CLONAL NURSERY EVALUATION FOR SHORTENING THE BREEDING CYCLE IN *HEVEA BRASILIENSIS*

Kavitha K. Mydin, J. Licy, Y. Annamma Varghese, Alice John, Ramesh B. Nair and C.K. Saraswathyamma
Rubber Research Institute of India, Kottayam – 686 009, Kerala, India.

Submitted: 18 March 2002 Accepted: 30 July 2004

Mydin, K.K., Licy, J., Varghese, Y.A., John, A., Nair, R.B. and Saraswathyamma, C.K. (2004). Clonal nursery evaluation for shortening the breeding cycle in *Hevea brasiliensis*. *Natural Rubber Research*, 17(1) : 60-66.

Twenty two hybrid clones of rubber (*Hevea brasiliensis* Muell. Arg.) evolved at the Rubber Research Institute of India were evaluated for growth and dry rubber yield in a clonal nursery and in the main field in small-scale trials. Clones with good yield and stable performance in the nursery were selected by a rank-sum method. Juvenile-mature correlations were worked out in an attempt to study the prospects of reducing the time span of clonal selection. Significant positive correlation between juvenile yield in the clonal nursery and initial yield at maturity suggested scope for preliminary evaluation of clones in a nursery.

Key words: Clonal nursery, Early selection, Girth, *Hevea brasiliensis*, Juvenile-mature correlations, Rank-sum, Yield.

INTRODUCTION

Hevea brasiliensis, the most important source of natural rubber, is a perennial tree species amenable to vegetative propagation. Clones thus form the most widely used planting material, which help to maintain homogeneity in plantations. Breeding in *Hevea* aims at evolving clones for specific objectives and environments. The perennial nature of the species poses hindrance to efforts for rapid genetic improvement. Clonal selection, which includes preliminary evaluation for yield in small-scale trials (SST) followed by more elaborate large-scale trials (LST) and on-farm evaluation trials (OFT) takes nearly 30 years before a clone is released for cultivation (Varghese and Mydin, 2000).

Early evaluation techniques are practised in seedling nursery screening of hybrids with considerable success. However, the clonal selection procedure remains to be shortened. Adoption of promotion plot trials (Subramaniam, 1980) is a successful effort at shortening the breeding cycle by 10 years. However, this approach can only be considered as an adjunct to the conventional procedure since the precision of the early prediction is relatively low (Ong *et al.*, 1986). Nair (1999) has suggested a scheme for evaluation of *Hevea* clones which involves conducting large-scale and on-farm trials concurrently using clones selected from small-scale trials based on data for the first five years of tapping, thus saving seven years in the evaluation process.

In an effort to study the prospects of further reducing the time span of the clonal selection procedure, a clonal nursery evaluation was attempted on the lines followed by Ho *et al.* (1973). This paper reports the performance of clones in the clonal nursery

Correspondence: Kavitha K. Mydin (kavitha@rubberboard.org.in)

in relation to their initial performance at maturity.

MATERIALS AND METHODS

Twenty-two hybrid clones developed at the Rubber Research Institute of India, Kottayam, Kerala, and planted in a clonal nursery and in the main field in small-scale trials (SST) were studied with respect to growth and dry rubber yield. The clonal nursery comprised two sets of clones planted in a randomised block design, one consisting of 15 clones replicated twice and the other, of seven clones replicated thrice. In both cases, the current popular clone, RRII 105, was planted as check. The spacing adopted in the nursery was 1 m x 1 m with five plants per plot. The SST of these clones was laid out as per standard practices (Rubber Board, 1989) in a randomised block design with five trees per plot, replicated thrice.

The clones in the nursery were test tapped by the modified Hammaker-Morris-Mann method during the peak yielding period (November) in the third, fourth and fifth years after planting. Ten consecutive tappings were done at 30 cm height following the ½ S d/3 system. Latex collected from the 10 tappings was coagulated and accumulated in the collection cup, following which the cup lumps were dried and weighed to record test tap yield. Girth of the plants was recorded at a height of 60 cm from the collar. Data on yield from the SST under ½ S d/3 system during the first year of tapping was recorded by cup coagulation at fortnightly intervals.

