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Performance of ten selections from a polyclonal seedling population of natural rubber (*Hevea brasiliensis*) in Assam

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Abstract

Yield potential of ten selections from a polyclonal seedling population of Hevea brasiliensis, grown under the agro-climatic conditions of Assam in North East India were evaluated over the first eleven years of tapping along with growth at the juvenile, immature and mature phases. Out of ten preliminary selections evaluated, the highest mean dry rubber yield (g/t/t) was recorded in S2 (93.98 g) followed by S1 (88.37 g), S9 (67.92 g), S3 (63.62 g) and S10 (62.49 g) while the lowest was in S8 (49 g). All the 10 selections recorded much higher mean yield than that of the population mean (29.2 g) and RRIM 600 (44.24 g). There was considerable yield increment in the selections like S2, S1, S9, S3 and S10 in comparison with that of RRIM 600, the most popular clone in the non traditional areas. In the juvenile growth phase, at an age of three years, maximum girth was measured in S8 (34 cm) followed by S2 (29.9 cm), S3 (29.0 cm), S6 (28.6 cm) and S5 (28 cm) and the minimum was in S7 (22.9 cm) while RRIM 600 recorded a girth of 24 cm. At an age of 18 years (10 years after tapping), S2 recorded the highest girth (118.7 cm) followed by S10 (112 cm), S7 (107.1 cm), S3 (104.0 cm) and S5 (103.4 cm) and the lowest was in S1 (86.5 cm) while RRIM 600 recorded a girth of 75.1 cm. Girth increment in the ten selections during the immature and mature phases was also compared with that of the base population mean and RRIM 600. Secondary attributes like Tapping Panel Dryness (TPD), wind damage and tolerance/susceptibility to powdery mildew disease were also evaluated in the ten selections.The two top yielders S2, and S1, were free from TPD, wind damage and also moderately tolerant to powdery mildew disease. Yield evaluation of the seedling population over eleven years indicated that all the ten selections were outstanding performers with higher yield potential than the popular clone RRIM 600 under the agro-climatic conditions of Assam. Significance of polycorss progeny evaluation for non-traditional areas is discussed.

Key words: Hevea brasiliensis, polycross population, yield, growth, DRC

Introduction

The potential of polyclonal seedling population for selection of outstanding genotypes in any new environment has been widely accepted (RRII 2002). Selection of outstanding seedling trees of polyclonal origin followed by their multiplication through budding and development of primary clones has been practised since the early years of rubber breeding. Many such clones (GT 1, PB 86, PR 107 etc.) are still under cultivation in different rubber growing countries (Fernando, 1974). The state of Assam in North East India is one of the non-traditional areas where rubber cultivation has been extended due to non-availability of potential land for further expansion of cultivation in the traditional rubber growing zone. The major environmental constraints for growth and productivity of rubber in NE India is the low temperature during winter season which retards the growth of *Hevea*, thus increasing the gestation period by one or two years than in the traditional zone (Mondal *et al.*,1999). Climatic adaptation involves the genetic adaptation of population through the ability of individuals to buffer against environmental changes by modifying their phenotypic response. Since scientific information on the performance of polyclonal seedlings in Assam is not available, the present study attempts to compare the yield performance of 10 best selections of a polyclonal

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seedling population with the most popular clone RRIM 600 grown in Assam, during the first 11 years of harvesting latex.

Materials and Methods

The polyclonal population of *Hevea* raised from seeds collected from polyclonal seed gardens in Kanyakumari district of Tamil Nadu in South India was used for the study. Three hundred and forty seedling stumps were planted in single-tree-single-plot completely randomised design during 1987 at the experimental farm of the Regional Research Station of the Rubber Research Institute of India at Sarutari Farm (Lat: 26°35′ N, Long: 90°52′E, Alt: 50-105 m above MSL) in Kamrup district of Assam.

