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EVALUATION OF GROWTH AND YIELD PERFORMANCE OF WILD *HEVEA* GERMPLASM IN TRIPURA

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The presently cultivated clones of *Hevea brasiliensis* represent only a very small gene pool. Considering the urgent need for broadening the narrow genetic base of *Hevea*, the wild germplasm collected through the 1981 IRRDB expedition from the three states of Acre, Rondonia and Mato Grosso of Brazil needs to be utilized for further improvement of the crop.

Eighty seven accessions belonging to the 1981 IRRDB collections were evaluated in two trials in the experimental farm in Tripura, North East India. The present study revealed that certain accessions had superior growth character compared to the check clone, RRIM 600. Two accessions *viz.* MT 4713 (74.4 cm) and MT 4874 (72.7 cm) showed significantly higher girth than RRIM 600 (63.5 cm) in trial I. In trial II, the accessions RO 5449 (46.8 g $t^{-1}t^{-1}$) and MT 4788 (22 g $t^{-1}t^{-1}$) recorded high dry rubber yield and RRIM 600 yield 55.1 g $t^{-1}t^{-1}$. The accession MT 4713 also recorded the highest clear bole volume (0.11 m^3) at the age of 13 years growth. Anatomical studies revealed that MT 4796 had the highest bark thickness (5.8 mm) and number of latex vessel rows (7.5) among the accessions evaluated. The accessions from Mato Grosso provenance revealed superiority for dry rubber yield in comparison with the accessions from Acre and Rondonia. The superior wild accessions identified for growth and yield in this study can be utilized as parents in future breeding programmes to enrich the available gene pool of *Hevea*.

Keywords: Gene pool, Growth and yield, Wild *Hevea* germplasm

Hevea brasiliensis (Willd. ex Adr de Juss.) Muell. Arg., a native of the Amazonian rain forest in Brazil, is the major source of natural rubber. Commercial rubber cultivation was the result of effective introduction of Wickham germplasm from the Amazonian rain forest of Brazil to the eastern hemisphere (Wycherley, 1968; Schultes, 1977) which consisted of a few surviving seeds collected by Sir Henry Wickham in 1876. Most of the clones under cultivation today are derived from the Wickham base and they represent a very small gene pool compared to the wide variability of the species in its natural habitat. This narrow genetic base has further narrowed down through directional selection for yield and wide spread adoption of clonal materials

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(Simmonds, 1989; George, 2000; Varghese, 1992; Varghese and Abraham, 2005; Varghese *et al.*, 2006). To broaden the genetic base, International Rubber Research and Development Board (IRRDB) organized an expedition of wild *Hevea* germplasm during 1981 from the three states of Acre, Rondonia and Mato Grosso of Brazil having diverse agro-climatic conditions. The share of this collection was distributed to all IRRDB member countries for characterization and evaluation in the respective agro-climates by selection of potential accessions. The present paper reports the evaluation of 87 wild *Hevea* germplasm accessions under the agro-climatic conditions of Tripura in North East India.

The experiment was conducted at the Experimental Farm at Regional Research Station, Taranagar, Agartala, Tripura (23°53' N, 91°15' E and situated at an elevation of above 20 MSL), of the Rubber Research Institute of India. Eighty seven wild Brazilian accessions were evaluated in two trials planted in 1993 (Trial I) and 1994 (Trial II) with 25 and 64 clones respectively. A total of 47 Mato Grosso, 34 Rondonia and 6 Acre accessions were evaluated along with RRIM 600, which is the local check clone. The trials were laid out in Simple Lattice Design with three replications (Trial I) and two replications (Trial II) with 3m x 3m spacing with four trees per replication.

Girth of the trees was recorded at 150 cm height from the bud union. The trials were opened for regular tapping in 2004 following S/2 d2 6 d/7 systems and yield was recorded at monthly interval for three years by cup-coagulation method.

