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PERFORMANCE OF CERTAIN EXOTIC *HEVEA* CLONES IN KANYAKUMARI REGION

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Growth and yield performance of nine recently introduced clones of *Hevea* and two established clones were evaluated in a large-scale trial in the Kanyakumari District of Tamil Nadu. Significant clonal variations for growth, yield and bark anatomical traits were evident. Four clones, two each introduced from Malaysia (PB 255 and PB 314) and Ivory Coast (IRCA 109 and IRCA 111), exhibited provising growth and yield in the panel B0-1. However, on completion of eight years of tapping, the yield performance of PB 314, IRCA 109 and IRCA 111 were found to be on par with the control clone RRII 105. The significant yield improvement show by PB 255, could be considered as a real reflection of the high yield potential of PB 255. Based on the vigorous growth, early tappability, excellent bark characteristics, stability parameters, consistent high yield, high summer yield *etc.* PB 255 was rated as the best selection for the Kanyakumari region. High girthing clones, in general, showed lower number of latex vessel rows, but higher values for both these characters were found combined in PB 255.

Keywords: Early tappability, Girth increment, Meteorological variables, Rubber yield

INTRODUCTION

Introduction and evaluation of *Hevea* clones of proven yield potential domesticated in other rubber producing countries have been one of the methods adopted for crop improvement in the Rubber Research Institute of India. So far, 127 such clones evolved in Malaysia, Indonesia, Sri Lanka, China, Ivory Coast, Brazil, Thailand and Liberia have been introduced and are under various stages of evaluation under the local agro-climatic conditions (Varghese *et al*., 2006). Most of these introductions were made by bilateral and multilateral clone exchange programs under the auspices of the International Rubber Research and Development Board (IRRDB) and Association of Natural Rubber Producing Countries (ANRPC).

Kanyakumari region of Tamil Nadu is characterized by an agro-climate distinct from other regions in the traditional rubber-growing belt in the country. Rain is moderate (less than 2000 mm), but the well-distributed rainfall pattern associated with fairly good summer showers provide a congenial agro-climate for the good performance of rubber. Almost half of the annual precipitation is

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received during the North-East monsoon season. The weak South West monsoon, interrupted by sunny days in between, helps the plants escape from heavy incidence of *Phytophthora* and pink diseases. Very few attempts were made to study the performance of *Hevea* clones in this region. Hence, three large-scale clone evaluation experiments were initiated during 1993, with financial aid from the World Bank. The present communication reports the growth and yield performance of 11 high yielding clones which include five introductions made recently from Cote de Ivoire, four promising introductions from Malaysia, one regional popular clone (PB 28/59) and the check clone RRII 105.

MATERIALS AND METHODS

The experiment was initiated in 1993 at the Keeriparai Division of Tamil Nadu Government Rubber Plantation (8.16′ N; 77.22′E; 15 MSL), Nagercoil in South India. Eleven clones of *Hevea*, consisting four Malaysian clones (RRIM 703, PB 255, PB 314 and PB 330), five clones from Cote de Ivoire introduced in 1990 (IRCA 18, IRCA 109, IRCA 111, IRCA 130 and IRCA 230) and a popular clone in this region (PB 28/59) were included in the trial, keeping RRII 105 as the check clone. A randomized block design with three replications and a net plot size of 16 plants was adopted with clone RRII 105 as common border planting. Field planting was done during 1994 at a spacing of 4.9 x 4.9m. Field maintenance and cultural operations were carried out following the package of practices recommended for the traditional rubber-growing region in India (Potty *et al*., 1980). The performance of clones was evaluated over eight years of tapping.

Girth recording at a height of 125 cm was done monthly from third year onwards till the initiation of tapping and thereafter once in a year. Bark thickness and number of latex vessel rows were recorded at a height of 150 cm when the trees were opened for regular tapping in the seventh year. Bark thickness was measured with a Schleipers guage (Nair and Marattukalam, 1981). Tappability, regarded as 50 cm girth at a height of 125 cm from the bud union (Dijkman, 1951; Sethuraj and George, 1980; Paardekooper, 1989), was assessed as percentage of trees attained the tappable girth per plot in the sixth and seventh years after planting. Tapping was done following the standard S/2, d/3 system. Yield was recorded every month by cup coagulation method up to the fourth year of tapping and by latex weight/DRC method in the remaining years.

