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LONG-TERM PERFORMANCE OF TWENTY CLONES OF *HEVEA BRASILIENSIS* UNDER LARGE-SCALE TRIAL IN INDIA

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Long-term growth and yield performance of twenty *Hevea brasiliensis* clones were evaluated in two trials in the traditional rubber growing zone of India. Yield, growth and secondary characters like tapping panel dryness and diseases were monitored. In Trial I, mean yield (g/t/t) ranged from 32.1 (IAN 45-873) to 47.7 (RRIM 703). Only four clones *viz.*, RRIM 703, RRIM 701, Harbel 1 and GT 1 yielded significantly more than the control clone PR 107. Girth of the trees recorded at 22 years from planting revealed significantly higher values for GT 1 (95.2 cm) than the control PR 107 (89.1 cm). In Trial II, the mean yield ranged from 41.3 (RRII 44 and PB 260) to 52.7 g/t/t (PR 255) in panel BO-1, from 46.8 (PR 260) to 61.6 g/t/t/ (PB 310) in panel BO-2 and from 47.6 (RRII 45) to 68.4 g/t/t (PB 310) in panel BI-1. Girth at 21 years ranged from 76.9 cm for RRII 105 to 105.0 cm for RRII 44. The results indicated that none of the clones tested were outstanding in their overall performance.

Key words: Clones, Growth, *Hevea brasiliensis*, Large-scale trial, Yield.

INTRODUCTION

Since the introduction of the natural rubber tree [*Hevea brasiliensis* (Willd. ex Adr. de Juss) Muell. Arg] into South East Asia in 1876 by Sir Henry Wickham (Baulkwill, 1989), different breeding and selection methods resulted in the development of many improved clones. In the breeding process, large-scale clone trial is the important step for selecting potential clones for on-farm trials. This paper reports the long-term performance of certain Indian and imported clones of *H. brasiliensis* in two large-scale trials condcuted in the traditional rubber growing zone of India.

MATERIALS AND METHODS

This study was conducted at the Central Experimental Station of the Rubber Research Institute of India at Chethackal (9° 22' N, 76° 50' E, 80 m above msl), in the South Kerala region of the traditional rubber growing zone (Vijayakumar *et al.*, 2000). Twenty clones were evaluated in two trials. Trial I included four Malaysian, two Indonesian, two Brazilian and one clone each from Sri Lanka and Liberia. Trial II included five Malaysian, two Indonesian and three Indian clones. Details of the clones evaluated are given in Table 1.

Trial I was laid out in an undulating land while Trial II was on a slope. Both the trials were laid out in randomized block design with three replications. Each experimental plot in the first trial consisted of 36 plants in square planting at a spacing of 4.9

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Table 1. **Details of the clones evaluated**

Clone	Country of origin	Parentage
Trial-I		
RRIM 701	Malaysia	44/553 x RRIM 501
RRIM 703	Malaysia	RRIM 600 x RRIM 500
PB 5/51	Malaysia	PB 86 x PB 24
Ch 153	Malaysia	Tjir 1 x Ch 5
IAN 45-713	Brazil	PB 86 x F 409
IAN 45-873	Brazil	PB 86 x F 1717
Wagga 6278	Sri Lanka	Primary clone
Harbel 1	Liberia	Primary clone
GT 1	Indonesia	Primary clone
PR 107 (control)	Indonesia	Primary clone
Trial-II		
RRIM 600	Malaysia	Tjir 1 x PB 86
PB 235	Malaysia	PB 5/51 x PB S/78
PB 260	Malaysia	PB 5/51 x PB 49
PB 310	Malaysia	PB 5/51 x RRIM 600
PB 311	Malaysia	RRIM 600 x PB 235
PR 255	Indonesia	Tjir 1 x PR 107
PR 261	Indonesia	Tjir 1 x PR 107
RRII 44	India	Primary clone
RRII 45	India	Primary clone
RRII 105 (control)	India	Tjir 1 x Gl 1

x 4.9 m (416 plants/ha). The plots in second trial consisted of 25 plants in square planting at a spacing of 5 x 5 m (400 plants/ha). Brown budded stumps were used as the planting material in both the trials. Cultural operations followed for field management were as per the recommended package of practices (Potty, 1980; Potty *et al.*, 1980; Pushpadas and Ahammed, 1980).

