SEEDLING PROGENY ANALYSIS FOR ESTIMATION OF PREPOTENCY IN EXOTIC *HEVEA* CLONES

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Abstract

In order to identify superior mother parents for polycross seed gardens, progeny analysis was carried out in a set of exotic clones. Significant variation was observed between progenies at the age of two years of growth. The highest correlation was observed between juvenile yield and vigour in terms of height followed by girth. Progenies of PB 255 recorded high percentage of superior seedlings in terms of juvenile yield and high performance index value. Progenies of seven clones, viz., PB 312, PB 314, RRII 105, PB 260, PB 310, PB 255 and PB 311 recorded high performance indices coupled with high percentage of recovery of superior seedlings considered as prepotent clones.

Key words: prepotency, *Hevea* clones, progeny analysis, seed garden, juvenile yield

Introduction

Prepotency is the genetic potentiality of a female parent to produce superior offspring irrespective of the nature of the male parent. The prepotent ability of *Hevea* clones to produce high quality seedlings could be determined by systematic and planned experiments like seedling progeny analysis (Mydin, 1990). Polycross trees are generally more vigorous and attained earlier tappability. They show more tolerance to adverse soil and climatic conditions and hence they are suitable for marginal areas (Saraswathyamma et al., 2000). The timber yield from such trees is high because of their high vigour and girthing. Polyclonal seeds are hybrid seeds produced in specially designed polyclonal seed gardens. In order to maximize cross pollination in polyclonal seed gardens clones are planted in a specific layout for enabling maximum cross pollinations. Earlier the selection of parents was mainly based on the phenotypic characteristics of a plant, however such selections did not take into consideration the combining ability of the parent with regard to yield components. Polyclonal seedlings resultant of cross pollination express heterosis or hybrid vigour. Polycross or synthetic seedling populations of polyclonal seed gardens have been successfully used as planting materials. Allogamy coupled with seed propagation increases variation through genetic recombination in seedling population. The seedling populations have special agricultural merits in maintaining the genetic variability and adaptability of the population (Mydin, 1990; Varghese, 1992). The present investigation was undertaken to evaluate genetically superior mother parents through seedling progeny analysis for incorporating in the seed gardens for the production of quality hybrid seeds. Seedlings, though not comparable with high yielding clones in production potential have special agricultural merits that there is a need for superior polycross progeny from special polyclonal seed gardens as planting material. The evaluation of such polycross population can be considered as selective breeding. Such 'multi parent' first generation synthetic varieties (Syn. 1) have been economically successful for many decades, (Simmonds, 1986) predominantly due to additive genetic control of vigour and yield as well as high general combining ability (Tan, 1987, Simmonds, 1986).

Materials and Methods

Open pollinated seeds were collected from 12 introduced clones from Malaysia and Thailand along with the seeds of Indian clone RRII 105 (Table 1). Seedling progenies were planted in randomized block design with three replications in the experimental farm of the Rubber Research Institute of India (RRII), Kottayam. Forty plants per progeny were raised in a plot with a spacing of 60 x 60 cm. Observations for yield, girth and number of whorls were taken from 16 plants/plot leaving the border trees. 48 plants/clone were subjected to detailed studies.

Observations for morphological traits viz., girth (at 10 cm from the ground level), height and total number of flushes produced were made at the first and second year of planting. Seedling height at the age of six months were also recorded. Juvenile yield was determined by the test tapping of the seedlings at the age of two years by the modified Hammaker Morris Mann method following a 1/2S d/3 system, at a height of 15 cm from the plant base. Latex from ten successive tappings was allowed to accumulate in collection cup, following which the cup lumps were oven dried and weighed to record yield. Analysis of variance was worked out to estimate variability among progenies with respect to all variables studied.

Performance index of the 13 clones was estimated based on vegetative vigour and juvenile yield (Mydin, 1990). Considering the variables, plant height (x1), girth (x2) number of leaf flushes produced (x3) and juvenile rubber yield (x4)

Performance index = W1x1 + W2x2 +W3x3 + W4x4

where W1, W2, W3 and W4 = $1/\sigma_1^2$, $1/\sigma_2^2$, $1/\sigma_3^2$, $1/\sigma_4^2$

denote weights attached to X1, X2, X3 and X4 respectively and provide information on each trait. x1, x2, x3 and x4 represents the mean value of the traits X1, X2, X3 and X4.

Progenies were ranked on the basis of their performance indices. The percentage of seedling progenies which recorded above average mean yield of the total seedling population were also computed.