Meteorological data such as maximum and minimum temperatures, relative humidity, bright sun shine hours, rain and evaporation were collected from the agro-meteorological observatory established near the trial area. Based on the rainfall pattern four distinct seasons were identified such as summer season (March to May), south-west monsoon season (June to August), north east monsoon season (September to November) and post-monsoon season (December to February). Growth, in terms of girth increment, in all the four seasons in the immaturity period (third to seventh year) were analyzed and the seasonal growth, recorded during the third to seventh years and yield recorded in panel B0-1 were correlated with agro-meteorological parameters recorded in the corresponding seasons. Summer yield depression was worked out based on the yield recorded during the period from February to May. Dry rubber content was determined by coagulating latex samples instantly using acetic-alcohol (5:95) and drying in both sunlight (seven days) and hot air oven (six hours). Tapping panel dryness (TPD) was recorded from individual plots and subjected to analysis of variance.

RESULTS AND DISCUSSION

The mean yield recorded in panels B0-1 and B0-2 and the pooled data for eight years of tapping are furnished in Table 1. Mean rubber yield in panel BO-1 ranged from 53.38 g/t/t (PB 330) to 75.79 g/t/t (PB 314) while yield in panel BO-2 ranged from 73.92 g/t/t (PB 33) to 112.01 g/t/t (PB 255). On completion of tapping in panel B0-1, four exotic clones *viz*. PB 314 (75.79 g/t/t), IRCA 109 (75.39 g/t/t), PB 255 (74.17 g/t/t) and IRCA 111 (73.97 g/t/t) exhibited a yield trend significantly higher than the control clone RRII 105 (57.52 g/t/t). RRII 105 was rather slow in growth during the initial years. This popular clone in the traditional belt presented an increasing yield trend from third year onwards and seems to be yielding better than the rest of the clones, except PB 255 during the second year of tapping in panel B0-2. A similar pattern of progressive increase in yield trend of RRII 105 was evident in two other large scale clone evaluation experiments initiated during the same year with different sets of modern high yielding clones (Soman, unpublished data). The high yield performance of RRII 105 in some plantations in the private sector also supports the suitability of this clone under the agro-climate of Kanyakumari region. The consistently significant yield improvement exhibited by PB 255 in comparison to RRII 105, could be considered as a reflection of the high yield potential of this clone. Ranked first in yield over 8 years of tapping with 84.26 g/t/t, this modern clone under experimentation was superior to be rest and presented an increasing yield trend from the third year onwards. This clone exhibited superior growth and yield in early years in large-scale trails across three locations (Varghese *et al*., 2009) and was upgraded from category 3 to category 2 of the planting recommendation for India (Rubber Board, 2010).

The clone IRCA 109 presented a yield trend identical with IRCA 111 and the growth and yield performance of the remaining IRCA clones were on par with that of RRII 105. Due to the occurrence of good summer showers, yield in summer season was on the higher side in this region.

Table 1. **Mean yield in panel B0-1, B0-2 and pooled data for 8 years**

Clone	Mean yield (g/t/t)		
	B0-1 (6 years)	B0-2 (2 years)	Pooled (8 years)
RRII 105	57.52	89.08	65.94
PB 314	75.79 *	82.82	77.67
IRCA 130	66.66	89.03	72.71
PB 28/59	58.71	76.15	63.36
IRCA 109	75.39 *	83.86	77.65
PB 330	53.38	73.92	58.86
IRCA 18	57.31	80.07	63.38
RRIM 703	62.22	84.86	69.72
IRCA 111	73.97 *	88.96	77.97
PB 255	74.17 *	112.01 *	84.26 *
IRCA 230	57.62	85.99	65.19
G. mean	64.79	86.10	70.61
CD (P =0.05)	15.28	22.11	16.99

