Indian J. Genet., **51** (3): 281–285 (1991)

GENERAL AND SPECIFIC COMBINING ABILITIES FOR LATEX YIELD IN *HEVEA BRASILIENSIS*

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(Received: May 23, 1990; accepted: August 4, 1990)

ABSTRACT

The yield of ten *Hevea* progenies derived from hand pollination in a set of 5 x 5 diallel crosses was analysed for combining ability. General combining ability variance (gca) and specific combining ability (sca) variances were highly significant. The gca : sca ratio was 1:2. Two parental clones, PR 107 and RRIM 628, were identified as general combiners with PR 107 being more suitable for the production of synthetic clones.

Key words: Combining ability, diallel cross, *Hevea brasiliensis*, clone, progenies.

The introduction of improved *Hevea* clones into Nigeria from Malaysia and Srilanka in the sixties, led the replacement of the existing low yielding *Hevea* genotypes and served as the new parental breeding stock.

The synthesis of hybrid clones by intermating these improved clonal material have resulted in the development of hundreds of hybrid progenies, some of which have spectacular yield improvement over the parental stock.

In *Hevea* breeding, there is a life cycle of about 15 years from hand pollination to clonal evaluation and selection [1]. This factor, coupled with the reported low heritability values for latex yield, calls for the adoption of selection differentials [1–4]. The present knowledge on the nature of gene action and inheritance of latex yield is very scanty. Progeny testing for significant combining ability was suggested [5]. This study is expected to throw light on combining ability for latex yield and the choice of better parents among the parental stock materials for future exploitation.

MATERIALS AND METHODS

Five parental *Hevea* clones from the genetic stocks imported and planted at the Rubber Research Institute of Nigeria (RRIN) were selected on the basis of the fitness of their progenies into the diallel mating design. The 10 progenies excluding reciprocals and parents formed the population for combining ability analysis by Griffings Method 4, Model 1.

The parental clonal materials were RRIM 501, RRIM 628, PR 107, RRIM 600 and PB 5/51. The 10 progenies of the resultant diallel cross shown in Table 1 were planted among others in single unreplicated plots of 9 trees in each progeny per plot, at a spacing of 5.5 m within and between plots. The trees were tapped on a half spiral alternate-day tapping system, that is, 14 times per month for 11 months each year as tapping was not done in February. Thus, a total of 154 tappings were done per year. Sampling was done twice each month on plot basis and the dry latex yield expressed in kg/ha/yr. The mean of 7-year yield data collected during 1980–86 was used for these analyses.

RESULTS AND DISCUSSION

The mean dry latex yield figures for each of the ten hybrid progenies is presented in Table 1.

The observed mean squares from the analysis of variance for latex yield are presented in Table 2. It showed that significant differences exist among the progenies of diallel crosss.

The analysis of variance for combining ability is presented in Table 3.

Table 1. Mean latex yield figures for 10 hybrid progenies of a 5 x 5 diallel cross (kg/ha/yr)

Parents	RRIM 628	PR 107	RRIM 600	PB 5/51
	(C162)	(C164)	(Ci)	(Cii)
RRIM 501	3526.1	2808.2	2336.6	2216.3
RRIM 628		(Ciii)	(Civ)	(Cv)
		2756.1	2416.8	2517.4
PR 107			(C83/NIG 801)	(C 257)
			3715.1	2937.8
RRIM 600				(C232)
PB 5/51				2620.6

*Figures in parentheses are identification numbers of each progeny.

The results show that both general (gca) and specific combining ability (sca) are highly significant, the ratio of gca:sca is 1:2, implying slightly greater importance of sca than gca in yield inheritance.

The estimates of the average performance of each parental line used in the crosses are presented in Table 4.

Estimates of specific combining ability effects are presented in Table 5.

Table 2. Analysis of variance from latex yield

Source	d.f.	Mean squares
Progenies	9	1704957.2**
Years	6	976744.2
Error	54	486650.1

**Significant at 1% level.

The estimates of gca and sca variances (σ^2_{gi} and σ^2_{si}) associated with each parent and environmental variances on individual and mean basis (σ^2_e and σ^2) are presented in Table 6.