Results and Discussion

The mean values for height of the plants after six months and one year are presented in Table 1. Analysis of variance indicated that there is no significant difference between seedling progenies with respect to height of seedlings at the age of six months and height and girth at one year after planting. Mydin (1990) reported that in rubber, 12 months period is too early for the expression of genotypic differences among progenies for height and girth. The result of the present experiment is in agreement with the findings of Markose (1984). The number of whorls recorded significant difference between seeding progenies at one year of age. Mean values for the number of whorls ranged from 2.78 (RRII 105) to 4.30 (PB 312). Mean values for yield, height, girth and number of whorls of leaves for the progenies of 13 clones are depicted in Table 3 and Fig. 1. Highly significant variation could be observed for the traits studied at the age of two years of planting (Table 4).

Juvenile yield ranged from 2.13 g/plant/10 tappings (KRS 163) to 6.24 g/plant/10 tappings (PB 311) while the control RRII 105 recorded 42 g/plant/10 tappings. The mean progeny yield recorded was 4.14 g/plant/10 tappings. Progenies of clones viz. PB 235, PB 255, PB 260, PB 311, PB 312, PB 314, RRII 105 exhibited above mean progeny yield.

Correlations among plant height, girth, number of leaf flushes and juvenile yield at the age of 2 years are given in Table 5. Significant positive correlations were observed for all the traits studied. The highest correlation was observed between juvenile yield and the vigour of seedlings in terms of height (r=0.6615) followed by girth (r=0.5785) while the lowest relationship was established between yield and number of leaf whorls produced, ie. (r=0.3147 at 5per cent level) and between girth and the number of leaf whorls (r = 0.3407). Significant correlation was reported between yield and girth in early clonal phase as well as in juvenile phase (Licy *et al.,* 1990). Correlation between seedling girth and height was also significantly high at 1 per cent level (r=0.4406). The relationship between seedling height and number of whorls were very high at 1 per cent level (r = 0.5620). Positive correlation for plant height and girth with juvenile yield of seedlings have also been reported earlier (Licy and Premakumari, 1988; Varghese *et al.*, 1989; Mydin 1990; Saraswathyamma, 1990). The result of the present study implies that seedling height, girth and the number of leaf whorls contribute to vigour which in turn determine yield potential.

To assess the performance of progenies, performance indices were estimated based on morphological traits and juvenile yield. Performance indices ranged from 88.46 (PB 217) to 125.57 (PB 311) with a general mean of 105.62. The performance indices of the progenies of the 13 clones are given in Table 6. Based on the performance indices, four clones exhibited highest ranks above the control RRII 105 (12.46), while progenies of the clones viz PB 314, RRII 105, PB 260, PB 310, PR 255 and PB 311 showed indices above the mean value of 105.62. The progenies of PB 311 and PB 255 exhibited highest index value of 125.57 and 124.24 respectively. Progenies of RRII 105 and GT 1 had earlier been reported to produce superior progeny under open pollinations (Saraswathyamma and Panikkar, 1989). Mydin *et al.*, (2002) reported that in a study of 11 clones, progenies of 5 clones viz., PB 255, RRII 203, RRII 105, PB 260 and GT 1 were identified as likely prepotent with a high performance index and high recovery of superior and elite seedlings in their progeny. The result of the present study is in conformity with the earlier report as it is evident from the high performance index value for the progenies of the clones PB 255 and PB 260.

Prepotent parent clones by way of their high GCA are best used as components in polyclonal seed gardens for producing good quality polycross seeds. The open pollinated progeny of such clones also comprises 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 ortet selection programmes as a means of evolving primary clones (Mydin *et al.*, 2002). The percentage of seedling which yielded above the mean yield of the progenies are represented in the Table 6. 30.23 per cent – 68 per cent of progenies of the clones showed above average progeny yield. The progenies of PB 255, PB 260, PB 310, PB 311, PB 312, PB 314 and RRII 105 recorded high percentage of seedlings showing above mean progeny yield and PB 255 recorded highest (68%) and KRS 25 (29.58%) recovered the lowest percentage of superior seedlings in terms of juvenile yield.

In the present study, out of the 13 clones evaluated, 7 clones were identified as prepotent with high performance index value and high percentage of recovery of better seedlings. High performance of progenies of a clone coupled with a high proportion of superior seedlings within the progeny is indicative of the ability of a parent to transmit superior traits to its offspring (Mydin et al., 1996). Seven clones viz., PB 312, PB 314, RRII 105, PB 260, PB 310, PB 255 and PB 311 exhibited high performance indices coupled with a high percentage of recovery of superior seedlings considered as likely prepotent. These prepotent clones can also be included in the breeding programme of rubber.

References:

Licy, J. and Premakumari, D. (1988). Association of characters in hand pollination progenies of *Hevea brasiliensis* (Willd. Ex. Adr. De Juss.) Muell. Arg. Indian Journal of natural Rubber Research, 1(1): 18-21.

