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PREPOTENCY IN RUBBER : HALF-SIB PROGENY EVALUATION

Kavitha K. Mydin, L. Sankariammal, Vinoth Thomas and C.K. Saraswathyamma

Rubber Research Institute of India, Kottayam, Kerala - 686 009

ABSTRACT

Rubber (*Hevea brasiliensis* Willd. ex. Adr. de Juss. Muell. Arg.) is a perennial outbreeding species in which polycross breeding is effected by means of isolated seed gardens. Prepotent clones for use as seed garden components were identified by half sib progeny analysis of 11 clones recommended for planting in India.

The two year old progenies showed significant variation for test tap yield, girth and bark thickness. Superior progenies were identified by a performance index based on yield, girth, bark thickness and number of latex vessel rows. Assigning index scores for the same traits, the recovery of superior seedlings within each progeny was worked out. The recovery of elite seedlings for cloning and further evaluation was also determined. Of the eleven clones evaluated, five clones viz., PB 255, RRII 203, RRII 105, PB 260 and GT-1 were identified as likely prepotents with a high performance index and a high recovery of superior and elite seedlings in their [illegible]y.

INTRODUCTION

Rubber (*Hevea brasiliensis* Willd. ex. Adr. de Juss Muell. Arg.), a perennial out breeding species exhibits highly variable performance, as would be expected, when propagated through seed. Vegetative propagation has contributed immensely to the realization of high yields resulting from fixation of desirable traits and uniformity in the planting material. However, in areas subject to the vagaries of climate and exposed to biotic and abiotic stresses, heterogeneity of plantations raised from seeds ensures stability of yield over seasons and over years when compared to clonal plantations (Mydin, 1990; Birari *et. al.*, 1998; Sasikumar *et al.*, 2001; Chandrashekar *et al.*, 2002). Plantations raised from seeds have also been [illegible]rted to perform better than clones in the traditional rubber growing region of South India (Krishnankutty and Sreenivasan, 1984).

Polyclonal seeds produced in specially laid out isolated seed gardens are recommended for planting in stress prone and marginal lands (Saraswathyamma *et. al.*, 2000 a). Such multiparent first generation synthetic varieties of rubber have been economically successful for decades and are recommended in category I, for wide scale planting in Malaysia. (Simmonds, 1986) Timber yield from such trees is usually high by way of their high vigour and girthing (Saraswathyamma *et. al.*, 2000 b).

In an effort to establish newer seed gardens for producing good quality polyclonal seeds, the Rubber Research Institute of India has conducted studies to identify seed garden components (Mydin, 1992). Progeny analysis of some promising clones has facilitated the identification of prepotent parents which have been used to lay out new polyclonal seed gardens (Saraswathyamma and Panikkar, 1989; Mydin *et. al.*, 1990, 1996). Prepotent parents can also provide a superior base population of seedling progeny from which elite individuals can be selected and developed into primary clones. The present study is a continuation of the efforts to identify prepotent parents among contemporary clones from India, Indonesia, Malaysia and China. The juvenile performance of their half sib progenies is analyzed and reported.

MATERIALS AND METHODS

Four Indian clones, four Malaysian clones, two Indonesian clones and one Chinese clone (Table 1) were taken up for study. Open pollinated seeds were collected and bulked from all replicates of field trials in which these clones were planted in a statistical lay out, thus obtaining a close approximation of polycross seeds. The germinated seeds were planted in a nursery in Randomised Block Design with three replications and 15-20 plants per plot.

The seedlings were test tapped at the age of two years by the modified Hammaker Morris Mann method following a 1/2S d/3 system, at a height of 15cm from the plant base. Latex from 15 consecutive tappings was allowed to accumulate in the collection cup, following which cup lumps were oven dried and weighed to record yield. Bark samples were collected at the time of test tapping, from the side opposite to the tapping panel, at the height of tapping. Bark thickness and number of latex vessel rows were recorded from radial longitudinal sections of the bark employing standard procedures. Seedling girth was also recorded at the tapping height. Plant height and number of leaf flushes were recorded as measures of vegetative growth.

Variability among the half-sib progenies for test tap yield, girth, bark thickness, number of latex vessel rows, plant height and number of leaf flushes was studied by the analysis of variance. Performance indices of progenies (Mydin *et. al.*, 1990) were computed as follows on the basis of their test tap yield (X_1), girth (X_2), bark thickness (X_3) and number of latex vessel rows (X_4):

Performance Index = $w_1x_1 + w_2x_2 + w_3x_3 + w_4x_4$, where,

$x_1 \ldots x_4$ are the progeny means for the traits $X_1 \ldots X_4$ and

$w_1 \ldots w_4 = 1/\sigma^2 e_1 \ldots 1/\sigma^2 e_1 \ldots 1/\sigma^2 e_4$ where $\sigma^2 e_1 \ldots \sigma^2 e_4$

denote the environmental variance for each trait.