The trees were opened for tapping eight years after planting. Tapping system followed was 1/2 S d/2 6d/7. During the monsoon, the trees were tapped with skirt-type polythene film rainguarding. No tapping rest was given during the summer months. Rubber yield of the trees determined by cup coagulation method was the basic data from which monthly, seasonal and annual yields were calculated. For this purpose, dry rubber yields of individual trees were determined once a month in the first trial and twice a month in the second trial by coagulating the latex yield of the trees in the collection cup itself on a predetermined tapping day. The coagulated fresh lumps were dried in a smokehouse and dry weights recorded. Actual dry rubber yield was calculated by discounting 10 per cent of the weight of the dry lumps to account for the moisture trapped in the smoke dried coagula.

The secondary characters recorded were girth at opening and on tapping, thickness of virgin and renewed bark, wind susceptibility, incidence of tapping panel dryness, abnormal leaf fall, powdery mildew and pink diseases. Girth was recorded at a height of 1.5 m above the bud union with a tailor's tape. Thickness of bark was measured with a Schleipers gauge at the same height (Nair and Marattukalam, 1981). The data were subjected to analysis of variance wherever necessary.

Table 2. **Yield characters* of the clones in Trial I**

Clone	Yield (g/t/t) Mean in panel				General mean (4 panels)	Summer depression in yield (%)	Mean estimated annual yield (kg/ha)
	B0 1 (5 years)	B0 2 (4 years)	BI 1 (4 years)	BI 2 (3 years)			
RRIM 701	35.0	47.0	56.4	45.9	45.3	37.6	1897
RRIM 703	45.9	50.3	52.2	37.8	47.7	40.4	1995
PB 5/51	35.4	35.6	36.0	31.2	35.0	27.5	1466
Ch 153	28.5	34.6	47.5	37.3	36.4	33.6	1522
IAN 45-713	23.7	36.5	46.5	39.2	35.3	20.6	1476
IAN 45-873	29.2	33.2	36.3	28.6	32.1	22.7	1341
Wagga 6278	28.9	35.9	49.5	39.8	37.7	31.7	1579
Harbel 1	34.1	49.9	57.2	40.6	45.3	32.7	1897
GT 1	35.5	44.1	50.9	43.6	43.0	34.2	1799
PR 107 (C)	28.1	38.0	45.5	33.1	36.0	30.0	1508
CV (%)	8.7	9.8	11.1	16.3	7.6	9.4	
CD (P≤0.05)	4.8	6.8	9.1	10.5	5.2	5.0	

* over 15 years of tapping

RESULTS AND DISCUSSION

Yield performance of the clones in Trial I is given in Table 2. Variation in yield (g/t/t) of the clones was from 23.7 (IAN 45-713) to 45.9 (RRIM 703) in panel BO-1, from 33.2 (IAN 45-873) to 50.3 (RRIM 703) in panel BO-2, from 36.0 (PB 5/51) to 57.2 (Harbel 1) in panel BI-1 and from 28.6 (IAN 45-873) to 45.9 (RRIM 701) in panel BI-2. When the mean yield (g/t/t) over 15 years was considered, the range was from 32.1 (IAN 45-873) to 47.7 (RRIM 703). Only four clones *viz.*, RRIM 703, RRIM 701, Harbel 1 and GT 1 yielded significantly more than the control clone PR 107. The clones RRIM 701 and RRIM 703 showed significantly higher summer yield depression compared to the control clone. High yield of RRIM 703 (Saraswathyamma *et. al.*, 1988), RRIM 701 (RRIM, 1992) and GT 1 (RRIM, 1970) has already been reported. Low yield of IAN 45-873 also has been reported earlier from South America (Marques, 1997).