Following the analysis of variance, the CV between years in respect of test tap yield was worked out. The rank-sum method (Huhn, 1979) was applied to data on yield and girth of clones during the third, fourth and fifth years in the clonal nursery, to identify the best performers having stability for yield and growth over the years. The correlations of mature yield with clonal nursery characters were estimated to study the scope for utilizing clonal nursery performance for identifying promising selections for large-scale testing.

RESULTS AND DISCUSSION

The yield of clones during the third, fourth and fifth years in the clonal nursery are depicted in Figure 1. There was significant clonal variation in the nursery, for the pooled mean juvenile yield over the three years, which ranged from 12.18 to 75.16 g per plant per 10 tappings and girth during the fifth year which ranged from 16.56 to 32.70 cm (Table 1). Of the 22 clones, two selections *viz.*, 86/68 and 86/111 with mean yields of 75.16 and 55.22 g per plant per 10 tappings respectively, were significantly superior to the check clone, RRII 105. These clones were also vigorous with a mean girth of 32.70 cm and 28.16 cm respectively, in the fifth year of growth.

Applying 25 per cent intensity of selection in the SST in respect of yield at maturity (Table 2) six clones *viz.*, 86/111, 86/44, 86/79, 86/120, 86/99 and 86/68 were ranked as the best, producing more than 30 g dry rubber per tree per tapping in the first year. These clones were better than / comparable to the check clone, RRII 105, which yielded 33.29 g per tree per tapping.

The performance of the clones in the nursery was evaluated in terms of ranksums for yield, girth and yield improvement over RRII 105, from the third to the fifth year of

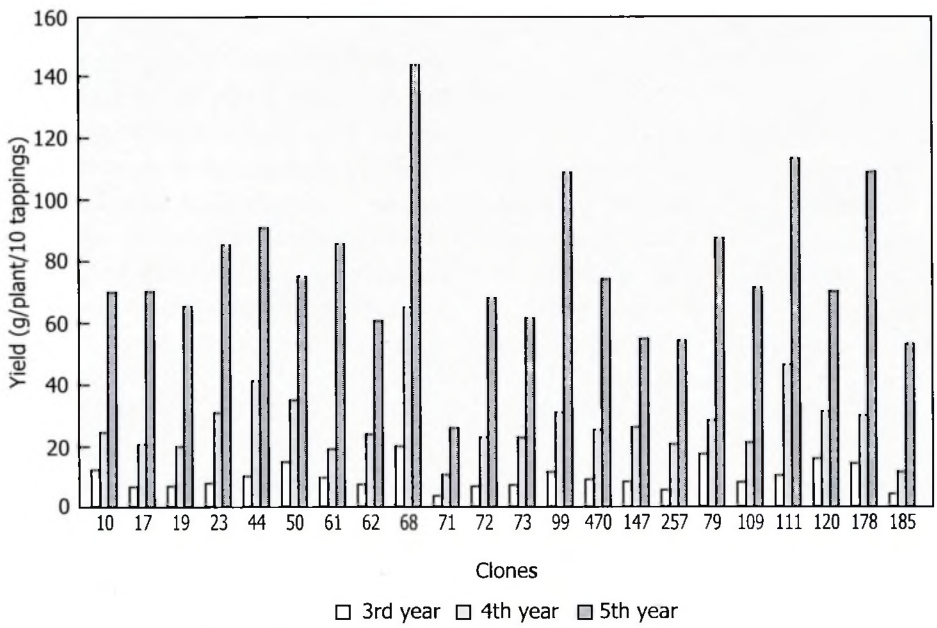

Fig. 1. Yield performance of hybrids in the clonal nursery

growth (Table 2). A high rank sum which is the sum of the rankings of a clone for the traits under study indicates a high mean value coupled with greater year to year stability of the clone. The rank sum values for yield ranged from 6 to 66 with a mean value of 34.40. Eleven clones had above average rank sum values for yield. Ten clones had rank sum values higher than 23.00 which was the mean value computed for girth. The mean ranksum value for yield improvement shown by the clones over RRII 105 in the nursery was 34.5 with 13 clones exceeding this value.

