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GENETIC PARAMETERS AND HETEROSIS IN RUBBER (*HEVEA BRASILIENSIS*) MUELL. ARG. IV. EARLY VERSUS MATURE PERFORMANCE OF HYBRID CLONES

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Performance of twenty three hybrid clones of rubber (*Hevea brasiliensis*) resultant of the cross of RRII 105 x RRIC 100 was evaluated during the first three years of tapping, in comparison to early performance in the immature phase of four and a half years (early phase) after field planting. The hybrid clones revealed significant clonal variation for yield and yield components *viz.*, total volume of latex per tap, rate of latex flow, dry rubber content, plugging index, girth at opening, girth increment rate on tapping, number of latex vessel rows and bark thickness, as was observed in the early phase indicating sufficient variability for selection. Significant inter-character correlations observed between yield and most of the above traits were in conformity with earlier reports. Yield in the early phase recorded a highly significant positive association of r = 0.918 with pooled yield over three years in the mature stage. Similarly highly significant early versus mature association was exhibited in the case of total volume of latex/tap (r = 0.796), rate of latex flow (r = 0.671), dry rubber content (r = 0.572), plugging index (r = 0.787), girth at opening (r = 0.651), girth increment rate on tapping (r = 0.584), number of latex vessel rows (r = 0.696) and bark thickness (r = 0.456). All the traits in the early phase with the exception of dry rubber content, girth increment rate and bark thickness revealed strong favourable associations with yield in the mature phase. Out of nine hybrid clones which were identified as having better potential for high yield on the basis of heterosis in the early phase, eight clones continued to exhibit the same trend in the mature phase too. The results are discussed with special emphasis on early detection of potential hybrid clones, causing a reduction in the yield testing period by about 6-7 years.

INTRODUCTION

Yield in rubber, as in other crop plants, is a complex multicomponent character. A clear understanding of the nature and magnitude of association between yield and its attributes is essential for any selection programme aimed at yield improvement. The present study throws light on the nature of association of rubber yield with other component characters in certain hybrid clones, both in the early as well as in the mature phases of evaluation. Early versus mature performance of the hybrid clones are discussed with special emphasis on early detection of potential clones aimed at a reduction in the period of yield testing.

MATERIALS AND METHODS

The experimental materials comprised twenty three hybrid clones resultant of the cross of RRII 105 x RRIC 100 and the respective parental clones. A small scale clone trial was laid out in a randomized block design with three replications and four plants per plot, at the Experiment Station of the Rubber Research Institute of India, Kottayam, during 1985. The plants were tapped at four and a half years after field

planting from January to December 1990 in order to evaluate the performance in the early growth phase. Yield was recorded as gram per tree per tap on all tapping days by cup coagulation followed by smoke house drying of the coagulum and subsequent weighing. The plants were opened for regular tapping during January 1993 and yield was recorded as mentioned above for a consecutive period of three years. 1/2 s d/3 system of tapping was followed both in the early and mature phases of evaluation. Observations on the following characters were recorded:

1. Dry rubber yield (Y. g/t/t. January to December)
   (1990 in the early phase and from January 1993 to December 1995 in the mature phase)
2. Total volume of latex (X1, ml/tap, bimonthly intervals)
3. Rate of latex flow (X2) ,,
4. Dry rubber content (d.r.c., X3) ,,
5. Plugging index (X4) ,,
6. Girth at opening (X5, cm)
7. Girth increment rate (X6,cm/year)
8. Number of latex vessel rows (X7, at opening and at the end of 3rd year of tapping)
9. Bark thickness (X8, mm) ,,

Variance ratios and correlations were estimated according to Panse and Sukhatme (1967). Heterosis in terms of superiority over the standard clone, RRII 105, was estimated following standard procedures.

RESULTS AND DISCUSSION

The hybrid clones displayed significant clonal variation for yield and yield attributes both in the early (Licy *et al.*, 1992) and mature stages of evaluation indicating sufficient variability for selection (Table 1). Significant clonal variations for yield and its components were reported by Mydin *et al.* (1992) in a population of forty clones of Wickham origin.

