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GROWTH PERFORMANCE OF *HEVEA* CLONES IN NORTHERN REGION OF WEST BENGAL

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Growth performance of *Hevea* clones was studied in Dooars area of West Bengal. Growth of *Hevea* was slow during December-March with a peak during June to September. Significantly higher growth was observed in cool season (1.13 cm/month) followed by monsoon (1.02 cm/month), hot (0.24 cm/month) and cold season (-0.01 cm/month). Among the 18 clones evaluated, GT 1, RRII 118, SCATC 88/13, SCATC 93/114 and Gl 1 showed comparatively more stability for growth. Except the clones PB 5/51, RRII 300, PR 107 and GT 1, all others recorded significantly higher girth during immaturity period and attained tappable girth by the seventh year. Preliminary observations during the initial year of tapping recorded significantly higher latex yield in clones SCATC 88/13, SCATC 93/114, PB 235 and RRII 118 compared to RRIM 612 and Haiken 1. Dry rubber content was more in PR 107, RRIM 612, PB 86 and Haiken 1.

Key words : Clonal performance, *Hevea*, Latex yield, Seasonal growth, Stability, West Bengal.

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INTRODUCTION

In order to meet the growing demand, rubber (*Hevea brasiliensis*) cultivation in India has been extended beyond the traditional region of Kerala and southern part of Tamil Nadu. The northern part of West Bengal, located in the sub-Himalayan region, has been identified as a potential area for rubber cultivation though there are some limitations. The region receives annual rainfall of 3300 mm which is comparable to that in the traditional region, but it is mainly distributed between May to September. Rest of the months receive less than 50-100 mm rain. Unlike the traditional region the winter temperature goes as low as 5°C. Because of moderate moisture regime and less favourable thermal regime the northern part of West Bengal is classified as a marginally suitable zone (Rao *et al.*, 1993). This study was undertaken to evaluate the performance of *Hevea* clones under the limiting hydrothermal conditions of northern part of West Bengal to identify clones suitable for the region.

MATRIALS AND METHODS

The study was conducted at the Regional Experiment Station (RES), Nagrakata with 18 clones in two separate trials laid out during 1990 in a randomised block design with three replications. Polybag plants were used as planting material and planted at 5 m x 5 m spacing.

Trial I comprised 11 clones (PB 311, RRII 300, Haiken 1, SCATC 88/13, SCATC 93/114, RRII 203, GT 1, RRIM 703, PB 5/51, RRII 118 and PB 235) with 25 trees per plot and trial II comprised 7 clones (PB 86, RRII 105, RRIM 605, RRIM 612, RRII 208, Gl 1 and PR 107) with 15 trees per plot. Both trials are located 50 m apart on plain land with uniform stand and soil fertility status. Normal cultural practices were followed for raising the plants. A combined evaluation of clones in both the trials was done for this study. Girth and girth increment (GI) were recorded at regular intervals. During the fifth year, monthly girth, GI and mean GI during four different seasons *viz.* hot (March-May), monsoon (June-September), cool (October-November) and cold (December-February), were recorded. Pooled analysis of variance in split plot design with clones as main plot treatments and seasons as sub-plot treatments for the mean GI (subjected to square root transformation) during different seasons was attempted to study the interaction between clones and seasons (Gomez and Gomez, 1984). Stability in growth performance of clones was assessed using ecovalence (W_i) concept (Wricke, 1962).

$$W_i = \sum_{j=1}^{J} (X_{ij} - X_{i\cdot} - X_{\cdot j} + X_{\cdot\cdot})^2$$

where i is the clone and j is the season.

Monthly weather data of the location were also recorded. Weekly mean temperature and total rainfall were recorded for the period from 5th November 1994 (*i.e.*, meteorological week No. 45) to 29th April 1995 (*i.e.*, meteorological week No. 17) representing the stress period, particularly cold stress. Tapping was started in May 1998. Plotwise latex yield (ml/tree) and dry rubber content (DRC) were recorded in November 1998 from three randomly selected trees of comparable girth.