In terms of the rank sums for yield, girth and yield improvement of each clone over the check RRII 105, the selections include 8 clones each for yield and for girth and 7 clones for their yield improvement. The six clones selected on the basis of mature yield had high rank sum values for nursery yield, girth and yield improvement over RRII 105 except clone 86/120 for which the rank sum for improvement over RRII 105 was above the mean value but not among the best 25 per cent.

The coefficient of variation between years in respect of test tap yield (Table 1) during the third to the fifth year in the clonal nursery ranged from 15.81 to 121.84 per cent with a mean of 93.33 per cent. Out of the six clones identified as high yielders in the SST, three clones (86/44, 86/68 and 86/79) showed less variation between years indicating greater stability in yield. These clones were also among the best in terms of mean yield in the nursery. Of the other three clones *viz.*, 86/111, 86/120 and 86/99, which were identified as promising yielders in the SST, the first showed a CV only slightly above the general mean, while 86/120 showed a low CV between years for juvenile yield, which,

Table 1. **Yield and girth of clones in the nursery**

Clone	Parentage	Test tap yield: Pooled mean of 3 years (g/tree/10 taps)	Test tap yield: CV (%) between years	Girth during fifth year (cm)
Trial I				
86/10	RRIM 600 X RRII 203	34.48	89.59	22.68
86/17	RRIM 600 X RRII 203	31.70	106.88	21.91
86/19	RRIM 600 X RRII 203	29.55	103.98	25.78
86/23	RRIM 600 X RRII 203	40.30	98.97	24.94
86/44	PB 242 X RRII 105	46.32	88.54	23.32
86/50	PB 242 X RRII 105	40.72	15.81	19.30
86/61	PB 5/51 X RRII 208	36.90	112.80	22.08
86/62	PB 5/51 X RRII 208	29.48	92.91	22.52
86/68	PB 5/51 X RRII 208	75.16	83.44	32.70
86/71	PB 5/51 X RRII 208	12.18	92.31	16.56
86/73	PB 5/51 X RRII 208	29.27	95.57	21.59
86/99	PB 242 X PB 86	49.47	104.48	25.13
86/147	RRII 105 X PB 217	28.20	83.53	18.53
86/257	RRIM 600 X PB 235	25.61	88.62	17.89
Trial II				
86/72	PB 5/51 X RRII 208	31.54	101.20	22.83
86/79	RRII 105 X PB 5/51	43.06	88.62	24.72
86/109	RRII 105 X RRII 118	32.11	103.39	22.44
86/111	RRII 105 X RRII 118	55.22	95.12	28.16
86/120	RRII 105 X RRII 118	37.38	75.95	25.44
86/178	RRII 105 X RRII 208	49.29	103.95	25.22
86/185	RRII 105 X RRII 208	21.35	121.84	18.17
86/470	PB 242 X PB 86	34.90	98.06	22.50
Check				
RRII 105‡	Tjir 1 X Gl 1	24.78	92.73	17.19
General mean		35.30	93.33	22.36
Variance ratio		2.67* (Trial I) 3.14*(Trial II)		5.90* (Trial I) 1.96 (Trial II)
CD (P≤0.05)		26.84 (Trial I) 17.31 (Trial II)		18.25 (Trial I) NS (Trial II)

* Significant at P≤ 0.05 ‡ Mean of both trials

per se, was not among the highest. The third clone, though a high juvenile yielder, was found to show inconsistent performance.

Juvenile-mature correlations are of significance in a perennial species like rubber since they provide a basis for undertaking early selection for traits at maturity. In the present study, yield at maturity showed significant positive correlation with test tap yield during the third, fourth and fifth years in the nursery (Table 3), the magnitude of correlation being higher (r=0.56, P<0.05) with yield in the fourth and fifth years. Girth of clones in the nursery was also positively correlated with yield at maturity.

