Indian J. Nat. Rubb. Res. 2 (2): 99-104, 1989

EVALUATION OF SEEDLING PROGENIES OF MALE STERILE CLONES OF *HEVEA BRASILIENSIS* (WILLD. EX ADR. DE JUSS.) MUELL. ARG. AT THE NURSERY STAGE

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Saraswathy Amma, 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 J. Nat. Rubb. Res. 2(2): 99-104.

Seedling progenies of three male sterile clones (GT 1, Ch 2, and RRII 35), along with progenies of a fertile clone (Mil 3/2) as standard, of *Hevea brasiliensis* were evaluated in the nursery. Seeds from the male sterile clones recorded early and higher percentage of germination. The progenies of the male sterile clones were more vigorous compared to the control. Test tapping yield also indicated the superiority of the progenies of male sterile clones. The male sterile clones recorded higher heritability along with higher genetic advance indicating additive gene action. They also had higher general combining ability. Among the male sterile clones, GT 1 showed significant superiority over the others.

Key words.—Male sterility, Genotypic variation, Phenotypic variation, General combining ability, Juvenile yield, *Hevea.*

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INTRODUCTION

Ortet selection is an important method of tree improvement in *Hevea brasiliensis* (Willd. ex Adr. de Juss.) Muell. Arg., the commercial source of natural rubber. In nature, the species is propagated through seeds and these were the propagules used during the early years of the plantation industry. The position, however, changed rapidly with the perfection of a budgrafting technique for vegetative propagation, by Van Helten in 1917. Seeds, however, constitute a reservoir of genetic variability, which is made use of in identifying superior genotypes through ortet selection. In the course of cytological screening of different selections, male sterility was observed in three clones (Saraswathy Amma *et al.*, 1988). Evaluation of the performance of seedling progenies of these clones was attempted at the nursery stage and the results are discussed in this communication.

MATERIALS AND METHODS

Three male sterile-clones, GT 1, Ch 2 and RRII 35 (D 15) and a fertile clone Mil 3/2 of *Hevea brasiliensis* (Willd. ex Adr. de Juss.) Muell. Arg. were selected for the study. All the male sterile clones as well as the control are ortet selections. Of these, three are exotic clones and RRII 35 is indigenous. Mature dry fruits resultant of open pollination were collected. The seeds were taken out by opening the fruits and sown in germination beds. The rate of germination was assessed from the seventh day onwards upto the nineteenth day. Utilizing the seeds which sprouted from the seventh to the thirteenth

day of sowing, a nursery was established adopting randomised block design with five replications of forty seedlings per plot. The planting was done at a spacing of 30 cm between plants in four rows of ten seedlings each, the distance between rows also being 30 cm. Observations were recorded from the sixteen inner plants in each plot. Height and girth of the seedlings were recorded at 12 and 24 months of growth. At the age of 30 months, test tapping was done adopting half spiral alternate daily ($\frac{1}{2}$S d/2 6d/7) system and yield recording carried out. This was repeated during two subsequent quarters also. Secondary characters like girth and bark thickness were also recorded. The data were subjected to statistical analysis (Panse and Sukhatme, 1957). The analysis of variance provided separate estimates for genotypic σ^2 g and environmental components of variance σ^2 e. The phenotypic variance σ^2 p was obtained by addition $\sigma^2 p = \sigma^2 g + \sigma^2 e$. The genotypic and phenotypic coefficients of variation were computed as:

Phenotypic coefficient of variation

$$C.V.p\ (x) = \frac{\sigma\, p\,(x) \times 100}{\bar{x}}$$

Genotypic coefficient of variation

$$C.V.g\ (x) = \frac{\sigma\, g\,(x) \times 100}{\bar{x}}$$

Heritability, combining ability and genetic advance were calculated following the methods suggested by Singh and Chaudhary (1979).

