 5, which could be considered superior in terms of adaptability to the stress situation existing in Orissa. However, their performance in respect of latex yield is yet to be evaluated.

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