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YIELD AND GROWTH OF HYBRIDS EVOLVED FRO CROSSES BETWEEN THE POPULAR CLONE RRII 10 AND WILD GERMPLASM IN RUBBER (*HEVEA BRASILIENSIS*(Willd. ex Adr. de Juss) Muell. Arg.

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ABSTRACT

The Rubber Research Institute of India maintains a large germplasm collection consisting of domesticated and wild accessions. Efforts on conservation, evaluation and utilization of wild germplasm received from the 1981 expedition to Brazil undertaken by the International Rubber Research and Development Board (IRRDB) is in progress. Accessions showing potential for important secondary traits such as girth, number of latex vessel rows, bark thickness, tolerance to biotic and abiotic stress have been identified and incorporated in breeding with potential Wickham clones from 1990 onwards with the intention of broadening the narrow genetic base of cultivated rubber and also towards developing location specific clones for cultivation in the marginal and non-traditional areas in India.

This paper summarizes the performance of 17 hybrid clones of *Hevea brasiliensis* resultant of 1990 hand pollination programme, incorporating wild germplasm for the first time in breeding in India. The characters studied were yield performance of the clones in a small scale trial over a period of 7 years, yield in the peak and summer season, mean girth at opening and in the fifth year of tapping, girth increment in the immature and mature phase, bark characters such as bark thickness and number of latex vessel rows at the time of opening the trees for tapping, important diseases and damages caused by wind. Mean yield over seven years of the hybrid clones ranged from 7.13 g/t/t to 45.00 g/t/t. The clone 90/274 recorded the highest yield. The control clone RRII 105 exhibited 46.22g/t/t. Mean girth at opening ranged from 29.14 cm in 90/88 to 56.04 cm in 90/274. Girth increment in the immature phase ranged from 3.64 cm in 90/88 to 7.01 cm in 90/274. In the mature phase it ranged from 1.24 cm in 90/97 to 3.58 cm in 90/55. Bark anatomical studies revealed that there is clonal variation. Total bark thickness ranged from 5.47 mm in 90/88 to 7.29 mm in 90/92. Latex vessel rows ranged from 5.78 in 90/102 to 15.28 in 90/97. Incidence of major diseases and wind damages in general were low. Among the seventeen hybrid clones ten clones showed heterosis

over the standard variety RRII 105 with respect to girth at opening and standard heterosis percentage ranged from 12.65 to 30.26 and it was highest in clone 90/274 (30.26 %). Heterosis over mid parent value with regard to yield and girth were worked out. Five clones *viz.* 90/55, 90/277, 90/109, 90/102 and 90/274 showed heterosis in yield over the mid parent value and it ranged from 10.95 % in 90/55 to 41.96 % in 90/274 and the same clones showed heterosis with respect to girth and it ranged from 12.67 to 42.45 %. These clones showed better secondary characters also, hence these five clones *viz.* 90/55, 90/102, 90/109, 90/277, and 90/247 were selected for the next phase of evaluation.

Key words: Biotic/ abiotic stresses, Conservation, Girth increment, *Hevea brasiliensis*, Latex vessel rows, Wild germplasm.

INTRODUCTION

The Rubber plantation industry occupies an important position in the economy of this country as it provides the principle raw material for the manufacture of a variety of products which are indispensable in modern life. The Rubber Research Institute of India (RRII) has been evolving new clones of rubber through breeding and selection from 1955 onwards. Over 127 clones evolved in other rubber producing countries like Malaysia, Indonesia, Sri Lanka, Thailand, China and Ivory Coast have been introduced to India and selected clones from this collection were used in hand pollination programmes which led to the release of some very successful cultivars as RRII 105, RRII 414, RRII 417, RRII 422 and RRII 430(Nair and Panikkar, 1966; Nair and George, 1968; Nazeer *et al.*, 1986, Licy *et al.*, 1992; Mydin *et al.*, 2005). Since rubber cultivation has been extended to non traditional areas i.e. in the north eastern states of India, producing location specific clones with resistance to drought and cold conditions also has become a major aim of breeding. Therefore steps were taken for introducing wild germplasm into the breeding pool even though wild accessions are generally low rubber yielders. Currently a total of 4548 wild germplasm accessions collected during 1981 IRRDB-EM BRAPA expedition to the centre of diversity in Brazil were introduced to India during 1984–1990 and are being conserved at RRII for characterization, evaluation and utilization in a phased manner. They were collected from three provenances in Brazil *viz.* Acre (AC), Rondonia (RO) and Mato Grosso (MT). By systematic screening, accessions with desirable agro morphologic traits have been selected (Abraham *et al.*, 2000; Mercy *et al.*, 1995) for utilization and these were used in crossing from 1990 onwards. This paper summarises the performance of 17 hybrid clones of *Hevea brasiliensis*, resultant of 1990 hand pollination programme incorporating wild germplasm for the first time in breeding in India.