The recovery of superior seedlings within each progeny as a measure of prepotency was determined by an index score method. For assigning index scores of 1 to 3 for the four traits viz. test tap yield, girth, bark thickness and number of latex vessel rows, the criterion adopted for determining class intervals was mean ± 2SE (Table 2). Seedlings with a total score of 8 and above were deemed superior. The seedlings were also ranked for the four traits and the rank sums were utilized for identifying elite seedlings i.e., the best 25 per cent of the population. The proportion of elite seedlings in each progeny was then determined.

RESULTS AND DISCUSSION

Among the 11 clones whose half sib progeny evaluated, RRII 105, PB 260, GT-1 and RRIM 600 were proven superior clones included in category I of the planting recommendations for

Table 1. Clones studied for prepotency

Clone	Parentage	Country of origin
RRII 105	Tjir - 1 x GI-1	India
RRII 203	PB 86 x Mil 3/2	India
RRII 208	Mil 3/2 x AVROS 255	India
RRII 308	GI-1 x PB 6/50	India
GT-1	Primary clone	Indonesia
PR 255	Tjir 1 x PR 107	Indonesia
RRIM 600	Tjir 1 x PB 86	Malaysia
PB 255	PB 5/51 x PB 32/36	Malaysia
PB 260	PB 5/51 x PB 49	Malaysia
PB 280	Primary clone	Malaysia
SCATC 88-13	RRIM 600 x Pil B 84	China

Table 2. Index score table showing class intervals for determining recovery of superior seedlings

Trait	Score 1	Score 2	Score 3
Test tap yield (g/plant/15 taps)	< 4.71	4.71 - 5.93	> 5.93
Girth (cm)	<13.23	13.23 - 14.13	> 14.13
Bark thickness (mm)	< 2.77	2.77 - 2.93	> 2.93
No. of latex vessel rows	< 3.95	3.95 - 4.35	> 4.35

wide scale planting in India. (Rubber Board, 2002) Desirable secondary characters of these clones were also well documented. The rest of the clones come under categories II and III depending on their performance in various stages of evaluation in India and in their country of origin (Saraswathyamma *et. al.*, 2000 a). Of these, clones PB 255 and PB 280 were reported to be the highest yielders with good vigour in large scale trials (John *et. al.*, 2002). It is, therefore, only appropriate that attempts be made to identify prepotents among these clones and utilize them effectively in polycross and hybridization programmes.

The concept of prepotency embodies the coherence of gene combinations and enbloc transmission of genes from parent to progeny irrespective of the genotype of the other parent (Harland, 1957). This functional homozygosity thus exhibited by prepotent individuals ensures superior progeny performance with desirable features of the parent.

The results of half sib progeny evaluation of the 11 promising *Hevea* clones revealed significant variation among progenies with respect to test tap yield, girth and bark thickness. No significant variation was evident for plant height, number of leaf flushes and number of latex vessel rows.

Juvenile yield on test tapping ranged from 2.15-7.61g/plant/15 taps with the progeny of RRII 203 showing the best mean performance (Table 3). Girth ranged from 7.75 - 15.47 cm with progeny of PB 260 showing the highest vigour. The progeny of RRII 208 proved to be inferior for both yield and girth. Bark thickness ranged from 2.25-3.14 mm and the mean number of latex vessel rows ranged from 3.02 to 4.61 among progenies (Table 4). Progeny of PB 255 and RRII 203 showed good bark thickness and high number of latex vessel rows.

Heritability and correlation estimates of juvenile traits like test tap yield, girth, bark thickness and number of latex vessel rows indicate promise for using them as selection indices (Mydin *et. al.*, 1996). Selection for multiple traits rather than yield per se is suggested. The performance index wherein the environmental variance is used to determine the weighted means enables selection of those progenies which show a high mean performance for the relatively stable traits. The recovery of superior seedlings was taken as a measure of prepotency following George *et. al.*, (1984) and Shylaraj and Gopakumar (1987).

The performance indices (Table 5) of the 11 progenies ranged from 43.86 (RRII 208) to 62.33 (PB 255) with a mean of 53.51. Six progenies with indices ranging from 54.05 to 62.33 could be rated superior. These include progenies of clones PB 255, RRII 203, GT-1, RRIM 600, PB 250 and RRII 105 in the order of superiority. The recovery of superior seedlings among the various progenies was 45.64 per cent with individual progeny values ranging from 28.57 - 63.27 per cent. Progenies of clones PB 255, PB 260, RRII 105, RRII 203 and GT-1 showed more than 45 per cent recovery of superior seedlings. These five clones which exhibited a high performance index coupled with a high recovery of superior seedlings in their progenies (Figure 1) could be considered as likely prepotents. Of these, clones RRII 105 and GT-1 have earlier been reported to produce superior progeny under open pollination (Saraswathyamma and Panikkar, 1989; Mydin *et. al.*, 1996). The newer clones, PB 255, PB 260 and RRII 203 which are high yielders with superior secondary attributes comprise promising candidates for polycross breeding alongwith other

Table 3. Performance of progenies for juvenile yield and girth

Progeny	Test tap yield (g/plant/15 taps)	Girth (cm)
RRII 105	3.63	13.37
RRII 203	7.61	14.25
RRII 208	2.15	7.75
RRII 308	3.87	11.78
GT-1	5.48	14.10
PR 255	4.88	13.03
RRIM 600	3.77	12.96
PB 255	7.29	14.66
PB 260	5.47	15.47
PB 280	3.11	11.80
SCATC 88-13	4.37	11.70
General mean	**4.70**	**12.81**
V.R. (P<0.05)	**2.47***	**2.90***
C.D. (0.05)	**3.20**	**3.66**

*Significant at P<0.05

prepotent parents. However, clone GT 1 being male sterile (Saraswathyamma and Panikkar, 1989) will not produce reciprocals when included in a polycross programme.