Virgin bark samples were collected from the trees at 150 cm height from the ground (Omman, 2005) for anatomical investigations after three years of tapping and fixed in formaldehyde-acetic acid-alcohol (FAA). Sections were taken at 30-60 µm thickness in different planes *viz.*, cross sectional (CS), tangential longitudinal (TLS) and radial longitudinal (RLS) plane using Leitz sledge microtome and stained with Oil red O (Omman and Reghu, 2003) for microscopic observations. The parameters such as number of latex vessel rows, density of laticifers per unit distance and diameter of latex vessels were recorded using Leitz

Table 1. **Range and mean of characters studied**

Trait	Trial	Wild genotypes Range	RRIM 600	General mean
Girth at opening (cm)	I	38.4 (RO 44/160) to 64.6 (MT 4713)	58.50	53.40
	II	39.3 (RO 5055) to 65.6 (MT 29/403)	63.10	54.40
Girth 3 years after tapping (cm)	I	42.9 (RO 44/160) to 74.4 (MT 4713)	63.50	59.70
	II	45.7 (MT 4740) to 75.4 (MT 29/403)	69.00	63.00
Forking height (m) at opening	I	1.99 (AC 4677) to 2.8 (MT 4713)	2.26	2.25
	II	1.86 (RO 6136) to 3.13 (AC 5523)	2.33	2.24
Bole volume (m^3), 3 years after tapping	I	0.03 (RO 44/160) to 0.11 (MT 4713)	0.05	0.06
	II	0.02 (RO 5432) to 0.09 (AC 5502)	0.06	0.06
Yield ($g\ t^{-1}t^{-1}$)	I	0.9 (RO 44/160) to 5.8 (MT 4796)	26.30	3.40
	II	4.3 (RO 5428) to 46.8 (RO 5449)	55.10	9.70

Aristoplan research microscope. Bole height and clear bole volume were recorded at the age of thirteen years (three years of tapping) as per standard procedure (Mydin and Saraswathyamma, 2005).

Table 1 depicts the range and general mean of characters studied. A wide range of variation was exhibited for girth and yield (Table 1).

In trial I, MT 4713 consistently showed the highest girth (64.6 cm) at the time of opening as well as three years of tapping (74.4 cm) and was higher than that of the check clone RRIM 600 (63.5 cm). Nine accessions in trial I had girth on par with RRIM 600 at the time of opening (Table 2). Girth after three years of tapping showed that MT 4874 also had significantly higher girth and 16 accessions had girth on par with RRIM 600. In trial II, MT 29/403 showed highest girth at opening (65.6 cm) and after three years of tapping (75.4 cm) which was higher than that of RRIM 600 (69.0 cm). In trial II, 44 accessions had girth on par with RRIM 600 at the time of opening, while 57 accessions had comparable girth after three years of tapping (Table 3). Both forking height (2.80 m) and bole volume (0.11 m^3) and was the highest in MT 4713 among all accessions in trial I, which was higher the check clone RRIM 600 (2.26 m and 0.05 m^3), respectively. In trial II, AC 5523 (3.13 m) had the highest forking height and AC 5502 (0.09 m^3) had the highest bole volume among the accessions.

Yield performance of wild accessions revealed that all wild accessions evaluated had significantly lower yield than RRIM 600. The accessions showed wide variability in their yield performance from 0.9 g $t^{-1}t^{-1}$ (RO 44/160) to 5.8 g $t^{-1}t^{-1}$ (MT 4796) in trial I and from 4.3 g $t^{-1}t^{-1}$ (RO 5428) to 46.8 g $t^{-1}t^{-1}$ (RO 5449) in trial II. Among the 24 accessions evaluated in trial I, only four