RESULTS AND DISCUSSION

Climate in the northern region of West Bengal is sub-humid with annual rainfall of 3300 mm and mean temperature of 22°C (Table 1). About 77 per cent of

Table 1. Weather parameters (mean of 1992-1997)

Month	Temperature (°C)			Rainfall	Sunshine
	Maximum	Minimum	Mean	(mm)	hours
January	21.6	7.4	14.5	22.0	6.5
February	23.7	9.1	16.4	28.7	6.6
March	28.3	13.6	21.0	32.1	6.8
April	29.8	17.8	23.8	119.9	7.0
May	30.6	21.0	25.8	409.5	6.1
June	30.8	21.9	26.4	771.9	4.7
July	31.5	24.1	27.8	833.4	3.1
August	30.7	23.8	27.3	522.2	4.1
September	30.9	22.5	26.7	417.7	5.0
October	30.5	17.0	23.8	120.9	8.0
November	24.9	12.0	18.5	21.3	8.0
December	22.3	7.6	14.9	9.6	7.1
Mean	28.0	16.5	22.2	275.8	6.1

annual rainfall is received between May to September and least during November to March. Mean maximum temperature is 28°C which rises as high as 31.5°C during July. Maximum temperature remains above 30°C during May to October. Mean minimum temperature is 16.5°C and it dips to as low as 5°C during the cold period (Fig. 1). It is interesting to note that during November to March the temperature range between maximum and minimum is wider (12-15°C). At the same time less than 60 mm rainfall is received during the period (Fig. 1). So the plants suffered from unfavourable hydrothermal conditions during the seasons except the monsoon and cold season.

Clonewise monthly girth increment and seasonal GI are presented in Fig. 2 and Table 2 respectively. Growth declined drastically in all the clones from December onwards. During January/February no appreciable growth was observed in the clones PB 86, Gl 1, RRII 105, RRII 208 and PR 107. Little or negligible growth continued in March/April but it picked up during May. However, the revival in growth was delayed by one month in the clones PB 5/51, GT 1, PB 311 and PR 107. Except RRII 203, RRIM 703 and RRII 118 all the other clones showed a peak in growth between June and September and then showed a declining trend by October. These three clones continued to show high growth rate up to October. Growth declined drastically during November in PB 5/51 and PR 107 whereas it was comparatively high in the rest of the clones. Among the seasons significantly higher growth was observed during the cool season (1.13 cm/month) followed by the monsoon (1.02 cm/month) (Table 2). Growth during monsoon and cool seasons constituted 64.85 and 24.09 per cent respectively of annual GI compared to 11.4 per cent for the hot season. Clonal variation in growth during cold season was not significant but the growth was least compared to other seasons and contributed negatively (-0.36%) to the total annual growth. There was no growth during cold season in most of the clones and it was below zero in RRII 105, PB 86, RRII 208, Gl 1, PR 107 and PB 311. During the hot

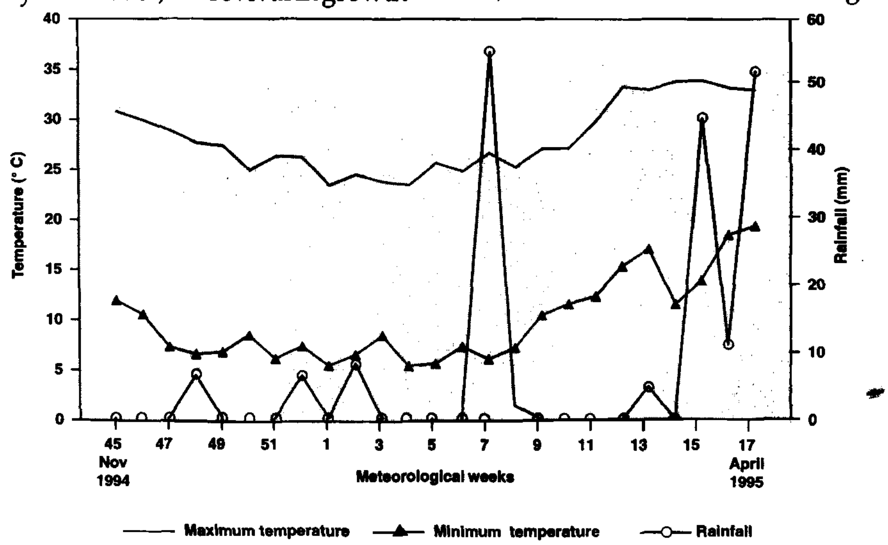

Fig.1. Temperature and rainfall profiles at RES, Nagrakata from November 1994 to April 1995