Inter-character correlations

Correlation coefficients estimated among yield and eight yield components in the mature phase are presented in Table 2. Dry rubber yield exhibited significant positive correlation with total volume of latex, rate of latex flow, number of latex vessel rows and bark thickness. Dry rubber content and girth revealed positive association with yield whereas the association of girth increment rate with yield was negative. Highly significant favourable negative association was observed in the case of correlation of plugging index with yield. Mydin *et al.* (1992) reported highly significant positive phenotypic correla-

Table 1. Range, mean and variance ratio for yield and yield attributes in hybrid clones (mature phase)

Parameters	Range	Mean	Variance ratio(F, Clones)
Dry rubber yield g/t/t	20.21 - 88.20	51.68	8.79**
Total volume of latex ml/t/t	63.65 -280.12	165.71	7.95**
Rate of latex flow	15.50 - 53.00	32.15	12.61**
Dry rubber content	27.10 - 36.74	32.13	3.97**
Plugging index	2.33 - 5.03	3.41	7.02**
Girth at opening, cm	49.04 - 62.77	53.49	2.27**
Girth increment rate on tapping, cm/yr	1.09 - 4.79	2.70	3.83**
Number of latexvessel rows 3rd yr.	9.33 - 22.00	16.92	4.13**
Bark thickness,mm, 3rd yr.	7.11 - 8.67	7.8	1.83*

* Significant at 5% level **Significant at 1% level

Table 2. Simple correlation coefficients among yield and yield componensts in hybrid clones (mature phase)

	Total volume of latex	Rate of flow	d.r.c	Plugging index	Girth at opening	Girth increment rate	No. latex vessel rows	Bark thicness
	(X1)	(X2)	(X3)	(X4)	(X5)	(X6)	(X7)	(X8)
(Y)	0.967**	0.684**	0.031	-0.672**	0.299	-0.261	0.769**	0.561**
(X1)		0.711**	-0.031	-0.691**	0.289	-0.295	0.763**	0.594**
(X2)			0.410*	-0.106	-0.114	-0.462	0.592**	0.399*
(X3)				0.498	-0.328	-0.318	0.264	-0.001
(X4)					-0.239	0.184	-0.389	-0.335
(X5)						0.276	0.294	0.268
(X6)							-0.242	-0.029
(X7)								0.605**

* *Significant at 5% level* ** *Significant at 1% level*

tion of rubber yield with total volume of latex, rate of latex flow, dry rubber content, bark thickness and girth, and highly significant negative correlation with plugging index. Narayan *et al.* (1974) reported a highly significant positive association of yield with girth, number of latex vessel rows and bark thickness and highly significant negative association with plugging index. Similar observations were reported by Tan *et al.* (1975). Ho *et al.* (1976) also reported similar supporting results both in the nursery as well as in the mature stages, in rubber. Varghese *et al.* (1993) observed a highly significant negative association of plugging index and highly significant positive association of dry rubber content with yield in juvenile seedlings. The negative relationship of girth increment rate on tapping, with yield suggests that once the tree is under tapping, more of the metabolites are channeled towards latex formation and less towards girthing and hence the decrease in girthing rate. The importance of girth increment rate on tapping was well documented by Premakumari (1992). Significant positive association of yield with anatomical parameters and latex flow characteristics reported by Premakumari (1992) are in agreement with the present findings.

The inter-character correlations estimated for yield components revealed that total volume of latex per tap, rate of latex flow, plugging index and number of latex vessel rows are significantly associated with one another. It indicates the possibility of simultaneous improvement of these traits by selection. This in turn will improve yield since they exhibit significant favourable association with yield.

Early versus mature character correlations

Early versus mature correlations for yield and the eight traits under study are presented in Table 3a and 3b. Early versus mature inter-character correlations revealed that dry rubber yield in the early phase had strong and significant favourable association with most of the characters in the mature phase. Similar trend was observed in the case of association of mature yield with most of the early characters (Table 3a).