Three years after planting, girth of 340 polyclonal seedling trees at a height of 110 cm was measured at an interval of three months in the immature phase from June 1991 to May 1995 (before tapping) and in mature phase from May 1995 to December 2005 (after tapping). Girth values of all 340 seedling trees were used to calculate the girth increment in immature and mature phases of growth. Out of the 340 original plants, 255 trees which attained tappable girth were opened for tapping at the age of eight years under ½ S d/2 system. Yield was recorded by cup coagulation method throughout the tapping days from May to December, for the first 11 years of tapping from 1995 to 2005. Dry rubber content (DRC) was also recorded in 10 promising selections of polyclonal seedling trees. Data on growth and yield for the first 11 years of tapping were utilised for evaluating the performance of genotypes in the present study. Visual scoring for the incidence of powdery mildew disease, tapping panel dryness (TPD) and wind damage were also undertaken for three consecutive years while selecting the outstanding performers. Ten preliminary selections were identified as potential mother trees based on mature yield in the virgin bark.

The seedling population was compared with the most popular clone in the North East, RRIM 600 planted with budded stumps in an adjacent field along with nine other clones employing a completely randomised design with 50 trees per clone.

Results and Discussion

Growth and yield performance

The growth and yield performance of 10 seedling selections in comparison to polyclonal seedlings and RRIM 600 are presented in Table 1. A comparison of the polyclonal seedling trees and RRIM 600 during juvenile, immature and mature phase revealed that the seedling population was more heterogeneous with respect to girth and yield. In the juvenile phase, selection S8 showed the highest girth (34 cm) followed by S2 (29.9 cm), S3 (29 cm) with the lowest in S10 (21.5 cm). Eight years after planting, selection S5 attained the highest girth (65.8 cm) followed by S10 (64.6 cm), S8 (62.3 cm) and S2 (61.2 cm) with the lowest in S1 (55.2 cm). At 18 years after planting, selection S2 showed the maximum girth (118.7 cm) followed by S10 (112 cm), S7 (107.1 cm) and S3 (104 cm) with the minimum in S1 (86.5 cm), indicating clearly that the selection S2 was most vigorous. The girth values of all 10 selections of promising polyclonal seedling trees were comparatively higher than the popular clone RRIM 600. The highest annual average girth increment was noticed in S10 (8.6 cm), closely followed by S5 (7.5 cm), S1 (6.9 cm) and S9 (6.7 cm) with the minimum i S3 (5.4 cm), at immature phase of growth. On the other hand, girth increment after opening was highest in the selection S2 (5.6 cm), followed by S7 (4.9 cm), S10 (4.7 cm) and S3 (4.3 cm) with the minimum in S8 (2.5 cm). Though both the plantations were raised by stump planting, the seedling plantation attained tappable girth by the eighth year, while the clonal plantation (RRIM 600) could be opened only by the ninth year. Similar results were reported under Tripura conditions by

Table 1. Growth and yield performance of ten promising selections from polyclonal seedling population.

Selection	Mean girth (cm)			Mean girth increment (cm)		Mean yield (g/t/t) (11 year
	Juvenile phase (3YAP)	Immature phase (8YAP)	Mature phase (18YAP)	Immature phase (5 years)	Mature phase (11 years)	
S1	20.7	55.2	86.5	6.9	3.3	88.37
S2	29.9	61.2	118.7	6.2	5.6	93.98
S3	29.0	56.1	104.0	5.4	4.3	63.62
S4	22.0	57.7	91.2	7.0	3.6	59.50
S5	28.0	65.8	103.4	7.5	4.0	49.49
S6	28.6	55.1	86.6	5.4	3.1	57.49
S7	22.9	58.9	107.1	6.4	4.9	58.92
S8	34.0	62.3	86.6	5.6	2.5	49.00
S9	24.2	58.1	95.8	6.7	4.1	67.92
S10	21.5	64.6	112.0	8.6	4.7	62.49
Base population	19.7	45.4	66.8	6.1	2.3	29.20
RRIM 600	24.0	52.5	75.1	6.0	2.0	44.24