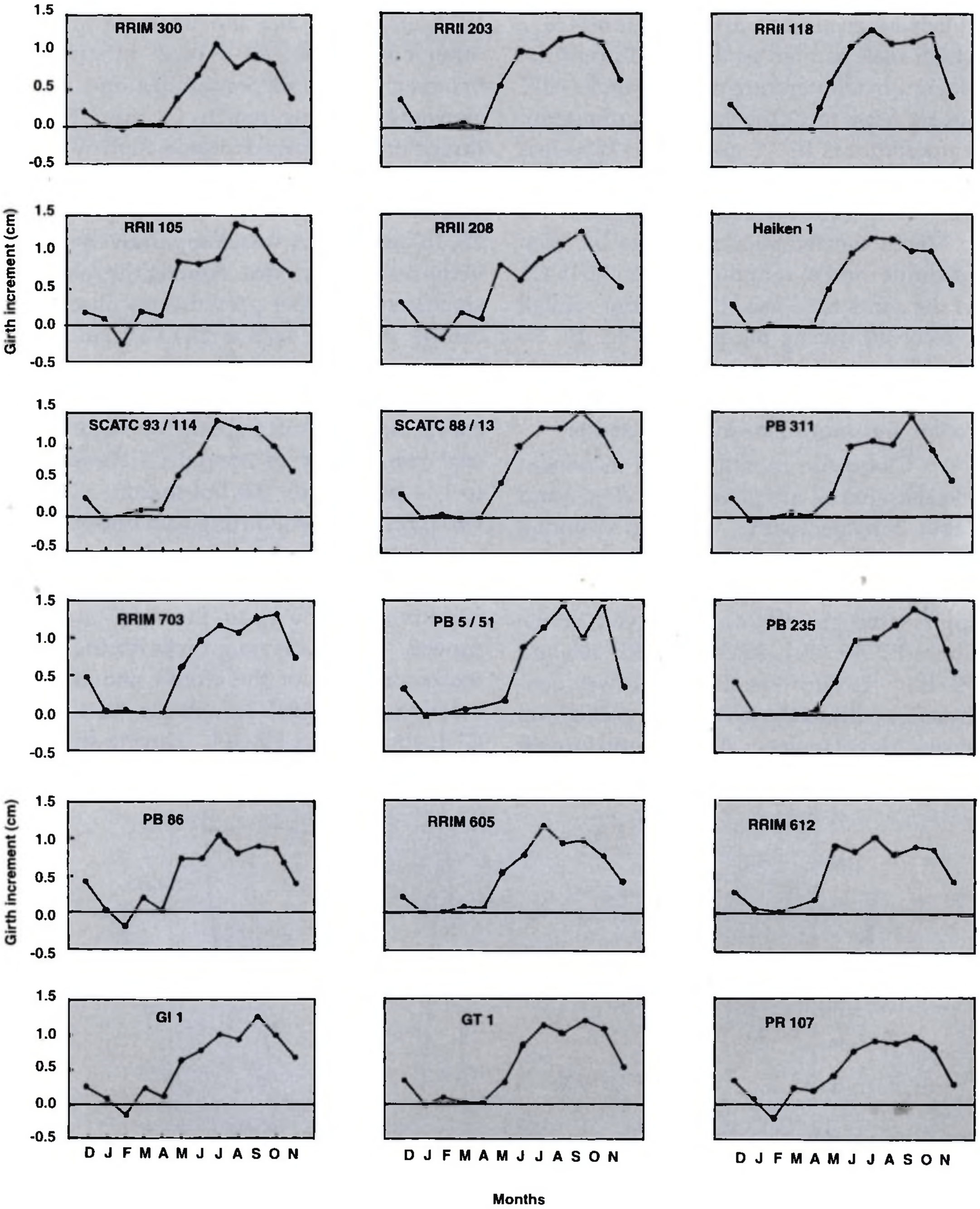

Fig. 2. Monthly growth profile of *Hevea* clones

Table 2. Girth increment (cm/month) of clones during different seasons

Clone	Season				
	Cold	Hot	Monsoon*	Cool**	Mean
Indian					
RRII 105	-0.08	0.40	1.02(1.04)	1.14(0.80)	0.62
RRII 118	0.00	0.20	1.03(1.07)	1.15(0.83)	0.60
RRII 203	0.02	0.21	1.00(1.00)	1.23(1.03)	0.61
RRII 208	-0.08	0.40	1.00(0.98)	1.07(0.65)	0.59
RRII 300	0.00	0.20	0.94(0.88)	1.00(0.5)	0.52
Malaysian					
GI 1	-0.02	0.32	1.00(0.99)	1.15(0.83)	0.61
PB 5/51	0.00	0.05	1.06(1.12)	1.11(0.73)	0.56
PB 86	-0.09	0.32	0.93(0.88)	1.06(0.63)	0.56
PB 235	0.02	0.17	1.06(1.14)	1.19(0.93)	0.61
PB 311	-0.02	0.13	1.08(1.15)	1.11(0.75)	0.58
RRIM 605	0.03	0.24	0.94(0.84)	1.04(0.60)	0.57
RRIM 612	0.05	0.51	0.97(0.96)	1.07(0.65)	0.65
RRIM 703	0.03	0.20	1.05(1.16)	1.23(1.03)	0.63
Indonesian					
GT 1	0.05	0.12	1.02(1.04)	1.14(0.80)	0.58
PR 107	-0.07	0.28	0.93(0.88)	1.01(0.53)	0.54
Chinese					
Haiken 1	0.00	0.19	1.09(1.19)	1.2(0.95)	0.62
SCATC 88/13	0.05	0.19	1.06(1.12)	1.16(0.87)	0.62
SCATC 93/114	0.00	0.27	1.10(1.22)	1.15(0.83)	0.63
Mean	-0.01	0.24	1.02(1.04)	1.13(0.77)	0.59

* (X)1/2 transformed ** (X+0.5)1/2 transformed

Figures in parentheses are original values

	S.Em	CD ($P \leq 0.05$)
Clone (A)	0.03	0.05
Season (B)	0.01	0.03
B at A level	0.06	0.11
A at same / different level of 'B'	0.06	0.11

season except PB 5/51 all the other clones showed significant improvement in the GI. Among the clones RRIM 612, RRII 208 and RRII 105 recorded significantly higher growth when compared to the clones PB 5/51, PB 311 and GT 1. During monsoon season all the clones performed better and the variation in growth was not significant. Cool season growth was significantly higher than monsoon season growth for all the clones except Haiken 1, PB 5/51, PB 311, PR 107, RRII 208, RRII 