Table 3. **Girth and bark characters of the clones in Trial I**

Clone	Girth (cm)		Annual girth increment	Thickness of virgin bark
	At opening	After 22 years		
RRIM 701	56.7	89.3	2.3	7.6
RRIM 703	51.7	88.8	2.7	8.0
PB 5/51	59.1	83.9	1.8	7.7
Ch 153	56.0	92.4	2.6	7.9
IAN 45-713	42.6	91.9	3.5	6.7
IAN 45-873	51.3	85.3	2.4	7.0
Wagga 6278	49.9	85.3	2.4	7.0
Harbel 1	52.9	93.9	2.9	8.4
GT 1	57.4	95.2	2.7	7.3
PR 107 (C)	49.5	89.1	2.8	8.8
CV (%)	509	3.5	10.5	10.5
CD (P≤0.05)	5.4	5.3	0.5	NS

Girth and bark characteristics of the clones are provided in Table 3. Mean girth of the clones at commencement of tapping was highest (59.1 cm) for PB 5/51 and the lowest (42.6 cm) for IAN 45-713. Only four clones *viz.*, PB 5/51, GT 1, RRIM 701 and Ch 153 had attained significantly higher girth than the control clone PR 107. Earlier studies have illustrated the high vigour of RRIM 701 (RRIM, 1992). However, PB 5/51 is not generally considered as a vigorous clone (RRIM, 1971). There were no significant differences between the clones for thickness of virgin bark though the values varied from 6.7 mm (IAN 45-713) to 8.8 (PR 107). Significantly higher girth increase on tapping compared to the control was recorded for IAN 45-713. All other clones were either on par or inferior to PR 107 for this character. Girth of the trees recorded 22 years after planting revealed that GT 1 alone had attained significantly higher girth than the control. Clone PB 5/51 which had the highest girth at opening exhibited the lowest girth at this stage showing poor rate of girth increase on tapping as has been reported earlier (RRIM, 1971).

Particulars of disease and other maladies of the clones are given in Table 4. Percent incidence of pink disease ranged from nil for IAN 45-713 and IAN 45-873 to 10.3 for RRIM 701. Tapping panel dryness was lowest for IAN 45-713 (8.7 %) while highest incidence was noted for clone RRIM 703 (55.8 %) which was significantly higher than that of the control. High susceptibility of this clone to this syndrome has already been reported (Marattukalam *et al.*, 1980). Percentage of uprooting varied from nil in PB 5/51 to 11.5 in RRIM 701 and trunk snap from nil (PR 107) to 10.2 (GT 1). Incidence of branch snap was very low in the trial. Only three clones *viz.*, Wagga 6278, GT 1 and PB 5/51, were afflicted. Total wind damage was highest for RRIM 701 (16.1 %) and lowest for PR 107 (1.2 %) as reported earlier (Marattukalam *et al.*, 1980).

Yield of the clones recorded from Trial II is given in Table 5. Yield (g/t/t) ranged from 41.3 (RRII 44 and PB 260) to 52.7 (PR 255) in panel BO 1, from 46.8 (PR 260) to 61.6 (PB 310) in panel BO 2, from