MATERIALS AND METHODS

The materials used in this study included 17 hybrid clones, the selected progenies of Wickham x Amazonian hybridization programme done in 1990 along with the parents. The parents used in this study were the most popular Wickham clone RRII 105 as female parent and six accessions *viz.* RO 24, RO 26, RO 34, RO 87, RO 132 and MT 196 from wild germplasm as male parents. The

hybrid clones, the progenies of seven cross combinations were evaluated in a small scale trial at the Central Experimental Station of RRII at Chethackal, near Ranny in Central Kerala. The clones and their parentage are given in Table. 1. The trial was laid out in 1995, employing randomized block design with three replications and four plants per plot with clone RRII 105 as control. The trees were opened for tapping during the eighth year of planting and the tapping system followed was S/2 d/3 6d/7 and yield were recorded at fortnightly intervals by cup coagulation method. Mean annual dry rubber yield, dry rubber yield during the stress period (February – May) and peak yielding period (October – January) were computed separately. The girth of the trees was recorded annually from the third year of planting on wards and was used to determine the tappability of clones and girth increment rate during the pre-tapping and tapping phase. Bark samples were collected at the time of opening, at a height of 150cm and the number of latex vessel rows was counted by microscopic observation of thin sections stained with Sudan IV. Incidence of diseases and damages caused by wind were assessed. The data on yield, girth, bark thickness and latex vessel rows were statistically analysed.

Table 1. Details of clones evaluated

Sl. No.	Clone	Parentage	Sl. No.	Clone	Parentage
1.	90/55	RRII 105 x RO 34	10.	90/136	RRII 105 x RO 24
2.	90/277	RRII 105 x RO 34	11.	90/102	RRII 105 x RO 24
3.	90/72	RRII 105 x RO 26	12.	90/140	RRII 105 x MT 196
4.	90/104	RRII 105 x RO 87	13.	90/274	RRII 105 x MT 196
5.	90/107	RRII 105 x RO 87	14.	90/88	RRII 105 x RO 132
6.	90/109	RRII 105 x RO 87	15.	90/92	RRII 105 x RO 132
7.	90/129	RRII 105 x RO 24	16.	90/94	RRII 105 x RO 132
8.	90/130	RRII 105 x RO 24	17.	90/97	RRII 105 x RO 132
9.	90/132	RRII 105 x RO 24			

RESULTS AND DISCUSSION

Yield of clones

Performance of clones with respect to yield is given in Table 2. Mean yield over seven years of the hybrid clones ranged from 7.13 g/t/t to 45.00 g/t/t. The clone 90/274 recorded the highest yield (45.00 g/t/t). The control clone RRII 105 exhibited 46.22g/t/t. During the peak yielding period, RRII 105 showed the highest yield of 72.01 g/t/t followed by 90/109 (66.32 g/t/t). In the summer season 90/109 recorded the highest yield (46.07g/t/t) followed by 90/55 (44.21 g/t/t). The control clone RRII 105 recorded only 29.23g/t/t in the summer season. Other clones which showed high summer yield were 90/129 and 90/274 with 40.40 g/t/t and 37.98 g/t/t respectively. High summer yield can be taken as an indication of drought tolerance, which was evident in the clone 90/109, the clone significantly superior for RRII 105.

Growth parameters

Growth parameters are given in Table 3. Mean girth at opening ranged from 29.14 cm in 90/88 to 56.04 cm in 90/274. In the seventh year of tapping mean girth ranged from 38.17cm in 90/88 to 76.25cm in 90/55. Girth increment in the mature phase ranged from 3.64 cm in 90/88 to 7.01 cm in 90/274 and in the mature phase it ranged from 1.24 cm in 90/97 to 3.58 cm in 90/55. In all the clones above 50 percent of the trees attained tappable girth at opening.

Table 2. Yield performance of clones

Sl. No.	Clone	Mean yield over 7 yrs (g/t/t)	Yield peak period (g/t/t)	Yield stress period (g/t/t)	Sl. No.	Clone	Mean yield over 7 yrs g/t/t)	Yield peak period (g/t/t)	Yield stress period (g/t/t)
1.	90/55	29.88	65.24	44.21	13.	90/274	45.00	46.02	37.98
2.	90/277	24.47	27.19	27.02	14.	90/88	11.02	26.25	19.17
3.	90/72	7.13	12.61	10.54	15.	90/92	16.13	27.60	28.27
4.	90/104	18.96	25.57	27.54	16.	90/94	21.98	46.69	26.74
5.	90/107	14.32	28.92	23.53	17.	90/97	12.88	22.16	14.17
6.	90/109	34.68	66.32	46.07	18.	RO 24	14.57	23.27	34.52
7.	90/129	28.49	48.98	40.40	19.	RO 26	6.86	13.75	18.33
8.	90/130	25.06	53.28	33.47	20.	RO 34	7.63	21.39	17.30
9.	90/132	27.86	65.73	32.94	21.	RO 87	11.10	21.94	23.49
10.	90/136	21.29	39.05	26.35	22.	RO132	9.90	16.56	20.36
11.	90/102	34.15	52.61	28.31	23.	MT196	17.18	28.33	23.87
12.	90/140	20.37	27.73	20.62	24.	RRII105	46.22	72.01	29.23
						CD = 0.05	18.13	21.01	17.93