300, RRIM 605, RRIM 612 and SCATC 88/13. During cool season PR 107, PB 86, PB 311, RRII 208, RRIM 605, RRIM 612 and RRII 300 showed significantly lower growth compared to RRII 203 and RRIM 703. Clonewise annual girth and the GI during the immaturity period are presented in Table 4. Except PB 5/51, GT 1, RRII 300 and PR 107 all the clones recorded significantly higher girth and GI and attained tappable girth by the seventh year.

Stability in growth between seasons, between months and between years was estimated using the ecovalence concept (Table 3). The one which shows lower value of ecovalence is the stable genotype. Considering the overall stability GT 1, RRII 118 and Gl 1 showed comparatively more stability in growth in all the three periods. Preliminary observations on latex yield and DRC, during the first year of tapping (Table 5), indicated that the clones SCATC 88/13, SCATC 93/114, PB235 and RRII 118 gave significantly higher latexyield compared to RRIM 612 and Haiken1 (Table 5). However, the dry rubber content was more in PR 107 (30.8%), RRIM 612 (30.2%), PB 86 (28.5%) and Haiken 1 (27.4%) compared to PB 235 (20.6%) and RRII 203 (20.8%).

Rubber plant needs a threshold temperature of 20-25°C for optimum growth

Table 3. Ecovalence of clones during different periods

Clone	Ecovalence value		
	Between season	Between years	Between months
Indian			
RRII 105	0.05	2.6	0.4
RRII 118	0.01	1.48	0.14
RRII 203	0.01	3.25	0.17
RRII 208	0.02	1.3	0.33
RRII 300	0.68	6.34	0.03
Malaysian			
Gl 1	0.02	1.35	0.16
PB 5/51	0.07	3.62	0.54
PB 86	0.03	6.6	0.22
PB 235	0.02	2.15	0.18
PB 311	0.03	0.53	0.18
RRIM 605	0.04	8.4	0.11
RRIM 612	0.16	0.5	0.35
RRIM 703	0.02	3.54	0.13
Indonesian			
GT 1	0.02	2.48	0.09
PR 107	0.05	2.32	0.22
Chinese			
Haiken 1	0.1	4.38	0.08
SCATC 88/13	0.05	3.71	0.17
SCATC 93/114	0.03	5.8	0.11
Mean	0.05	3.4	