Table 4. **Maladies of the clones in Trial I**

Clone	Uprooting (%)	Trunk snap (%)	Branch snap (%)	Total wind damage (%)	Pink disease (%)	Abnormal leaf fall	Powdery mildew	Tapping panel dryness (%)
RRIM 701	11.5	4.6	0.0	16.1	10.3	Moderate	Severe	16.2
RRIM 703	1.3	2.8	0.0	4.1	3.9	Severe	Mild	55.8
PB 5/51	0.0	3.3	1.0	4.3	3.1	Moderate	Severe	24.2
Ch 153	2.1	5.2	0.0	7.3	6.5	Mild	Severe	22.1
IAN 45-713	2.4	8.3	0.0	10.7	0.0	Mild	Mild	8.7
IAN 45-873	1.1	1.1	0.0	2.2	0.0	Moderate	Moderate	12.0
Wagga 6278	6.7	5.7	1.5	13.9	1.5	Moderate	Mild	23.2
Harbel 1	1.4	4.1	0.0	5.5	9.1	Mild	Moderate	21.2
GT 1	2.5	10.2	1.0	13.7	6.4	Moderate	Severe	17.8
PR 107 (C)	1.2	0.0	0.0	1.2	3.5	Severe	Mild	12.2
CV (%)	-	-	-	-	-		-	44.5
CD (P≤0.05)	-	-	-	-	-		-	16.3

Table 5. **Yield characters* of the clones in Trial II**

Clone	Yield (g/t/t) Mean in panel			General mean (3 panels)	Summer depression in yield (%)	Mean estimated annual yield (kg/ha)
	B0 1 (5 years)	B0 2 (4 years)	BI 1 (4 years)			
PB 235	44.0	58.6	58.3	52.9	30.2	2213
PB 260	41.3	46.8	52.1	46.3	23.4	1939
PB 310	48.7	61.6	68.4	58.8	17.2	2459
PB 311	47.6	50.3	56.0	51.0	20.2	2134
RRIM 600	47.9	58.0	66.4	56.7	26.6	2373
PR 255	52.7	58.3	58.4	56.2	30.0	2351
PR 261	45.4	55.0	50.7	50.0	29.5	2091
RRII 44	41.3	56.2	63.9	52.9	28.7	2212
RRII 45	49.8	49.0	47.6	48.9	22.7	2045
RRII 105 (C)	50.9	55.3	53.1	53.0	21.8	2216
CV (%)	22.0	21.1	20.3	19.8	18.6	-
CD (P≤0.05)	NS	NS	NS	NS	8.0	-

* Over 13 years of tapping

47.6 (RRII 45 to 68.4 (PB 310) in panel BI 1 and 46.3 (PB 260) to 58.8 (PB 310) when all the three panels were pooled together. High yield potential of some of these clones has already been observed in other countries (RRIM, 1992; RRIM, 1995; Huat *et al.*, 1998). However, none of these differences was statistically significant. The clones showed very wide variation in depression in yield during the summer period. The percentage of decline ranged from 17.2 (PB 310) to 30.2 (PB 235). Only two clones, PB 235 and PR 255, showed significantly higher yield decline in summer than the control.

Growth characteristics of the clones are provided in Table 6. Mean girth of the clones varied from 40.9 (RRII 45) to 48.9 cm (RRII 44) at the time of the commencement of tapping. However, differences were not significant. Girth at the age of 21 years also was not significantly different even

Table 6. **Girth and bark characters of clones in the Trial II**

Clone	Girth (cm)		Annual girth increment	Thickness of virgin bark (mm)	Renewed bark thickness at 6 years (mm)
	At opening	At 21 years			
PB 235	46.3	89.6	3.3	6.1	9.4
PB 260	46.0	78.9	2.5	6.5	9.6
PB 310	45.5	92.6	3.6	6.0	10.4
PB 311	47.5	87.7	3.1	5.6	9.3
RRIM 600	41.8	92.4	3.9	5.6	10.0
PR 255	42.6	85.0	3.3	6.4	9.8
PR 261	42.6	93.3	3.9	6.6	9.2
RRII 44	48.9	104.9	4.3	6.7	10.7
RRII 45	40.9	77.4	2.8	6.8	9.7
RRII 105	42.7	76.9	2.6	6.9	10.3
CV (%)	15.2	11.7	17.9	7.3	9.8
CD (P≤0.05)	NS	NS	1.0	0.8	NS