* significantly superior to RRII 105

Table 2. **Summer yield, summer depression and percentage depression**

Clone	B0-1			B0-2			Pooled data for 8 years		
	S. yield (g/t/t)	S. drop (g/t/t)	Drop (%)	S. yield (g/t/t)	S. drop (g/t/t)	Drop (%)	S. yield (g/t/t)	S. drop (g/t/t)	Drop (%)
RRII 105	36.87	20.64	35.46	60.26	28.82	31.68	39.96	25.97	38.79
PB 314	48.76	27.03	35.09	61.93	20.90	28.30	48.55	29.12	37.51
IRCA 130	50.40	16.26	24.49	78.77	7.31	12.55	52.41	20.30	28.61
PB 28/59	38.43	20.28	34.60	62.89	13.26	15.12	40.88	22.48	35.50
IRCA 109	56.31	19.08	25.37	69.91	13.95	16.53	55.07	22.58	29.06
PB 330	36.15	17.23	32.34	52.27	21.65	30.77	36.50	22.35	38.24
IRCA 18	37.16	20.15	35.18	56.63	23.45	29.47	37.68	25.70	38.71
RRIM 703	39.05	25.17	39.33	48.43	36.43	43.49	39.40	30.33	43.56
IRCA 111	52.86	21.11	28.59	77.14	11.82	13.83	54.65	23.31	29.86
PB 255	51.19	22.98	30.66	91.33	20.68	18.01	53.09	31.16	36.72
IRCA 230	43.66	13.96	24.58	76.04	9.95	11.17	46.00	19.14	29.53
G. mean	44.77	20.86	32.04	62.872	19.49	24.92	45.01	25.28	36.16
CD (P = 0.05)	12.55	7.09	8.44	8.18	12.01	16.1	13.13	7.62	7.55

(S. yield = summer yield, S. drop = summer depression in yield)

The summer yield recorded in panel B0-1, B0-2 and the pooled data for eight years are furnished in Table 2. Analysis of the data points that the overall yield performance of the clones is highly influenced by the summer yield, except in RRII 105. In B0-1, for example, all the high yielding clones presented significantly high summer yield also. In B0-2, on the other hand, PB 255 was the only clone, which presented significant differences in the total as well as the summer yield in comparison with RRII 105. The pooled data for eight years revealed IRCA 109 as the best yielder during the summer, followed by IRCA 111 and PB 255. In general, percentage drop was found to be the minimum in clones from Ivory Coast, except IRCA 18, which is an indication of their tolerance to summer stress, which could perhaps be a reflection of their origin in West Africa, in proximity to the Sahara. The maximum percentage drop during summer in B0-1 was exhibited by RRIM 703 followed by RRII

Table 3. **Girth at opening and bark characters of *Hevea* clones**

Clone	Girth at opening (cm)	Bark thickness at 7th year of planting (mm)	No. of LVR at 7th year of planting
RRII 105	44.62	6.3	8
PB 314	52.68	5.37	10
IRCA 130	46.52	6.92	9
PB 28/59	43.1	6.32	10
IRCA 109	50.09	6.19	12
PB 330	50.52	7.84	9
IRCA 18	47.03	6.04	10
RRIM 703	51.39	8.04	10
IRCA 111	54.93	5.85	8
PB 255	54.06	8.54	15
IRCA 230	53.88	7.34	8
G. mean	49.89	6.79	10
SE	1.88	0.8	1
CD (P=0.05)	5.56	1.37	2