YAP: Years after planting

Table 2. Monthly dry rubber yield among the ten selections of polyclonal seedling population (Mean of 11 years)

Selection	Yield (g/t/t)							
	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
S1	75.01	82.70	81.06	81.41	81.82	109.00	108.80	81.95
S2	76.57	70.54	61.56	77.63	78.47	104.00	143.75	142.65
S3	44.85	49.27	40.37	40.25	44.58	63.46	106.47	112.11
S4	39.75	41.11	41.08	44.20	52.61	63.83	81.61	108.78
S5	30.14	35.47	30.65	36.28	42.22	42.63	76.84	98.47
S6	35.11	38.80	38.32	42.81	62.73	65.92	90.11	80.26
S7	44.69	43.36	37.69	39.19	42.94	55.38	98.61	112.00
S8	32.10	33.34	28.29	34.44	44.49	47.94	76.56	89.06
S9	34.11	36.73	37.36	46.24	60.28	87.63	126.57	110.40
S10	36.98	44.54	40.60	42.80	52.25	71.41	95.88	110.34
RRIM 600	45.20	35.70	26.00	32.30	43.30	57.80	65.20	55.00

Sasikumar *et al.* (2001). Girth was comparatively higher in all the 10 selections of polyclonal seedling trees than the popular clone RRIM 600 during the immature and mature phases of growth and the selections also exhibited a higher rate of girth increment.

The data on mean dry rubber yield (g/t/t) of 10 selections of polyclonal seedling trees over the first 11 years of tapping are given in Table 1. The mean dry rubber yield was the maximum in the selection S2 (93.98 g/t/t), followed by S1 (88.37 g), S9 (67.92 g), S3 (63.62 g) and S10 (62.49 g) with the minimum in S8 (49 g). On the basis of the mean yield over 11 years, the high yielding selections could be ranked in the order of S2, S1, S9, S3, S10, S4, S7, S6, S5 and S8. All the ten selections of polyclonal seedling trees were superior to the popular clone RRIM 600, which yielded 44.24 g per tree per tapping. Yield evaluation of the seedling population over the first eleven years revealed that two genotypes S2 and S1 were outstanding performers with two times higher yield than the popular clone RRIM 600. The usefulness of these selections for large scale planting in North East, particularly in Assam, will be further confirmed through large scale on-farm trials.

The dry rubber yield recorded in different months from the 10 selections of polyclonal seedling trees are presented in Table 2. In general, yield was low during May to September, except in selections S1 and S2, with peak yield attained during November and December. All the selections showed an increment in yield towards the onset of cold season during October-November. It is implicit that the cold weather (18-20° C) is favourable to latex flow and the onset of cold season renders a stimulatory effect and the trend continues till the temperature falls below 15° C during January (Priyadarshan *et al.*, 2000). The relatively low yield in summer months as reported here could be due to the low level of soil moisture and high vapour pressure deficits during the period (Sethuraj and George,1976; Sethuraj and Raghavendra, 1984; Chandrasekhar *et al.*,1990). The lower dry rubber yield in summer months could be the result of low flow rate of latex and reduced duration of flow (Devakumar *et al.*,1988). A comparison of the monthly yielding pattern of the 10 selections with the popular clone RRIM 600 is given in Fig. 1. The mean performance of these selections was better than that of RRIM 600.

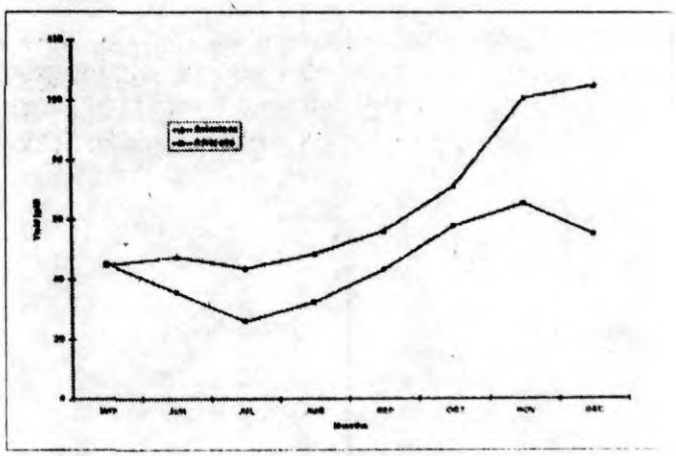

Fig. 1. Yielding pattern of selections of polyclonal seeding trees & the popular clone RRIM 600 in different months (Mean Of 11 years)