and at 10°C ambient temperature ceasing of photosynthesis has been reported (Zongdao and Xueqin, 1983). During winter in the northern part of West Bengal, plants are exposed to temperature as low as 5°C followed by moderately high temperature during day time. High photon flux induced photo-inhibition of photosynthesis has been reported in the plants experiencing abiotic stress like low temperature (Sathik *et al.*, 1998). Because of the cold stress and photo-inhibition of photosynthesis, plants might have utilized their reserve energy resulting in negative growth and stem shrinkage and growth was very low in all the clones between December and February. Similar reports of growth retardation during winter have been reported from North East India and China (Sethuraj *et al.*, 1989; Zongdao and Xueqin, 1983). Chandrashekar *et al.* (1996) also reported shrinkage of stem during January due to adverse atmospheric conditions observed in north Konkan region of Maharashtra. The new flush produced after winter season failed to contribute substantially during March/April due to very high atmospheric temperature and low rainfall received (Fig. 1). Except PB 5/51, GT 1, PB 311 and PR 107 all other clones showed revival in growth by May due to fairly good amount of pre-monsoon rains (Fig. 2). Because of favourable rainfall and temperature conditions all the clones put up maximum growth during June-September. Growth rate declined drastically during October/November but was still substantially high and comparable with growth during June-September.

Growth during monsoon and cool seasons constituted 64.85 per cent and 24.1 per cent of the annual GI compared to 11.4 per cent and–0.36 per cent during hot and cold seasons. The strong positive relationship of monthly GI with mean monthly minimum temperature (r=0.76) and maximum temperature (r=0.65) followed by monthly total rainfall (r=0.64) shows that temperature is the limiting factor for the growth of *Hevea* in the northern part of West Bengal. This is reflected in the higher growth observed during cool (1.13 cm/month) and monsoon seasons (1.03 cm/month) compared to hot (0.24 cm/month) and cold seasons (-0.01 cm/month). 70 to 80 per cent of growth during June-November and growth retardation during winter months have been reported from Assam, Tripura and high elevation region of Tura in Meghalaya (Sethuraj *et al.*, 1989). During cold season the growth of RRII 105, PB 86, RRII 208, PR 107, Gl 1 and PB 311 was poor. This is in conformity with the reports that the performance of RRII 105, PB 86, RRIM 501, PR 107 and Gl 1 was not satisfactory in the nontraditional regions (Sethuraj *et al.*, 1989). However, Priyadarshan *et al.* (1998) reported that under the agro-climatic conditions of Tripura, Haiken 1 and RRII 208 contributed more towards GI during winter (November-February).

Among the clones GT 1, RRII 118 and Gl 1 showed more stability in growth compared to the other clones. These clones interacted stably and positively indicating their greater flexibility in adapting to different environments. Similarly under the Tripura agro-climatic conditions RRIM 600, PB 86 and GT 1 showed more stability in growth during winter as well as summer (Meenattoor *et al.*, 1991). It is well known that in *Hevea* girth is the important criteria for opening of trees for tapping. In the present study, except PB 5/51, Gl 1, GT 1, RRII 300 and PR 107 all other clones