Table 3. Important growth parameters

Sl. No	Clone	Mean girth at opening (cm)	Girth in the 7th yr. of taping (cm)	Girth increment in the immature phase (cm/yr)	Girth increment in the mature phase (cm/yr)	Sl. No	Clone	Mean girth at opening (cm)	Girth in the 7th yr. of taping (cm)	Girth increment in the immature phase (cm/yr)	Girth increment in the mature phase (cm/yr)
1.	90/55	54.75	76.25	6.84	3.58	13.	90/274	56.04	69.17	7.01	2.19
2.	90/277	54.90	70.61	6.86	2.62	14.	90/88	29.14	38.17	3.64	1.51
3.	90/72	51.90	63.92	6.49	2.00	15.	90/92	41.36	55.25	5.17	2.32
4.	90/104	48.55	62.50	6.07	2.33	16.	90/94	42.58	59.92	5.32	2.89
5.	90/107	42.05	58.04	5.26	2.67	17.	90/97	33.89	41.35	4.24	1.24
6.	90/109	53.21	73.04	6.65	3.31	18.	RO 24	43.00	56.89	5.38	2.32
7.	90/129	53.81	72.79	6.73	3.16	19.	RO 26	35.52	50.52	4.44	2.50
8.	90/130	55.71	72.38	6.96	2.78	20.	RO 34	34.07	50.60	4.26	2.76
9.	90/132	49.75	68.13	6.22	3.06	21.	RO 87	40.54	54.88	5.07	2.39
10.	90/136	36.67	45.92	4.58	1.54	22.	RO132	37.63	52.08	4.70	2.41
11.	90/102	48.46	58.75	6.06	1.72	23.	MT 196	40.63	59.17	5.08	3.09
12.	90/140	39.33	54.92	4.92	2.60	24.	RRII105	43.02	52.44	5.38	1.57
							CD= 0.05	7.28	9.32	1.04	0.65

Anatomical observations

Bark samples were collected at the time of opening the trees for tapping and recorded the structural components related to yield. Total bark thickness and number of latex vessel rows are given in Table 4. Thirteen clones recorded higher bark thickness and nine clones, higher number of latex vessel rows when compared to the general mean. Total bark thickness ranged from 5.47

mm in 90/88 to 7.29 mm in 90/92. Latex vessel rows ranged from 5.78 in 90/102 to 15.28 in 90/97. Clone 90/274 recorded higher value for both bark thickness and latex vessel rows.

Tolerance to various biotic and abiotic stresses is of great significance in assessing the performance of clones in different localities. Diseases such as tapping panel dryness (TPD), pink and patch canker were observed in few clones. In clones 90/107, 90/140, 90/88 and 90/130, two trees per clone were affected by TPD, in 90/94, 90/136, 90/88 and 90/92, one tree per clone was affected by pink and patch canker was noticed in 90/107,90/92 and 90/130. Wind damage was observed in 90/72, 90/94, 90/104and 90/102.

Table 4. Anatomical parameters

Sl. No	Clone	TBT (mm)*	No. of LVR**	Sl. No	Clone	TBT (mm)*	No. of LVR**
1.	90/55	6.27	10.73	13.	90/274	6.73	15.00
2.	90/277	6.72	10.17	14.	90/88	5.47	12.33
3.	90/72	6.25	7.67	15.	90/92	7.29	9.28
4.	90/104	6.06	9.11	16.	90/94	6.53	8.95
5.	90/107	6.54	8.45	17.	90/97	6.35	15.28
6.	90/109	6.68	11.67	18.	RO 24	5.58	7.17
7.	90/129	6.06	9.61	19.	RO 26	5.79	7.39
8.	90/130	7.01	9.94	20.	RO 34	5.62	7.95
9.	90/132	5.72	9.5	21.	RO 87	5.25	9.22
10.	90/136	5.72	8.22	22.	RO132	6.02	8.89
11.	90/102	6.52	5.78	23.	MT 196	5.18	9.44
12.	90/140	6.71	11.06	24.	RRII105	6.69	12.89
					GM	6.2	9.82
					CV	12.61	21.82