Table 3. Variability in dry rubber content of ten promising selections from polyclonal population (Mean of three years: 2003-2005)

Selections	Dry rubber content (%) in different months								Mean
	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
S1	35.24	36.72	36.00	41.22	42.84	38.05	37.20	22.54	36.2
S2	39.05	35.68	39.65	43.07	40.43	38.34	37.97	30.81	38.1
S3	39.33	38.43	36.92	42.28	41.33	40.53	35.62	28.40	37.9
S4	39.29	42.32	44.67	43.07	40.67	37.05	34.20	24.33	38.2
S5	44.90	45.70	49.80	50.66	37.64	34.43	35.82	33.17	41.5
S6	40.78	39.66	40.04	37.18	39.55	41.10	34.87	23.86	37.1
S7	45.27	46.74	35.72	38.00	36.04	36.32	34.28	30.83	37.9
S8	39.82	37.44	44.36	36.52	36.67	34.33	35.39	24.10	36.0
S9	36.72	46.31	41.86	41.93	35.42	42.28	37.73	30.04	39.0
S10	48.61	44.40	44.43	46.81	45.80	44.38	41.05	29.45	43.1
RRIM 600	34.20	34.70	35.80	36.40	37.20	36.50	33.10	26.80	34.3

The dry rubber content (DRC) obtained in different months is presented in Table 3. Maximum DRC was recorded in August/September with the highest annual average in selection S10 (43.1%) followed by S5 (41.5%), S9 (39%), S4 (38.2 %) and S2 (38.1%) with the minimum in S8 (36 %). Lower DRC observed in all the ten selections of polyclonal seedling trees during December was probably due to fall in minimum temperature below 15°C (Sethuraj, 1992; Mondal *et al.*, 1999). This drop in dry rubber content is presumably a direct effect of temperature on the rate of rubber biosynthesis. The mean DRC in different months of these ten selections was far better than that of RRIM 600 thereby, indicating that all these selections were superior to RRIM 600.

Data on yielding pattern of the 10 selections of polyclonal seedling trees over the first 11 years of tapping under Assam conditions (Table 4) revealed that among the 10 selections of polyclonal seedling trees, the highest annual mean yield at the 11th year of tapping was observed in S2 (208.98g) followed by S1 (140.24 g), S10 (109.17 g), S9 (105.76 g), S7 (99.56 g) and S6 (97.99 g) with the minimum in S8 (27.72 g). Comparison of the yielding pattern of the mean values of 10 selections during each year with RRIM 600 are shown in Fig. 2. The mean performance of these selections was initially low for the first three years and then improved remarkably from 4th year onwards and was better than that of RRIM 600 under the agro-climatic conditions of Assam.

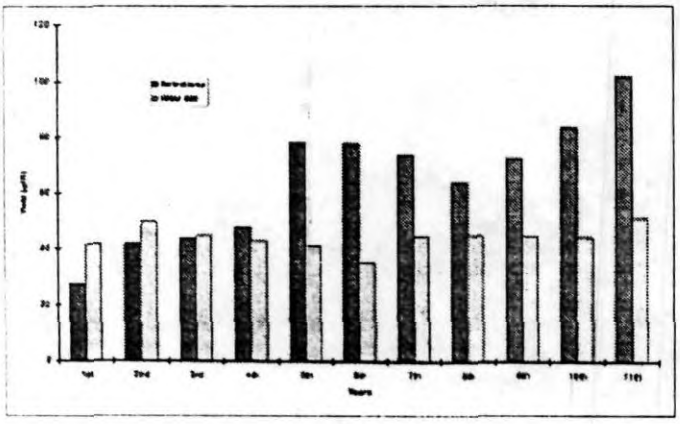

Fig. 2. Yielding pattern of selections of polyclonal seeding trees & the popular clone RRIM 600