Nursery yield of hybrid seedlings had shown low positive correlation (r=0.3) with yield in small-scale trials (Tan, 1987). This necessitates selection of a large number of seedlings to be cloned and put to test in SST leading to experimental land being locked up for over 20 years with a large number of

Table 2. **Performance of clones at maturity and in the clonal nursery**

Clone	First year yield at maturity in SST (g/t/t)	Clonal nursery performance		
		Rank sum (yield)	Rank sum (girth)	Rank sum (yield improvement over RRII 105)#
86/10	19.50	37	17	35
86/17	16.86	21	16	20
86/19	16.95	17	33*	18
86/23	23.83	42	33*	37
86/44	34.51*	53*	33*	49*
86/50	26.20	53*	19	49*
86/61	26.87	32	19	28
86/62	17.68	23	15	22
86/68	30.02*	66*	44*	65*
86/71	17.88	3	2	4
86/73	23.98	21	12	15
86/99	33.49*	53*	38*	42*
86/111	52.63*	56*	41*	60*
86/147	28.56	26	16	32
86/257	14.44	12	5	13
86/72	19.26	22	20	39
86/79	34.48*	52*	30*	55*
86/470	17.04	37	16	41
86/109	21.38	29	26	41
86/120	33.79*	44*	37*	35
86/178	25.61	52*	29	43*
86/185	29.48	6	5	16
Mean	25.99	34.40	23.00	34.5

Yield of clone RRII 105 at maturity : 33.29 g/tree/tap * Included among top 25% ranks

Table 3. **Correlation of mature yield with clonal nursery performance**

Parameter	Correlation coefficient (r)
Mature yield vs. test tap yield (third year)	0.44*
Mature yield vs. girth (third year)	0.52*
Mature yield vs. test tap yield (fourth year)	0.56**
Mature yield vs. girth (fifth year)	0.46*
Mature yield vs. test tap yield (fifth year)	0.56**

* Significant at $P \leq 0.05$ ** Significant at $P \leq 0.01$

clones, most of which may finally prove inferior. Rise in the correlation (r = 0.73) with SST has been reported (Ho, 1976) when the seedlings are budded and selection made on the basis of test tapping of the young budded plants. The present estimates of correlation between yield in the clonal nursery and that in the SST (r = 0.56, P<0.05) also confirm this. Earlier studies on juvenile-mature correlations (Tan, 1998) have established that nursery yield alone could be adopted as the early selection criterion and additional parameters could only marginally enhance the selection efficiency.

High positive correlations among yields in the first, second and third years of tapping in SST has been reported (Alika, 1980; Licy *et al.*, 1998). It has been concluded from earlier studies that the first two years' data is adequate for selecting superior clones from SST (Ong, 1981; Swaminathan, 1975; Varghese *et al.*, 1992). Ong (1981) reported that yield in small-scale trials and subsequent large-scale trials were also positively correlated (r=0.46 to 0.97).

Small-scale trials in rubber breeding programmes, are essentially fairly rough 'sorting trials' (Simmonds, 1989) with numerous entries, while it is the large-scale trials that have wider functions. They are aimed not only at identifying the highest yielders but also at producing information upon which to base recommendations. The present observation of a significant positive correlation between juvenile performance in growth and yield in the clonal nursery and mature yield in SST and the best 25 per cent clones in SST being among the best in respect of yield, girth and improvement in yield over the check in the clonal nursery, offers scope for conducting small-scale evaluation of clones in a nursery rather than in elaborate field trials which demand more time, land and resources. The *Hevea* breeding programme in Cote de Ivoire (Clement *et al.*, 2001) follows a similar procedure wherein selected hybrid seedlings are evaluated in small-scale trials at close spacing for 4 to 8 years. The time interval for identifying precocious high yielders for carrying forward to LST could thus be reduced from 10 years in the present practice to 5 years with clonal nursery evaluation. Detailed study of yield in later years, secondary characters and wood characteristics could be done in the LST, with more number of trees per clone. However, this procedure has the limitation that non-precocious high yielders may not be identified.