Licy, J., Nazeer, M.a., Varghese, Y.a. and Panikkar, A.O.N. (1990). Correlation studies in a hybrid population of *Hevea brasiliensis* (Willd ex. Adr. De Juss.) Muell Arg. National Symposium on new trends in crop improvement of perennial species, 30 August 1990, Kottayam, India, pp.78-83.

Markose, V.C. (1984). Biometric analysis of Yield and certain yield attributes in para rubber tree *Hevea brasiliensis* Muell. Arg. Ph.D thesis submitted to Kerala Agricultural University, pp.113-114.

Mydin, K.K. (1990). Polyclonal seed gardens : their role in rubber improvement and production. Rubber Board Bulletin, 26(1): 3-4.

Mydin, K.K., Nair, V.G., Panikkar, A.O.N., Saraswathy, P., Sethuraj, M.R. (1990). Prepotency in rubber; 1. Early estimation through juvenile traits. Proceedings of the National Symposium on New Trends on Crop improvement of Perennial species, 1990, Rubber Research Institute of India, Kottayam, pp. 114-123.

Mydin, K.K., Nair, V.G., Sethuraj, M.R., Panikkar, A.O.N., Nazeer, M.A., Saraswathy, P. (1996). Prepotency in rubber: 2. Seedling progeny Analysis for yield and certain yield attributes. Indian Journal of Natural Rubber Research, 9(1): pp.63-66.

Mydin, K.K., Sankariammal, L., Vinoth Thomas and Saraswathyamma, C.K. (2002). Prepotency in rubber : Halfsib progeny evaluation. Placrosym XV, 10-13, December, pp.25-26.

Saraswathyamma, C.K. and Panikkar, A.O.N. (1989). Evaluation of seedling progenies of male sterile clones of *Hevea brasiliensis* (Willd. Ex. Adr. De Juss.) Muell. Arg. At the nursery stage. Indian Journal of Natural Rubber Research, 2(2): 99-104.

Saraswathyamma, C.K. (1990). Morphological, cytological and genetic investigations on induced and male sterile clones of para rubber tree [*Hevea brasiliensis* (willd ex. Adr. De Juss) Muell Arg] Ph.D Thesis, University of Kerala, India, 176 p.

Saraswathyamma, C.K., Joseph G. Marattukalam, Chandrasekhar, T.R., Licy, J., Vinoth Thomas, Premakumari, D., Kavitha M. Mydin, Mercykutty, V.C., Rajeswari meenattoor, J., Alice John, Gireesh, T., Meenakumari, T. and Sankari Ammal, L. (2000). Rubber Clones, Rubber Research Institute of India, Kottayam, pp.66.

Simmonds, N.W. (1986). Theoretical aspects of Synthetic/polycross populations of rubber seedlings. Journal of natural Rubber Research, 1(1): 1-15.

Simmonds, N.W. (1989). Rubber breeding. In: Rubber, C.C. Webster and W.J. Baulkwill (eds. Longman Scientifc and Technical, pp. 85-124.

Tan, H. (1987). Strategies in Rubber Tree Breeding. In: Improving vegetatively propagated crops. Abbott, A.J. and Atkin, R.K. (Eds). Academic Press, London, pp.28-54.

Tan, H. (1998). A study on nursery selection in *Hevea* breeding. Proceedings of the symposium on natural rubber (*Hevea brasiliensis*) Vil. 1. General, soils and fertilization, breeding and selection. International Rubber Research and Development Board, Brickendonbury, UK, pp.114-120.

Varghese, Y.A., Licy, J., Alice John and Panikkar, A.O.N. (1989). An incision method for early selection of *Hevea* seedlings. Indian Journal of Natural Rubber Research, 2(2): 12-117.

Varghese, Y.A. (1992). Germplasm Resources and genetic improvement. In: Natural Rubber, Biology, Cultivation and Technology (Eds. M.R. Sethuraj and N.M. Mathew) Elsievier, Amsterdam, pp.85-115.