105. High summer drop of RRII 105 was earlier reported by Mydin and Mercykutty (2007).

The girth (Table 3) of clones ranged from 43.10 cm (PB 28/59) to 54.93 cm (IRCA 111). Among the five new clones introduced recently from Ivory Coast, IRCA 111 was the most vigorous clone and second best in terms of yield. Growth, in terms of annual girth increment, is furnished in Table 4. Bark thickness (8.54 mm) and the number of latex vessel rows (15) were highest in clone PB 255. Maximum growth rate of *Hevea* clones was observed during the fourth year of planting and the girth increment decreased gradually from the fifth year onwards. This progressive decrease in growth rate, as the plants grow, is in agreement with the reported literature for a variety of crops (Templeton, 1968), as well as for rubber (Chandrasekhar *et al.*, 1994). A drastic reduction in growth rate observed from the second year of tapping onwards could be ascribed to the loss of metabolites in the form of latex. Correlation analysis of seasonal growth with the corresponding agro-meteorological parameters revealed a high and positive correlation with minimum temperature, relative humidity and precipitation and substantial, but negative correlation with maximum temperature, hours of bright sun shine and evaporation (Table 5). Percentage mean girth increment at different seasons (mean of five years) is presented in Table 6. Almost three fourth of the annual growth was attained during the monsoon season that extended from June to November. Growth recorded during the post-monsoon season was negligible. Post-monsoon season was characterized by low values of positively correlated agro-meteorological parameters such as minimum temperature, relative humidity and rainfall and high values of negatively correlated parameters such as maximum temperature, hours of bright sunshine and

Table 4. **Annual girth increment (%) from 4th to 16th year of planting**

Clone	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
RRII 105	79.1	55.2	36.0	18.0	25.9	8.6	7.0	6.4	6.6	4.7	4.7	3.8	2.5
PB 314	84.8	63.3	28.4	13.8	19.2	5.4	3.4	5.6	6.2	5.0	4.9	2.8	2.0
IRCA 130	86.6	46.4	29.5	15.3	23.9	7.7	4.2	5.7	6.3	3.9	5.7	2.0	2.2
PB 28/59	88.9	58.3	29.1	10.2	20.9	6.7	4.8	5.4	7.2	5.1	4.9	2.0	3.6
IRCA 109	77.0	54.6	24.5	18.7	17.2	6.7	5.2	2.9	5.7	3.4	4.9	2.7	2.3
PB 330	87.6	54.2	29.0	13.0	17.6	6.9	5.5	4.7	6.8	4.7	4.0	2.7	2.3
IRCA 18	86.7	48.5	34.1	14.8	18.3	7.1	5.4	5.7	6.8	5.2	7.6	3.0	1.4
RRIM 703	84.8	50.2	35.7	15.6	19.0	9.8	5.6	1.2	2.5	8.4	5.4	1.2	2.8
IRCA 111	82.2	61.1	25.5	12.0	19.5	6.7	5.2	6.8	6.0	4.9	2.3	1.3	2.7
PB 255	97.2	62.6	31.8	13.6	18.3	6.3	4.4	8.4	5.9	4.2	3.5	1.8	2.7
IRCA 230	90.8	90.9	12.6	11.8	20.2	6.5	4.2	8.2	6.1	2.3	2.9	2.5	2.3
G. mean	85.97	58.69	28.74	14.25	20.0	7.12	4.99	5.54	6.0	4.7	4.62	2.34	2.43
SD	5.53	12.01	6.57	2.58	2.68	1.19	0.95	2.1	1.25	1.5	1.44	0.78	0.54
CD (P=0.05)	—	—	—	—	—	—	—	1.7	—	2.6	—	—	—

Table 5. **Correlation of girth increment and yield at different seasons with ago-meteorological parameters**

	Yield	T-max	T-min	RH	HBSS	Rain	Evaporation
Girth increment	0.57 *	-0.42	0.81 **	0.78 **	-0.41	0.64 *	-0.54 *
Yield	1	-0.17	0.49	0.41	-0.32	0.09	-0.43

* Significant at 5% level, ** Significant at 1% level
T-max: Maximum temperature, T-min: Minimum temperature
RH: Relative humidity, HBSS: Hours of bright sunshine.