ACKNOWLEDGEMENT

The authors are grateful to the Director, Rubber Research Institute of India, for facilities provided.

REFERENCES

Alika, J.E. (1980). Possibilities of early selection in *Hevea brasiliensis*. *Silvae Genetica*, **29** : 161-162.

Clement, D.A., Legnate, H., Seguin, M., Carron, M.P, Leguen, V., Chapuser, T. and Nicolas, D. (2001). Rubber trees. In: *Tropical Plant Breeding* (Eds. Andre Charrier, Michel Jacquot, Serge Hamon and Dominique Nicolas). Oxford and IBH Publishing Co., New Delhi, pp. 455-480.

Ho, C.Y. (1976). Clonal characters determining the yield of *Hevea brasiliensis*. *Proceedings of the International Rubber Conference*, 1975, Kuala Lumpur, pp. 27-44.

Ho, C.Y., Narayanan, R. and Chen, K.T. (1973). Clonal nursery studies in *Hevea:* I. Nursery yields and associated structural characteristics and their variations. *Journal of Rubber Research Institute of Malaysia*, 23(4) : 305-316.

Huhn, M. (1979). Beitrage zur Erfassung der Phanotypischen Stabilitat. I. Vorschlag einiger auf Ranginformationen Beruhenden Stabilitatparameter. *EDP in Medicine and Biology*, **10** : 112-117.

Licy, J., Panikkar, A.O.N., Premakumari, D., Saraswathyamma, C.K., Nazeer, M.A. and Sethuraj, M.R. (1998). Genetic parameters and heterosis in rubber (*Hevea brasiliensis*) Muell. Arg. IV. Early versus mature performance of hybrid clones. In: *Developments in Plantation Crops Research* (Eds. N.M. Mathew and C. Kuruvilla Jacob), Rubber Research Institute of India, Kottayam, pp. 9-15.

Nair, V.G. (1999). A Compendium on Crop Improvement Research in Kerala: Accomplishments and Future Strategies. Department of Science, Technology and Environment, Government of Kerala and Kerala Agricultural University, pp. 77-93.

Ong, S.H. (1981). Correlation between yield, girth and bark thickness from RRIM clone trials. *Journal of Rubber Research Institute of Malaysia*, **29**(1) : 1-14.

Ong, S.H., Tan, H., Khoo, S.K. and Sultan, M.O. (1986). Selection of promising clones through accelerated evaluation of *Hevea*. *Proceedings of International Rubber Conference*, 1985, Kuala Lumpur, Malaysia, **3** : 157-174.

Rubber Board (1989). Rubber and its cultivation. The Rubber Board, Kottayam, Kerala, India.

Simmonds, N.W. (1989). Rubber breeding. In: *Rubber* (Eds. C.C. Webster and W.J. Baulkwill), Tropical Agriculture Series, Longman Scientific and Technical, U.K., pp. 85-124.

Subramaniam, S. (1980). Developments in *Hevea* breeding and its future. *National Rubber Symposium*, 1980, Brazil.

Swaminathan, M.S. (1975). Recent trends in plant breeding. *Proceedings of International Rubber Conference*, 1975, Kuala Lumpur, Malaysia, 1 : 143-158.

Tan, H. (1987). Strategies in rubber tree breeding. In: *Improving Vegetatively Propagated Crops* (Eds. A.J. Abbott and R.K. Atkin). Academic Press, London, pp. 27-62.

Tan, H. (1998). A study on nursery selection in *Hevea* breeding. *Journal of Rubber Research*, **1**(4) : 253-262.

Varghese, Y.A., John, A., Premakumari, D., Panikkar, A.O.N. and Sethuraj, M.R. (1992). Early evaluation of *Hevea* : Growth and yield at the juvenile phase. *Indian Journal of Natural Rubber Research*, **6**(1&2) : 19-23.

Varghese, Y.A. and Mydin, K.K. (2000). Genetic improvement. In: *Natural Rubber: Agromanagement and Crop Processing* (Eds. P.J. George and C. Kuruvilla Jacob), Rubber Research Institute of India, Kottayam, India, pp. 36-46.