Table 1. Details of the clones used for progeny analysis

Clone	Parentage	Country of origin
PB 217	PB 5/51 X PB 6/9	Malaysia
PB 235	PB 5/51 X PB S/78	Malaysia
PB 255	PB 5/51 X PB 32/36	Malaysia
PB 260	PB 5/51 X PB 49	Malaysia
PB 280	PBIG seedling	Malaysia
PB 310	PB 5/51 X RRIM 600	Malaysia
PB 311	RRIM 600 X PB 235	Malaysia
PB 312	RRIM 600 X PB 235	Malaysia
PB 314	RRIM 600 X PB 235	Malaysia
KRS 25	Primary Clone	Indonesia
KRS 128	PB 5/63 X KRS 13	Indonesia
KRS 163	PB 6/63 X RRIM 501	Indonesia
RRII 105	Tjir 1 x Gl 1	India

Table 2. Performance of progenies during the first year of establishment

Progeny	Height (cm)	Girth (cm)	Number of whorls
PB 217	116.78^{a}	3.10^{ab}	3.53^{bc}
PB 235	100.29^{abc}	2.72^{abcd}	3.67^{abc}
PB 255	102.67^{ab}	3.20^{a}	3.82^{ab}
PB 260	99.58^{abc}	2.70^{abc}	3.60^{bc}
PB 280	112.60^{ab}	2.99^{abc}	3.16^{bcd}
PB 310	109.84^{ab}	2.95^{bcd}	3.70^{abc}
PB 311	103.88^{ab}	2.60^{bcd}	3.52^{bc}
PB 312	103.69^{ab}	2.57^{bcd}	4.30a
PB 314	86.79^{bc}	2.54^{bcd}	3.47^{bc}
KRS 25	87.11^{bc}	2.52^{bcd}	3.04^{cd}
KRS 128	87.35^{bc}	2.45^{cd}	3.47^{bc}
KRS 163	94.39^{abc}	2.48^{cd}	3.61^{bc}
RRII 105	73.64^{c}	2.22^{d}	2.78^{d}
General Mean	**98.35**	**2.69**	**3.51**
V.R. (%)	**16.58**	**12.87**	**11.40**
C.D. (0.05)	**27.43**	**0.58**	**0.65**

Significant at $P<0.05$

Means followed by the same letters are not significantly different at 5 per cent error

Table 3. Performance of progenies for yield and vigour during the second year of establishment

Progeny	Yield (g/plant/10 tappings)	Girth (cm)	Height (m)	Number of whorls
PB 217	3.52^{cde}	6.70^{a}	2.30^{e}	8.28^{c}
PB 235	4.50^{abcd}	4.90^{d}	3.11^{bcd}	9.49^{ab}
PB 255	5.81^{ab}	9.57^{a}	3.66^{a}	9.35^{b}
PB 260	1.23^{bcd}	8.17^{b}	3.49^{abc}	9.80^{ab}
PB 280	3.36^{cde}	6.70^{e}	3.03^{cd}	8.23^{c}
PB 310	4.11^{bcd}	8.23^{b}	3.41^{abc}	10.42^{a}
PB 311	6.24^{a}	10.07^{a}	3.40^{cd}	9.77^{ab}
PB 312	4.18bcd	7.10d^{e}	3.28^{abc}	9.00^{bc}
PB 314	4.89^{abc}	7.43e^{d}	3.57^{ab}	8.17^{c}
KRS 25	2.71^{de}	7.00d^{e}	2.40^{e}	8.21^{c}
KRS 128	3.58^{ade}	8.13^{bc}	2.68^{de}	8.24^{c}
KRS 163	2.13^{e}	7.13^{de}	3.03^{cd}	9.64^{ab}
RRII 105	4.60^{abcd}	8.63^{b}	3.10^{bed}	9.50^{ab}
General Mean	**4.14**	**7.67**	**3.11**	**9.08**
V.R. (%)	**27.96**	**5.53**	**9.65**	**6.61**
C.D. (0.05)	**1.95**	**0.71**	**0.50**	**1.01**

Means followed by the same letters are not significantly different at 5 per cent error

Table 4. ANOVA for juvenile traits during the second year of establishment

Characters	Range	Mean	F value	Significant
Juvenile yield	2.13 – 6.24	4.14	2.90	**
Girth	4.90 – 10.07	7.67	30.29	**
Height	2.30 – 3.66	3.11	5.95	**
Number of whorls	8.17 – 10.42	9.08	4.93	**

** Significant at P<0.01

Table 5. Correlation between juvenile yield and growth characters

	Yield	Girth	Height
Yield			
Girth	0.579**		
Height	0.669**	0.441**	
Number of whorls	0.315*	0.344*	0.557**

* Significant at P<0.05
** Significant at P<0.01

Table 6. Performance index and percentage of superior progenies after second year of growth

Progeny	Performance Index	Per cent seedlings with above mean progeny yield
PB 217	88.46	43.59
PB 235	91.59	40.00
PB 255	124.24	68.00
PB 260	114.55	58.00
PB 280	96.28	30.23
PB 310	115.70	61.11
PB 311	125.57	60.00
PB 312	104.07	56.00
PB 314	107.37	60.00
KRS 25	90.43	31.58
KRS 128	100.58	43.48
KRS 163	101.77	33.33
RRII 105	112.46	54.50
Mean	**105.8 2**	**49.22**