RESULTS

All the three male sterile clones were good seed bearers. The data on germination of seeds are given in Table 1. Compared to the seeds of the control, Mil 3/2, the seeds from the male sterile clones recorded early germination as well as higher percentage of germination. The male sterile clones RRII 35, Ch 2 and GT 1 recorded 84, 87 and 95 per cent germination respectively whereas, the control showed only 70 per cent germination.

The growth attributes of the progenies from the male sterile and the control clones are depicted in Table 2. All the progenies of male sterile clones recorded significantly more height and girth compared to those of the control during the first year. During the second year also, the male sterile clones

Table 1. **Germination of open pollinated seeds of male sterile and control clones of** *Hevea brasiliensis*

Days after sowing	GT 1	Ch 2	RRII 35	Mil 3/2
Seventh day	321	255	120	5
Tenth day	400	84	220	80
Thirteenth day	100	24	200	200
Sixteenth day	45	60	150	100
Nineteenth day	50	9	40	120
Total seeds germinated	916	432	730	508
Percentage of germination	95.32	87.09	83.91	70.06

Table 2. **Growth attributes of the seedling progenies of male sterile clones and control (mean values)**

Sl. No.	Treatment	at 12 months		at 24 months	
		Height (cm)	Girth (cm)	Height (cm)	Girth (cm)
1.	GT 1	190.10	6.58	318.14	9.03
2.	Ch 2	180.42	6.39	286.51	8.10
3.	RRII 35	169.44	5.64	316.45	8.72
4.	Mil 3/2	149.11	4.43	206.86	5.53
	SE:	5.80	0.29	7.87	0.31
	CD:	17.87	0.89	24.24	0.95

Table 3. **Juvenile yield and secondary characters of seedling progenies of male sterile clones and control (mean values)**

Clones	January – February			June – July		October – November		
	Height (cm)	Girth (cm)	Yield g/tree/tap	Girth (cm)	Yield g/tree/tap	Girth (cm)	Bark thickness (mm)	Yield g/tree/tap
GT 1	489.60	13.93	0.3940	18.05	0.5711	21.38	4.08	1.3820
Ch 2	430.10	12.97	0.3485	17.48	0.5195	20.78	3.50	1.1893
RRII 35	495.23	13.57	0.3554	19.07	0.4496	22.87	3.62	0.9054
Mil 3/2	449.27	10.93	0.1901	15.83	0.1469	18.70	3.27	0.4397
SE	N.S.	0.44	0.04	0.61	0.05	0.80	0.17	0.09
CD	N.S.	1.34	0.12	1.84	0.15	2.40	0.51	0.28

recorded the same trend. With regard to height at 30 months, there was no significant difference among the treatments (Table 3). For all the other parameters significant differences were noted among the treatments. In the case of yield on test tapping, the progenies of the male sterile clones performed better than the control.

Genetic parameters of growth attributes and juvenile yield are given in Table 4. The difference between genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) is wider for yield, compared to other characters. Heritability for height and girth was more during the first and second years. After two and a half years, the heritability for height was very low (24 per cent). Heritability was found to be high for yield during three years' growth. The general combining ability (GCA) of the four clones is given in Table 5. GCA for the male sterile clones was more compared to that for the control except for girth at three and a half years.

DISCUSSION

In the male sterile clones there is no chance for self fertilisation as the pollen produced is

Table 4. **Genetic parameters of growth attributes and juvenile yield of seedling progenies of male sterile clones**

Age	Characters	General mean	PCV	GCV	h^2	GA
1st year	Height (cm)	172.27	12.23	9.64	0.62	26.97
	Girth (cm)	5.76	17.22	16.84	0.95	6.23
2nd year	Height (cm)	281.99	19.16	18.29	0.90	100.99
	Girth (cm)	7.85	21.78	19.87	0.84	2.94
After 2½ years	Height (cm)	458.55	9.05	4.45	0.24	20.68
	Girth (cm)	12.85	12.99	9.81	0.57	1.97
	Yield (g/tree/tap)	0.322	37.50	25.63	0.43	0.11
After 3 years	Girth (cm)	17.61	6.87	10.91	0.39	1.56
	Yield (g/tree/tap)	0.4308	148.84	120.93	0.66	0.28
After 3½ years	Girth (cm)	20.93	11.85	7.31	0.38	1.95
	Bark thickness (mm)	3.60	14.17	8.33	0.34	0.36
	Yield (g/tree/tap)	0.9800	46.94	40.82	0.75	0.71