* Total Bark Thickness; ** No. of Latex Vessel Rows

Standard heterosis with regard to girth at opening and heterosis over mid parent value with regard to yield and girth were worked out. Standard heterosis on girth revealed that out of seventeen hybrid clones, ten showed 12.65 to 30.26 per cent heterosis over the standard check clone RRII 105 and it was highest in clone 90/274 (30.26 %). Heterosis over mid parent value with regard to yield showed that five clones *viz.* 90/55, 90/277, 90/109, 90/102 and 90/274 were superior in yield over the mid parent and it ranged from 10.95 % in 90/55 to 41.96 % in 90/274. These clones showed heterosis with respect to girth also and it ranged from 12.67 to 42.45 %. Yield and girth of the hybrids that showed heterosis over the mid-parent is given in Fig 1. Among the five clones, both yield and girth was highest in 90/274. This clone exhibited high yield on par with RRII 105 with high bark thickness and number of latex vessel rows.

The Rubber Research Institute of India maintains a large collection of wild germplasm. Though the wild accessions are not high yielders they were incorporated in breeding with special objectives like drought tolerance, disease resistance and good timber yield. According to Varghese *et al.* (2002) and John *et al.* (2001) sources of resistance have been located in wild Brazilian germplasm. Among the better yielders, clone 90/274 was the highest yielder, the yield of which is on par with the high yielding clone RRII 105. The parentage of this clone was RRII 105 and MT 196. Among the six wild male parents, MT 196 showed the highest yield. The other better yielding clones were 90/55, 90/277, 90/109 and 90/102. These clones showed high vigour with good

Table 5. Estimates of heterosis in the hybrid clones

Sl. No.	Parentage	Clone	Standard heterosis on girth at opening (%)	Heterosis over mid-parent (%)	
				Girth at opening	Yield over seven years
1.	RRII 105 x RO 34	90/55	27.27	42.06	10.95
2.	RRII 105 x RO 34	90/277	27.62	42.45	24.47
3.	RRII 105 x RO 26	90/72	20.64	32.16	–
4.	RRII 105 x RO 26	90/104	12.85	23.63	–
5.	RRII 105 x RO 26	90/107	–	7.08	–
6.	RRII 105 x RO 26	90/109	23.69	35.50	30.67
7.	RRII 105 x RO 24	90/129	25.08	25.11	–
8.	RRII 105 x RO 24	90/130	29.50	29.53	–
9.	RRII 105 x RO 24	90/132	15.64	15.67	–
10.	RRII 105 x RO 24	90/136	–	–	–
11.	RRII 105 x RO 23	90/102	12.65	12.67	12.34
12.	RRII 105 x MT 196	90/140	–	–	–
13.	RRII 105 x MT 196	90/274	30.26	33.97	41.96
14.	RRII 105 x RO 132	90/88	–	–	–
15.	RRII 105 x RO 132	90/92	–	2.55	–
16.	RRII 105 x RO 132	90/94	–	5.58	–
17.	RRII 105 x RO 132	90/97	–	–	–

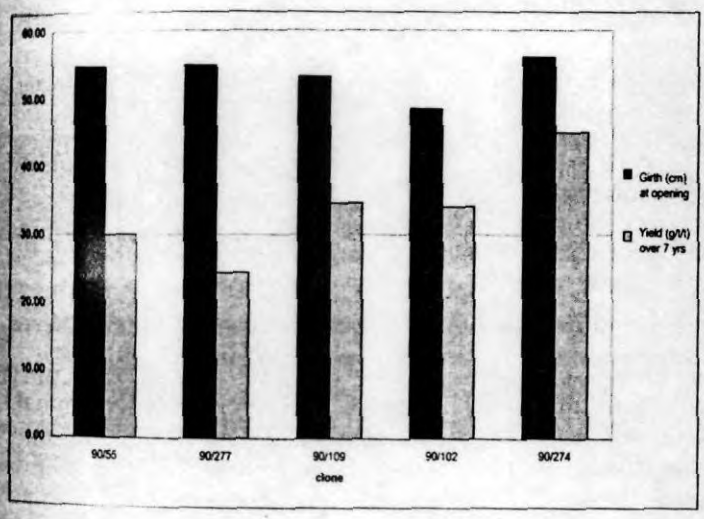

Figure 1. Yield and Girth of Hybrids that showed heterosis over mid-parent

structural components and resistance to biotic/abiotic stresses. Wild germplasm is known to be a reservoir of variability and desirable genes. It is not generally expected to give direct selection. Instead it provides genes for enhancing yield, for resistance to biotic/abiotic stresses or for quality enhancement by hybridization. Since the genetic base of rubber is narrow, incorporation of these desirable wild genes in the cultivars by hand pollination will improve yield and simultaneously broaden the genetic base of the crop. Based on small scale evaluation, five clones *viz.* 90/274, 90/55, 90/277, 90/109 and 90/102 which showed better yield and other secondary attributes were selected for the next phase of evaluation.

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