though it varied from 76.9 (RRII 105) to 105.0 cm (RRII 44). However, the clones exhibited significant variation in girth increment on tapping. Three clones, RRII 44 (4.3 cm), PR 261 (3.9 cm) and RRIM 600 (3.9 cm) showed significantly more girth increase than the control clone RRII 105. High girth increase of RRIM 600 has been reported (RRIM, 1992; Mercykutty *et al.*, 1995). There was variation between clones in the case of thickness of the virgin bark which varied from 5.6 (PB 311 and RRIM 600) to 6.9 mm (RRII 105). However, none of the clones was significantly superior to the control clone in this aspect. On the other hand, three clones *viz.*, PB 310 (6.0 mm), PB 311 and RRIM 600 (5.6 mm) were significantly inferior to the control. Though the renewed bark thickness at six years varied from 9.2 mm (PR 261) to 10.7 mm (RRII 44), the difference was not statistically significant. This is contrary to the earlier reports that bark renewal of RRIM 600 is high (RRIM, 1970).

Disease incidence and wind damage recorded for the clones in Trial II are detailed in Table 7. Percentage of trees with tapping panel dryness ranged from 29.8 (RRIM 600) to 69.8 (RRII 45), though the variation was not significant. The percent incidence of pink disease varied from 3.5 (RRII 45) to 15.3 (RRIM 600). Percentage of uprooted trees ranged from nil (PB 235, PB 260, PR 255 and RRII 45) to 7.1 (PB 310), trunk-snapped trees from nil (PB 260, RRIM 600 and RRII 44) to 22.7 (PB 311), branch-snapped treed from nil (PB 260, PB 311, RRIM 600, PR 255 and RRII 105) to 3.0 (RRII 44) and the total trees damaged by wind ranged from nil (PB 260) to 28.8 (PB 311). Incidence of abnormal leaf fall was severe in PB 235 and RRIM 600; moderate in PB 260, PB 310, PR 255 and PR 261; mild in PB 311, RRII 44, RRII 45 and RRII 105. Severe incidence of abnormal leaf fall in PB 235 and RRIM 600 in India has already been reported (Saraswathyamma *et al.*, 2000). Powdery mildew was severe in PB 235, PR 255 and PR 261; moderate in PB 260, RRII 44, RRII 45 and RRII 105 and mild in PB 310, PB 311 and RRIM 600. High incidence of powdery mildew in PB

Table 7. **Maladies of the clones in Trial II**

Clone	Uprooting (%)	Trunk snap (%)	Branch Snap (%)	Wind damage (%)	Pink Disease (%)	Abnormal lead fall	Powdery mildew	Tapping Panel Dryness (%)
PB 235	0.0	11.0	1.3	12.4	7.5	Severe	Severe	36.1
PB 260	0.0	0.0	0.0	0.0	5.3	Moderate	Moderate	56.2
PB 310	7.1	8.7	1.6	17.5	6.3	Moderate	Mild	42.2
PB 311	6.1	22.7	0.0	28.8	13.6	Mild	Mild	40.9
RRIM 600	5.3	0.0	0.0	5.3	15.3	Severe	Mild	29.8
PR 255	0.0	6.3	0.0	6.3	9.5	Moderate	Severe	54.8
PR 261	6.4	14.5	2.9	23.7	4.8	Moderate	Severe	30.0
RRII 44	6.0	0.0	3.0	9.0	9.0	Mild	Moderate	42.4
RRII 45	0.0	5.3	2.0	7.2	3.5	Mild	Moderate	69.8
RRII 105	1.5	10.0	0.0	11.5	10.8	Mild	Moderate	54.8
CV (%)	-	-	-	-	-		-	35.2
CD (P≤0.05)	-	-	-	-	-		-	NS

235, PR 255 and PR 261 has already been observed (Saraswathyamma *et al.*, 2000). For the major characteristics like yield and vigour, all the clones were on par. None of the clones evaluated was found to be outstanding in their overall performance.

REFERENCES

Baulkwill, W.J. (1989). The history of natural rubber production. In: *Rubber* (Eds. C.C. Webster and W.J. Baulkwill). Longman Scientific and Technical, England, pp. 1-56.