Table 5. **General combining ability**

Characters	Age (years)	GT 1	Ch 2	RRII 35	Mil 3/2
Height	1	17.83	8.15	—2.83	—23.16
Girth	1	2.62	1.99	—0.38	—4.23
Height	2	36.14	4.52	34.46	—75.13
Girth	2	1.19	0.25	0.88	—2.31
Height	2	31.05	28.45	6.68	—9.28
Girth	2½	0.07	0.02	0.03	—0.13
Yield	2½	0.14	0.08	0.01	—0.24
Girth	3	0.44	—0.12	1.46	—1.23
Yield	3	0.14	0.08	0.01	—0.24
Girth	3½	0.44	—0.15	1.93	2.23
Bark thickness	3½	0.46	—0.11	0	—0.35
Yield	3½	0.87	—0.21	0.40	—0.53

totally sterile. Hence the seeds collected are hybrid seeds. In the control, since the male and female flowers are fertile, there is chance for self pollination. The seeds from the male sterile clones recorded higher percentage of germination compared to those from the control. The vigour of the progenies of male sterile clones was also significantly more compared to that of the control. In the case of juvenile yield also the seedlings from the male sterile clones showed superiority over the control. However, the progenies of male sterile clones were not found to be superior to control with regard to plant height at 30 months (Table 3). Among the three male sterile clones studied, GT 1 is significantly superior to Ch 2 and RRII 35 in all the growth attributes. The progenies of GT 1 were reported to be superior in vigour in the nursery stage (Saraswathy Amma *et al.*, 1984). The inferiority in growth and juvenile yield exhibited by the seedling progenies of the control clone Mil 3/2 may be due to the effect of self pollination. However, selected progenies from all male sterile clones demand detailed evaluation.

Since the difference between GCV and PCV is more on yield, profound environmental influence is implied. High genotypic variance and high heritability indicate the involvement of additive gene action for these characters. The response of selection is expected to be the best in crosses involving parents having high GCA effects (Singh and Singh, 1976). Among the three male sterile clones studied, GT 1 is showing comparatively higher GCA and this clone is a high yielding one with desirable characters. Gill *et al.* (1973) indicated that high yielding plants usually have high GCA.

Effective improvement by selection within a population depends on the presence of sufficient additive genetic variation. Progeny testing allows an accurate estimate of genetic value of each established clone and those that produce poor progeny could be eliminated. In other words, progeny tests are important to assess genetic variability (Farmer, 1970). Eldridge (1978) suggested individual tree selection among open pollinated seed source in *Eucalyptus* as a method for genetic improvement. In forest trees, the information from progeny test is used for predicting the genetic gain from seed orchards (Krusche *et al.*, 1980; Sniezko and Zobel, 1988). In *Hevea*, seedling vigour and juvenile yield are considered for selection (Tan, 1978b, 1981). Tan (1978 a) found some of the high GCA parents obtained from 2–3 year old seedlings to be in the high GCA parental group in the mature stage. Ng *et al.* (1982) reported that crossed seeds are better than monoclonal seeds in *Hevea*. Girth and juvenile yield which are showing high heritability (h^2), genetic advance (GA) and GCA can be useful for early evaluation in seedling progenies. Since all the three male sterile clones are good seed bearers these can be utilised for seed gardens. Clones showing total male sterility can also be incorporated in designing two clone breeding gardens.

ACKNOWLEDGEMENT

The authors are grateful to Dr. M. R. Sethuraj, Director of Research, Rubber Research Institute of India for providing necessary facilities and Dr. K. C. George, Professor and Head, Department of Statistics, College of Veterinary and Animal Sciences, Kerala Agricultural University for analysing the data.

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