Association of all the characters in the early phase with the same characters in all the three consecutive years of the mature phase were highly significant and promising (Table 3b) indicating possibility of a more reliable selection of potential clones in the early phase ie. 6-7 years earlier than the conventional period. This also suggests that performance of potential clones can be confirmed in the first year of tapping itself. Premakumari *et al.* (1989) obtained a correlation coefficient of r = 0.55 between immature yield and yield of trees under first year of regular tapping in a seedling population. Alika

(1980) reported very high positive correlation (r = 0.92) between 1st and 2nd year mature yields with a gradual drop in magnitude with yields of later years. Positive correlation at 5% level of significance between nursery yield and small scale clone trial yield was observed by Ong *et al.* (1985) in a population resultant of hand pollinations. Tan (1978) suggested that selection

Table 3a. Early versus mature character correlations for yield and yield components in hybrid clones

	Mature characters								
	Mean over 3 years							3rd year of tapping	
	Y	X1	X2	X3	X4	X5	X6	X7	X8
Dry rubber yield (Y)	0.918**	0.877**	0.530**	-0.157	-0.724**	0.391*	-0.296	0.696**	0.443*
Total volume of latex (X1)	0.872**	0.844**	0.461*	-0.131	-0.727**	0.289	-0.357	0.620**	0.383
Rate of latex flox (X2)	0.827**	0.821**	0.718**	0.182	-0.449*	0.115	-0.517**	0.695**	0.427*
Dry rubber content (X3)	-0.213	-0.216	0.202	0.541**	0.493*	-0.253	-0.151	-0.083	-0.298
Plugging index (X4)	-0.555**	-0.529**	0.088	0.416*	0.829**	0.222	0.315	-0.271	-0.095
Girth at opening (X5)	0.175	0.199	-0.084	-0.413*	-0.234	0.651**	0.102	-0.014	0.172
Girth increment rate (X6)	-0.433*	-0.411*	-0.503*	-0.275	0.324	0.465*	0.999**	-0.349	-0.071
No.of latex vessel rows (X7)	0.466*	0.474*	0.371	0.154	-0.138	0.404*	0.106	0.556**	0.449*
Bark thickness (X8)	-0.393	-0.317	-0.414*	-0.521**	0.120	0.200	0.322	-0.407*	0.209

*Significant at 5% level **Significant at 1% level

Table 3b. Yearwise early versus mature correlations between nine characters in hybrid clones

Character pairs	1st year of tapping	2nd year of tapping	3rd year of tapping	Mean over 3 years
Early Y Vs mature Y	0.913**	0.918**	0.811**	0.918**
,, X1 Vs ,, X1	0.796**	0.881**	0.709**	0.844**
,, X2 Vs ,, X2	0.671**	0.741**	0.567**	0.718**
,, X3 Vs ,, X3	0.572**	0.392*	0.478*	0.541**
,, X4 Vs ,, X4	0.787**	0.846**	0.612**	0.829**
,, X5 Vs ,, X5	0.651**	—	—	—
,, X6 Vs ,, X6	0.584**	0.582**	0.701**	0.999**
,, X7 Vs ,, X7	0.696**	—	0.556**	—
,, X8 Vs ,, X8	0.456*	—	0.209^{NS}	—

* Significant at 5% level ** Significant at 1% level

Y - Dry rubber yield X1 - Total volume of latex X2 - Rate of latex flow

X3 - Dry rubber content X4 - Plugging index X5 - Girth at opening

X6 - Girth increment rate on tapping X7 - No. of latex vessel rows (3rd year) X8 - Bark thickness (3rd year)