Table 4. **Girth and girth increment (cm) during different years**

Clone	Year 1	2		3		4		5		6		7	
	Girth	Girth	GI	Girth	GI	Girth	GI	Girth	GI	Girth	GI	Girth	GI
Indian													
RRII 105	5.4	10.4	5.0	18.0	7.6	28.5	10.4	36.7	8.3	44.8	8.1	48.8	4.0
RRII 118	6.0	11.2	5.2	18.7	7.6	30.0	11.3	38.3	8.3	46.8	8.5	52.1	5.3
RRII 203	7.0	11.9	4.8	17.8	5.9	28.0	10.2	36.8	8.8	46.2	9.4	51.5	5.2
RRII 208	5.1	10.3	5.1	18.3	8.0	28.3	10.0	36.4	8.1	44.1	7.7	49.9	5.8
RRII 300	6.5	10.8	4.3	17.6	6.8	28.6	11.0	36.1	7.5	42.6	6.5	43.9	3.3
Malaysian													
GI 1	5.4	10.1	4.8	16.7	6.6	25.7	9.0	33.1	7.4	40.6	7.5	46.3	5.8
PB 5/51	6.1	10.6	4.5	16.2	5.7	23.7	7.5	35.6	7.8	39.5	8.0	44.4	4.9
PB 86	5.8	10.9	5.1	19.4	8.5	29.6	10.2	37.0	7.4	43.4	6.4	49.4	6.1
PB 235	6.4	10.9	4.6	17.2	6.3	26.9	9.7	35.6	8.7	44.4	8.8	50.8	6.4
PB 311	6.0	10.6	4.8	18.0	7.4	28.2	10.2	36.9	8.2	44.0	7.6	49.3	5.2
RRIM 605	5.1	10.4	5.3	19.7	9.3	29.8	10.2	37.5	7.6	44.1	6.7	48.9	4.8
RRIM 612	4.9	10.3	5.4	18.0	7.7	28.9	10.9	37.9	9.0	46.0	8.2	52.2	6.2
RRIM 703	6.1	11.1	5.0	17.6	6.5	28.0	10.3	31.5	8.9	46.8	9.9	51.7	5.0
Indonesian													
PR 107	4.5	9.6	5.0	16.2	6.6	26.0	9.8	33.7	7.7	40.0	6.3	44.7	4.6
GT 1	6.2	11.4	5.2	18.1	6.7	26.7	8.6	33.6	6.9	41.4	7.8	46.8	5.4
Chinese													
Haiken 1	7.1	11.3	4.2	16.9	5.6	26.1	9.2	35.0	8.9	44.2	9.2	49.8	5.5
SCATC 88/13	6.6	10.5	3.9	16.7	6.2	25.7	9.0	35.3	9.5	43.5	8.2	49.1	5.5
SCATC 93/114	6.3	10.9	4.5	16.7	5.8	25.4	8.7	34.8	9.4	44.0	9.2	50.0	5.9
Mean	4.8	10.7	4.8	17.7	6.9	27.4	9.8	35.7	8.2	43.7	8.0	48.9	5.3
S.Em	0.4	0.7	0.3	1.2	0.7	1.5	0.6	1.6	0.5	1.6	0.8	1.9	0.7
CD ($P \leq 0.05$)	1.0	NS	NS	NS	1.4	3.0	1.3	3.2	1.0	3.2	1.6	3.9	1.5

recorded significantly higher girth during immaturity period and attained tappable girth by seventh year (Table 4). This was because of the cumulative effect of their higher and stable annual GI and mean monthly GI during different seasons (Table 2). The five clones listed showed less stability in growth resulting in lower annual GI during immaturity period. These clones put up negligible growth during winter and hot season, showed late pick up in GI after the onset of monsoon and maintained low growth profile in all the months (Fig. 2 and 3). Better growth performance and early maturity of RRII 118, RRII 203, PB 235, RRIM 605, RRIM 612 and PB 311 have been reported from Assam, Tripura and Meghalaya in North East India (Sethuraj *et al.*, 1989) and Konkan region in Western India (Nazeer *et al.*, 1992). Haiken 1 and SCATC 93/114 are preferred for moderate cold areas of China (Watson, 1989). Better growth performance of these clones under the cold

Table 5. **Latex yield and dry rubber content during the first year of tapping**

Clone	Total volume (ml/plant/tap)	DRC (%)
Indian		
RRII 105	74.7	26.8
RRII 118	99.9	23.6
RRII 208	62.7	22.9
RRII 203	80.3	20.8
RRII 300	78.0	22.8
Malaysian		
Gl 1	72.8	25.0
PB 5/51	84.5	22.3
PB 86	68.6	28.5
PB 235	103.2	20.6
PB 311	76.5	22.7
RRIM 605	53.2	27.8
RRIM 612	47.0	30.2
RRIM 703	58.0	22.93
Indonesian		
GT 1	88.0	21.4
PR 107	68.7	30.8
Chinese		
Haiken 1	40.4	27.4
SCATC 88/13	141.9	22.9
SCATC 93/114	101.9	24.7
Mean	77.6	24.6
S.Em	16.7	1.77
CD ($P \leq 0.05$)	47.6	5.00

conditions of northern part of West Bengal corroborate well with the above report. However, latex yield is the final criteria for assessing the performance of clones. Preliminary observation on yield during first year of tapping indicates better performance of SCATC 88/13, SCATC 93/114, PB 235 and RRII 118 in terms of yield compared to RRIM 612 and Haiken 1 (Table 5). Despite better growth, RRIM 612 and Haiken 1 failed to contribute significantly towards latex yield. The DRC was higher in PR 107, RRIM 612, PB 86 and Haiken 1. Hence growth does not appear to be the sole criteria for variation in latex yield.

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