Prepotent parent clones, by way of their high GCA are best used a components in polyclonal seed gardens for producing good quality polycross seeds. The open pollinated progeny of such clones also comprise a superior base population for selection and cloning of the best individuals as is the practice in *Hevea* breeding procedures (Simmonds, 1989; Tan, 1998). This could supplement the ortet selection programmes, as a means of evolving primary clones.

The percentage of elite seedlings among the 11 progenies (Table 5) ranged from 0 (RRII 208) to 42.11 (RRII 203) with a mean of 22.38. The five clones identified as likely prepotents produced elite seedlings in the range of 23.21 to 42.11 per cent within their progenies. The present results

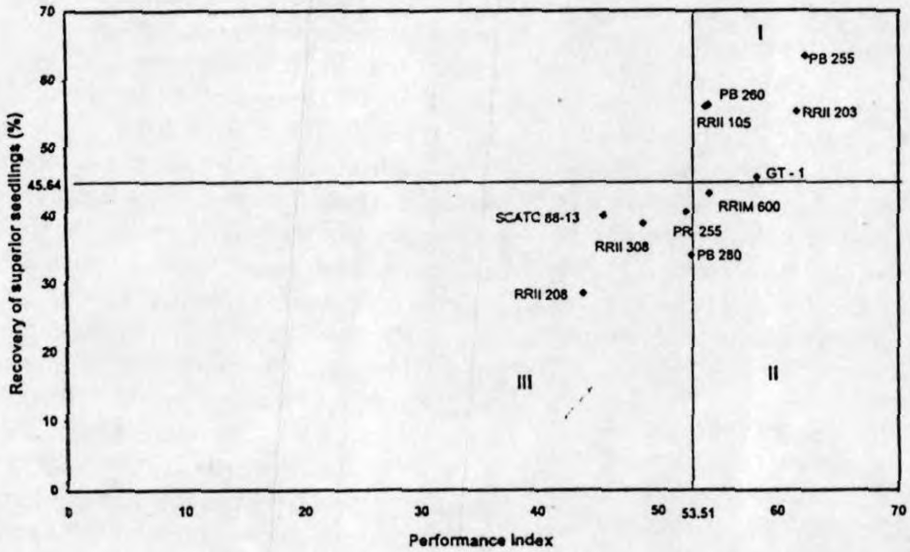

Fig. 1. Identification of likely prepotents

Table 4. Performance of juvenile progenies for vegetative and structural attributes

Progeny	Plant height (m)	Leaf flushes (no.)	Bark thickness (mm)	L.V.R. (no.)
RRII 105	3.36	8.72	2.73	4.19
RRII 203	3.97	9.97	3.09	4.61
RRII 208	2.85	7.53	2.35	3.02
RRII 308	3.54	9.26	2.51	3.51
GT 1	3.90	11.30	3.00	4.09
PR 255	3.74	11.85	2.74	3.40
RRIM 600	3.75	9.46	2.83	3.79
PB 255	4.35	11.42	3.14	4.60
PB 260	3.93	12.23	2.73	3.91
PB 280	3.46	8.92	2.75	3.82
SCATC 88-13	3.34	9.11	2.25	3.63
General Mean	**3.65**	**9.98**	**2.74**	**3.87**
V.R. (P < 0.05)	**0.68 (NS)**	**2.01 (NS)**	**3.63 ****	**1.86 (NS)**
C.D. (0.05)	**-**	**-**	**0.45**	**-**

Table 5. Performance index and recovery of superior and elite seedlings

Progeny	Performance index	Superior seedlings (%)	Elite Seedlings (%)
RRII 105	54.05	56.00	32.00
RRII 203	61.65	55.26	42.11
RRII 208	43.86	28.57	0
RRII 308	48.83	38.89	11.11
GT-1	58.34	45.66	23.21
PR 255	52.40	40.63	21.88
RRIM 600	54.37	43.33	10.00
PB 255	62.33	63.27	34.69
PB 260	54.31	56.25	32.81
PB 280	52.86	34.21	18.42
SCATC 88-13	45.56	40.00	20.00
Mean	**53.51**	**45.64**	**22.38**

thus revealed that prepotent parents also produced a high proportion of seedlings, which fall among the best 25 per cent of the population, with respect to juvenile selection parameters. Therefore, clones like RRII 105, PB 255, RRII 203 and PB 260 could be utilized as polyclonal seed garden components. Clone GT 1 alongwith the prepotents identified from the present study could be utilized for generating a superior base population of seedling progeny to evolve primary clones.

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