Table 3. Mean squares from combining ability analysis for latex yield

Source	d.f.	Mean squares	F ratio
General combining ability (gca)	4	162643.5**	21.0
Specific combining ability (sca)	5	309414.5**	40.0
Error	54	7724.6	
Gca: sca ratio			1.2

**Significant at 1% level.

The partitioning of the variations among the progenies to those due to combining ability effects, revealed significant differences in general and specific combining abilities. Comparison of the relative magnitudes of mean square values of gca and sca indicate that the sca or nonadditive genetic variance is more important in causing the observed variations in latex yield than gca or additive genetic variance (Table 3). This result is in agreement with our earlier claim that sca contribute significantly to the improvement of growth characteristics in *Hevea* [5]. The overall performance of a clone/progeny in terms of yield will therefore depend on the different genetic combinations and gene actions that will ensure, among others, good growth characteristics for optimum physiological processes of metabolism.

Table 4. Estimate of general combining ability effects ($\hat{g}i$) for latex yield

Parent	($\hat{g}i$)
RRIM 501	–84.4
RRIM 628	+ 25.3
PR 107	+ 358.9
RRIM 600	–17.1
PB 5/51	–282.8
SE ($\hat{g}_i$–$\hat{g}i$)	71.8

The estimate of $\hat{g}i$ effects (Table 4), showed that clone PR 107 is the best general combiner, followed by RRIM 628. The estimates of variances (Table 6) indicate that PR 107 had a lower sca variance than RRIM 628. This implies that PR 107 transmits its high yielding trait more uniformly into its progenies than RRIM 628.

The clone PR 107 will, therefore, be the best for development of a synthetic clone. This may explain why the cross PR 107 x RRIM 600 produced the highest yielding clone (C83/NIG 801). This progeny (C83) was earlier selected as one of the highest yielding among 130 clones evaluated in 1982 and it was named NIG 801 [2].

The very higher sca variances of RRIM 628 (Table 6) imply that the clone will transmit its high yielding potential only in certain crosses. This may also explain why the progeny C162 was the second best yielder among the ten progenies, while the cross PR 107 x RRIM 628 (both parents with positive ($\hat{g}i$) effects) failed to produce the highest yielding progenies.

Although the parental latex yields were not expressed in these analyses, yield figures obtained for the progenies of the crosses PR 107 x RRIM 600 (C83/NIG 801) and RRIM 501 x RRIM 628 (C162) were clear manifestation of heterosis. This may dispel the claim of narrow genetic base in *Hevea* as a hindrance to yield improvement [1, 6].

Table 5. Estimate of specific combining ability ($\hat{S}ij$) effects for latex yield

Parents	RRIM 628	PR 107	PRIM 600	PB 5/51
RRIM 501	800.0	–252.0	–347.0	–201.6
RRIM 628		–413.3	–376.5	–10.2
PR 107			558.1	76.5
RRIM 600				135.3
PB 5/51				

SE ($\hat{S}ij$–$\hat{S}ik$) = 101.5, SE ($\hat{S}ij$–$\hat{S}kl$) = 71.8.

The variability in the mode of character transmission from clone to clone as revealed by this study is also in agreement with our earlier claim of the presence of sufficient genetic variability in *Hevea* population, which need to be exploited. Vegetative propagation of the promising *Hevea* progenies, which displayed heterosis, is another advantage in this crop.

Higher and significant sca variance than gca variances obtained in this study suggest a higher nonadditive gene action than additive gene action. It therefore calls for stringent pressure in the selection of parents in the breeding programmes aimed at the improvement of latex yield in *Hevea*. It is also possible to exploit heterosis by taking advantage of vegetative propagation now in common practice.

Table 6. Estimates of σ^2_{gi}, $\sigma^2 si$, σ^2_e and σ^2

Parent	Gca (σ^2_{gi})	Sca (σ^2_{si})	Individual (σ^2_e)	Mean (σ^2)
RRIM 501	5063.5	282,955.2	486650.1	7,724.6
RRIM 628	–1418.3	312418.3	486650.1	7,724.6
PR 107	126778.0	109109.6	486650.1	7,724.6
RRIM 600	–1767.5	199497.8	486650.1	7,724.6
PR 5/51	77,893.3	16496.7	486650.1	7,724.6

ACKNOWLEDGEMENTS

The author is grateful to Dr. E. K. Okaisabor, Director, RRIN, for his support in carrying out this study. The contributions of the Plant Breeding Staff in data collection, particularly, W. E. Momoh and S. E. Arasomwan, is highly appreciated.

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