Table 2. **Growth and yield performance of wild accessions in trial I**

Sl. No.	Accession	Girth at opening (cm)	Girth 3 years after tapping (cm)	Yield (g $t^{-1}t^{-1}$)
1	MT 4796	58.8#	65.4#	5.8
2	MT 6051	53.0	58.1#	4.4
3	MT 4713	64.6*	74.4*	4.3
4	MT 5097	57.9#	64.2#	3.5
5	MT 4859	44.9	49.9	3.3
6	MT 6025	53.2	59.1#	3.0
7	RO 5067	54.9#	61.0#	2.8
8	MT 4874	62.3#	72.7*	2.8
9	RO 24/105	54.4#	60.3#	2.6
10	MT 4757	50.4	57.9#	2.6
11	RO 5422	54.2	60.1#	2.1
12	MT 6046	47.2	51.6	2.0
13	MT 5979	56.1#	62.3#	2.0
14	MT 4785	61.3#	66.6#	2.0
15	RO 5365	43.3	49.4	1.9
16	MT 4702	45.3	48.1	1.9
17	AC 4677	53.9	62.1#	1.8
18	MT 5971	52.4	59.8#	1.8
19	RO 5348	61.5#	69.0#	1.8
20	RO 3794	58.4#	64.1#	1.8
21	MT 4810	51.6	57.3#	1.7
22	RO 4618	48.8	56.8#	1.4
23	MT 4840	49.2	55.2	1.0
24	RO 44/160	38.4	42.9	0.9
25	RRIM 600	58.5	63.5	26.3
	Mean	53.4	59.7	3.4
	CD (P=0.05)	4.2	6.7	4.0

*Significantly higher than RRIM 600
#On par with RRIM 600

accessions *viz.*, MT 4796, MT 6051, MT 4713 and MT 5097 had the yield higher than the grand mean (3.4 g $t^{-1}t^{-1}$) of the trial (Table 2), whereas in trial II, RO 5449 (46.8 g $t^{-1}t^{-1}$) had yield on par with RRIM 600. MT 4788 (22.0 g $t^{-1}t^{-1}$) also recorded high yield, while

Table 3. **Growth and yield performance of wild accessions in trial II**

Sl. No.	Accession	Girth at opening (cm)	Girth 3 years after tapping (cm)	Yield (g $t^{-1}t^{-1}$)
1	RO 5449	58.6#	64.9#	46.8#
2	MT 4788	52.8#	57.9#	22.0
3	MT 6005	50.7	58.5#	12.9
4	MT 10/162	57.0#	67.5#	11.7
5	MT 5973	50.7	52.3	11.5
6	RO 5853	57.6#	65.4#	10.9
7	RO 5423	61.2#	71.7#	10.6
8	MT 4757	55.1#	64.0#	10.5
9	MT 4888	54.6#	64.7#	10.4
10	MT 5112	47.1	56.9#	10.1
11	AC 5502	61.7#	71.3#	10.1
12	RO 5004	63.4#	70.4#	10.0
13	MT 5935	54.8#	66.7#	9.8
14	MT 4906	62.0#	74.7#	9.7
15	MT 5824	55.8#	63.5#	9.6
16	MT 5081	53.4#	61.9#	9.5
17	RO 5562	49.8	57.5#	9.3
18	RO 5348	57.4#	68.4#	9.2
19	**MT 6047**	51.2#	59.9#	9.1
20	**RO 5442**	60.5#	69.2#	8.7
21	MT 6048	47.5	55.8#	8.6
22	MT 4777	53.2#	61.8#	8.6
23	MT 6024	57.8#	67.0#	8.5
24	MT 4694	52.7#	59.5#	8.5
25	AC 5523	64.0#	74.0#	8.3
26	MT 4862	50.7	58.6#	8.2
27	RO 5404	50.7	63.2#	8.1
28	MT 29/403	65.6#	75.4#	8.0
29	MT 5924	49.0	61.6#	7.9
30	RO 25/363	55.8#	65.6#	7.9
31	AC 4835	52.2#	61.0#	7.7
32	MT 5136	64.2#	74.7#	7.5
33	RO 5364	49.3	60.2#	7.3
34	MT 4899	56.3#	63.8#	7.3
35	RO 5055	39.3	47.5	7.1
36	MT 4863	51.6#	61.1#	7.0
37	MT 5158	54.5#	65.4#	7.0
38	MT 4810	54.0#	61.9#	6.8
39	MT 4707	54.5#	66.5#	6.7
40	RO 2841	55.1#	62.0#	6.6
41	MT 5095	56.6#	64.9#	6.5
42	RO 5018	53.4#	60.0#	6.5
43	MT 6000	61.1#	72.2#	6.3
44	MT 5130	50.4	58.6#	6.2
45	RO 4612	57.5#	67.3#	6.2
46	RO 5849	52.5#	58.4#	6.0
47	MT 5085	49.9	56.9#	5.8
48	RO 5407	55.6#	63.1#	5.7
49	RO 5170	63.4#	70.3#	5.1
50	RO 5020	62.3#	74.0#	5.1
51	RO 5414	54.5#	63.1#	5.1
52	RO 5022	56.0#	66.5#	5.0
53	RO 4574	52.7#	57.7#	4.4
54	MT 6006	47.2	55.5#	4.4
55	RO 5428	58.7#	67.8#	4.3
56	RO 20/39	52.8#	60.7#	–
57	AC 54/115	40.3	50.7	–
58	RO 5432	46.7	53.6	–
59	MT 26/116	50.6	57.5#	–
60	RO 6136	48.4	58.2#	–
61	RO 3/149	54.8#	64.7#	–
62	MT 4740	42.6	45.7	–
63	AC 4825	–	–	–
64	RRIM 600	63.1	69.0	55.1
Mean		54.4	63.0	9.7
CD (P=0.05)		12.2	14.6	6.9