Table 6. **Agro-meteorological parameters and growth at different seasons (mean of six years)**

Season	Period	T-max. (^{0}C)	T-min. (^{0}C)	RH (%)	HBSS	Rain (%)	Rainy days	Evapo-ration	% girth increment
Summer	March- ay	33.94	23.38	59.91	7.28	19.44	8.21	5.07	26.81
S-W monsoon	June–August	30.92	23.79	70.03	5.33	27.22	14.99	3.32	36.59
N-E monsoon	September – November	31.11	22.73	72.86	5.54	43.36	14.66	3.17	28.10
Post monsoon	December – February	32.70	21.56	55.84	6.54	9.96	5.21	4.58	8.50

T-max: Maximum temperature, T-min: Minimum temperature RH: Relative humidity,
HBSS: Hours of bright sunshine.

evaporation. The negative influence of the unfavorable agro-climate together with the diversion of metabolites in connection with wintering and re-foliation might be the reasons for the low growth rate recorded during the post monsoon season. However, in spite of the above factors, the maximum yield was recorded during the post-monsoon season. A similar trend of increased yield during the post-monsoon

Table 7. **Tappability, dry rubber content and tapping panel dryness in *Hevea* clones**

Clone	Tappability (%)		Mean DRC	TPD (%)
	6th year	7th year	over 8 years	over 8 years
RRII 105	18.48	53.33	39.76	13.33
PB 314	74.55	86.67	33.27	51.96
IRCA 130	36.11	61.67	35.78	39.27
PB 28/59	31.44	61.82	40.66	15.76
IRCA 109	74.39	88.36	39.66	15.38
PB 330	66.88	87.10	38.33	30.17
IRCA 18	35.58	76.39	37.82	20.20
RRIM 703	64.12	92.67	36.17	34.47
IRCA 111	79.17	100.00	35.77	19.47
PB 255	75.55	93.89	38.72	20.55
IRCA 230	78.64	95.24	37.53	7.43
G. mean	57.72	81.56	37.58	33.81
SE	11.73	13.07	8.61	11.76
CD (P=0.05)	34.61	NS	NS	30.17

season was reported by Reju *et al.* (2001). The agro-climate prevalent during these months may be ideal for latex production and latex flow (Shangpu, 1986). Yield exhibited substantial and positive correlation with growth, minimum temperature and relative humidity and negative correlation with evaporation.

Vigour in terms of tree girth is as important as yield. Vigorous juvenile growth and early opening for regular tapping are important, because it determines how long farmers have to wait for income from their plantations (Simmonds, 1989). Tappability attained by the clones at the sixth and seventh years of planting are presented in Table 7. Clones IRCA 111, IRCA 230, PB 255, PB 314 and IRCA 109 exhibited early tappability with 74-79% of the trees having attained tappable girth by the sixth year after planting. The clones showed significant variations with respect to girth at opening and tappability at sixth year, but the tappability at the seventh year of planting was on par among the clones. IRCA 111 exhibited maximum juvenile growth as well as tappability, followed by PB 255. Good growth of trees under tapping is also very important to maintain sustained yield levels. The poor growth rate exhibited by RRII 105 during the juvenile phase could be the reason for the poor yield performance this clone exhibited during the initial years of tapping. However, the clone has presented an increasing growth rate from the third year of tapping and a corresponding increase was visible in the yield also.

High DRC of *Hevea* clones is quite characteristic of Kanyakumari region. Latex of PB 28/59 recorded the highest DRC in the present study (Table 7), closely followed by RRII 105. The clone PB 314, which has recorded the highest yield and lowest DRC in B0-1, was observed to be affected by TPD at a significant level. The popular clone of this region, PB 28/59 was noticed to lag behind with respect to both growth and yield and was also highly susceptible to *Phytophthora* and pink diseases.

CONCLUSION

Among the 11 clones included in the present study gave PB 255 significantly better yield than the control clone RRII 105 up to the eighth year of tapping. This clone has also recorded high values with respect to growth, early tappability, bark thickness, number of latex vessel rows, summer yield *etc.* and hence could be considered as the best selection for the Kanyakumari Region. The clone IRCA 111 stood first in terms of growth as well as early tappability and second best in terms of yield. The clones PB 314 and IRCA 109, IRCA 130 and RRIM 703 were also comparable in yield with IRCA 111. These clones also deserve close monitoring for their yield performance in the coming years as these clones presented comparable yield with the control clone RRII 105 up to the eighth year of tapping.

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