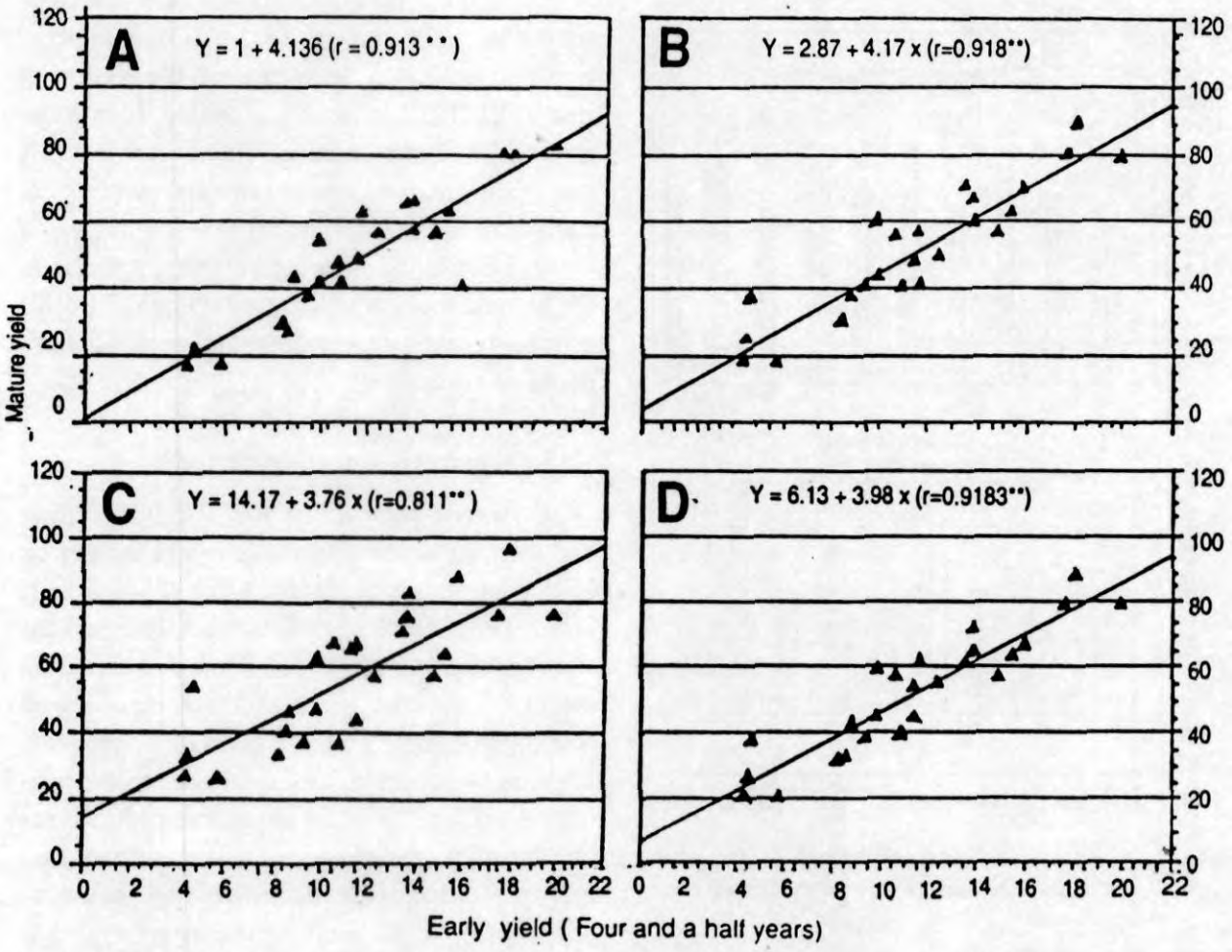

Fig.1. Relationship between early yield and first year mature yield (A) second year mature yield (B) third year mature yield (C) and mean over three years (D) in hybrid clones of *Hevea brasiliensis* (Yield in g/t/t)

based on early mature yield would be more effective than nurseryyield. Based on the early performance of the present population under study, Licy *et al.* (1990) predicted the possible chance of gaining potential hybrid clones from among them (which were to be confirmed in the mature phase) that would result in shortening the testing period by about 6 -7 years. In the present investigation the highly significant positive association of early yield and yield attributes with those of first and subsequent years of tapping suggests more possibilities of reliable selection based on early performance thus confirming the earlier predictions. (Table 3b). Scrutiny of regression of mature yield (yearwise) on early yield revealed that early yield could be considered as a fair predictor of mature yield (Fig.1 A-D).