#On par with RRIM 600

Table 4. **Range and mean of anatomical traits**

Trait	Trial	Wild genotypes range	RRIM 600	General mean
Bark Thickness (mm)	I	3.0 (RO 44/160) to 5.9 (MT 4796)	5.9	4.3
	II	3.2 (MT 4707) to 5.4 (MT 5130)	5.7	4.1
No. of Latex Vessel Rows	I	4 (MT 5971) to 8 (MT 4796)	16.0	5.9
	II	3 (RO 5442) to 9.5 (MT 29/403)	12.5	6.4
Density of Latex Vessels	I	12 (RO 5422) to 18.5 (MT 4785)	21.5	16.3
	II	14 (MT 26/116) to 21.5 (MT 6005)	28.5	16.8
Diameter of the Latex Vessels (µm)	I	14 (RO 5348) to 21(MT 6051)	26.0	18.0
	II	14 (RO 5849) to 23 (MT 4788)	28.0	18.0

the check clone RRIM 600 was the highest yielder (55.1 g $t^{-1}t^{-1}$). Thirteen wild accessions evaluated in trial II had yield higher than the grand mean of the trial (Table 3). Low yield of the wild germplasm accessions was also reported by Reghu *et al.* (2004). Even though same management practices were adopted for both trials, it was observed that the growth and yield of accessions (including check clone RRIM 600) was better in trial II possibly due to inherent soil properties. Wide variation in girth and yield in germplasm accessions of *Hevea* was also reported by Varghese *et al.* (1986) and Mercy *et al.* (1995).

Anatomical traits like bark thickness, number of latex vessel rows, density and diameter of latex vessels were studied for all the accessions. The bark thickness ranged from 3.0 to 5.9 mm in the wild accessions in trial I and from 3.2 to 5.4 mm in trial II (Table 4). In trial I, MT 4796 which was the highest yielding wild accession, also had the highest bark thickness and number of latex vessel rows among the accessions with higher yield than the grand mean (Table 5). High yielding accessions in trial II, *viz.* MT 4788 and RO 5449 also had higher bark thickness and diameter of latex vessels than the grand mean of the trial.

Mean yield and growth performance of the accessions from different provenances were analyzed and are depicted in the Table 6. In general, the yield of Mato Grosso accession was better than that of Acre and Rondonia accessions. This type of yield had also been reported earlier in the early phase of evaluation of wild *Hevea* accessions (Abraham *et al.*, 1992; Mercy *et al.*, 1995 and Reghu *et al.*, 2004). The present study also revealed better growth performance of Mato Grosso accessions as reported earlier by Mercy *et al.* (1995) and Rondonia accessions (Varghese and Abraham, 1997; Krishan *et al.*, 2011).

The observations made during the study revealed that some wild accessions had superior growth characters, while all had inferior yield performance compared to the check clone RRIM 600. Though the possibility of direct utilization of wild accessions of *Hevea* is remote, their utilization in breeding programmes is crucial for broadening the genetic base. Development of latex timber clones has become a priority area in rubber breeding recently. Since the selected wild accessions have high growth rate, they can be utilized for hybridization programmes. Inclusion of superior wild accessions like RO 5449, MT 4713 and MT 4788 identified in this study,

in future breeding programmes will help in enriching the available gene pool of *Hevea*.

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