Huat, O.S., Othman, R.B. Samy, A.A, Wah, C.P., Shari, I.B., Jayasunthar, K., Mohammed, M.B. and Kasir, M.Y.B. (1998). LGM planting recommendations 1998-2000. *Planters' Bulletin* **3**: 3-46.

Marattukalam, J.G., Saraswathyamma, C.K. and George, P.J. (1980). *Hevea* clones. In: *Handbook of Natural Rubber Production in India* (Ed. P.N. Radhakrishna Pillay). Rubber Research Institute of India, Kottayam, pp. 47-60.

Marques, P.C. (1997). Yield of dry latex in rubber clones in Municipio de Viana, Espirito Santo. *Communicado-Ternicio.* EMCAPA 83, 7.

Mercykutty, V.C., Saraswathyamma, C.K., Sethuraj, M.R. and Varghese, Y.A. (1995). Performance of eight popular clones of rubber (*Hevea brasiliensis*) from certain large estates. *Rubber Board Bulletin*, 27 (2): 7-14.

Nair, V.K.B. and Marattukalam, J.G. (1975). Report on the performance of RRIM clones in India (500 & 600 series). *Rubber Board Bulletin*, **12**: 41-49.

Nair, V.K.B. and Marattukalam, J.G. (1981). Performance of some RRIM clones in India. *Proceedings of the Fourth Annual Symposium on Plantation Crops*, pp. 262-269.

Potty, S.N. (1980). Nursery establishment and field planting. In: *Handbook of Natural Rubber Production in India* (Ed. P.N. Radhakrishna Pillay). Rubber Research Institute of India, Kottayam, pp. 113-131.

Potty, S.N., Kothandaraman, R. and Mathew, M. (1980). Field upkeep. In: *Handbook of natural Rubber Production in India* (Ed. P.N. Radhakrishna Pillay). Rubber Research Institute of India, Kottayam, pp. 135-156.

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Pushpadas, M.V. and Ahammed, M. (1980). Nutritional requirements and manurial recommendations. In: *Handbook of Natural Rubber Production in India.* (Ed. P.N. Radhakrishna Pillay). Rubber Research Institute of India, Kottayam, pp.159-185.

RRIM Planting Recommendation Committee. (1992). RRIM planting recommendations 1992-94. *Planters' Bulletin*, **210**: 31-50.

RRIM Planting Recommendation Committee. (1995). RRIM planting recommendations 1995-97. *Planters' Bulletin*, **224-225**: 51-72.

Rubber Research Institute of Malaya. (1970). Review of modern *Hevea* clones : 1, Clone RRIM 600. *Planters' Bulletin*, **107**: 49-64.

Rubber Research Institute of Malaya. (1971). Review of modern *Hevea* clones: 4, Clone PB 5/51. *Planters' Bulletin*, **114**: 151-168.

Saraswathyamma, C.K. and Marattukalam, J.G. (1996). Rubber Planting materials : Development and propagation. Rubber Board, Kottayam, 114p. (Malayalam).

Saraswathyamma, C.K., Marattukalam, J.G. and Panikkar, A.O.N. (1988). Rubber planting materials : A review 4. Crop improvement in Malaysia. *Rubber Reporter*, **13** (4&5): 105-108.

Saraswathyamma, C.K., Licy, J, and Marattukalam, J.G. (2000). Planting materials. In: *Natural Rubber: Agromanagement and Crop Processing* (Eds. P.J. George and C. Kuruvilla Jacob). Rubber Research Institute of India, Kottayam, India, pp. 59-74.

Vijayakumar, K.R., Chandrasheker, T.R. and Varghese Philip (2000). Agroclimate. In: *Natural Rubber: Agromanagement and Crop Processing* (Eds. P.J. George and C. Kuruvilla Jacob) Rubber Research Institute of India, Kottayam. pp. 97-116.