Heterosis

Comparison of hybrid clones with the best ones among the released varieties is more important than their performance above their parents. Hence estimation of standard heterosis is given importance in the present study. Significant heterotic response for yield and yield attributes in the population under study was observed in the early phase of 4 1/2 years by Licy *et al.* (1992). Very high estimates of heterosis for latex yield in certain hybrid progenies of *Hevea* was observed by Olapade (1988). Early evaluation of the 23 hybrid clones under study resulted in the identification of 15 clones having heterotic improvement for yield over the standard clone RRII 105 (Licy *et al.*, 1992). Based on a critical evaluation of yield and yield

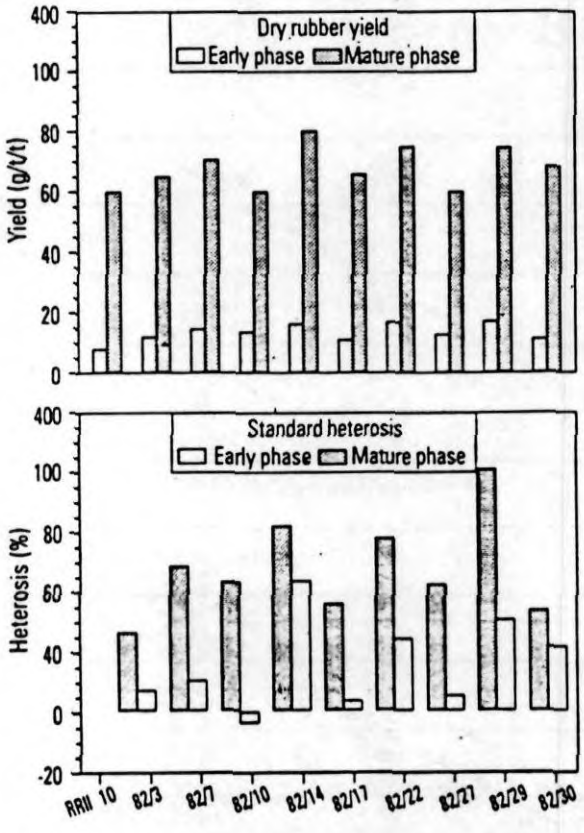

Fig.2. Dry rubber yield and standard heterosis during early and mature phases in hybrid clones of *Hevea brasiliensis*

components in the early phase, from among the 15, nine clones namely 82/3, 82/7, 82/10, 82/14, 82/17, 82/22, 82/27, 82/29 and 82/30 were identified as having better potential for yield with a minimum of above 35 per cent yield improvement over RRII 105 (Fig. 2). These clones were put for testing in the further stage of evaluation during 1993 for further large scale evaluation. Eight out of these 9 clones continued to exhibit their superiority over RRII 105 in the mature phase too, though with a decrease in the magnitude of heterotic increase and were confirmed to be promising. This holds good especially in the case of three clones *viz*, 82/14, 82/22 and 82/29 which were confirmed to be top rankers and significantly superior to RRII 105 in the mature phase also (Fig. 2). Clone 82/10 though performed slightly lower than RRII 105 was found to be statistically on par.

In the context of the possible hazards of monoclonal planting of RRII 105, any alternative clone having at least comparable yield with that of RRII 105 is highly desirable. Identification of the above potential clones satisfies this need to a great extent. All the above observations lead to the inference that a fair degree of early selection of superior heterotic hybrids in the immature phase will definitely hold the most promising ones to be selected after the mature phase of evaluation.

Reduction in yield testing period

Hevea brasiliensis has a long breeding and selection cycle and reduction in the period of evaluation is a necessity (Alika 1980; Gilbert *et al.*, 1973; Tan 1979). In rubber, the conventional method of direct selection was based on the first five years' yield and now it is viewed that the first three years' yield data is adequate for selecting superior clones to shorten the testing time (Ong, 1980; Swaminathan, 1975). Inclusion of all the above nine clones (based on early performance) in the further stage of evaluation during 1993 itself, without prolonging it for a further period of five years to get a confirmatory performance over the first five years of tapping, as is the case with the conventional practice, has helped in saving around 6 to 7 years yield testing period, in the small scale clone trial.

Inspite of creditable improvement in productivity within a short span of time, theoretical conclusions indicate more potential in terms of yield (Sethuraj, 1981). The encouraging results of the present investigation suggest further scope of exploitation of heterosis for crop improvement in rubber.

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