Secondary attributes

The secondary attributes like the incidence of tapping panel dryness (TPD), wind damage and powdery mildew disease caused by *Oidium heveae* in the promising 10 selections of polyclonal seedling origin were examined. The typical symptoms of panel dryness like prolonged latex flow with low DRC during the peak yielding period, ultimately leading to cessation of latex flow and rupture of the bark below the taping panel was noticed only in S3. This indicates that selection S3 was susceptible to TPD whereas all other promising genotypes were free from TPD even after 11 years of tapping. Tapping panel dryness, generally considered to be a physiological disorder associated with excessive exploitation and occurs in varying intensities among clones (Mydin *et al.*, 2005). All the 10 promising selections exhibited wind fast characters and were free from wind damage . However, these genotypes were found to be affected by powdery mildew disease caused by *Oidium heveae* with varying intensity. Out of 10 selections assessed, only S4 recorded an infection grade above 3.5, indicating that the selection S4 was susceptible to powdery mildew disease. The severity of powdery mildew disease in terms of infection grade ranged from 1.6 to 2.5 in the selections S1, S2, S5, S7, S8 and S9 indicating, that these selections are moderately tolerant to the disease. The remaining three selections *viz.* S3, S6 and S10 were tolerant to *Oidium* with infection grade below 1.6.

Table 4. Yield pattern of 10 selections from polyclonal seedling population over the first 11 years of tapping

Selections	Dry rubber yield (g/t/t)										
	1st year	2nd year	3rd year	4th year	5th year	6th year	7th year	8th year	9th year	10th year	11th year
S1	26.21	54.37	53.71	70.05	111.89	121.90	82.35	79.82	101.97	129.65	140.24
S2	27.10	48.27	44.16	46.89	90.48	118.30	111.18	93.51	116.19	128.76	208.98
S3	34.06	41.76	60.91	36.65	61.06	76.40	60.48	57.37	84.96	90.55	95.64
S4	31.77	35.51	34.62	38.05	67.96	76.30	88.15	52.14	75.80	78.56	76.11
S5	22.80	28.08	38.69	40.00	80.36	84.30	58.67	55.88	25.20	47.17	63.29
S6	30.31	49.23	41.94	40.14	61.18	60.02	65.52	69.58	50.87	65.76	97.99
S7	18.67	26.39	30.93	26.46	56.83	65.50	74.14	69.16	94.69	85.85	99.56
S8	31.80	40.88	51.29	67.35	84.03	48.40	51.11	28.37	46.84	61.26	27.72
S9	23.27	55.37	40.07	59.06	88.24	68.00	84.53	80.27	72.74	69.86	105.76
S10	27.47	40.41	41.15	54.81	84.24	63.70	65.57	57.07	61.25	82.58	109.17
RRIM 600	41.58	49.54	44.80	42.92	41.49	35.34	44.92	45.10	45.00	44.58	51.37

Selection of putative clones

Yield evaluation of the seedling population over the 11 years revealed that certain mother trees were exceptional, which were closely monitored for growth, yield and secondary attributes. The criteria for selection were consistent yield over months and years, good girth increment on tapping as well as desirable secondary attributes. The mean dry rubber yield of the 10 selections over 11 years was substantially higher than that of the base population mean and higher compared to the popular clone RRIM 600. Similar performance of seedlings has been reported from the Konkan region of Maharashtra (Birari *et al.*, 1998; RRII, 2002) a non-traditional region in the Western India, where the plantations are under drought stress. Polyclonal seedling trees are expected to adapt well to new areas due to their genetic heterogeneity. Therefore, selection of advanced polycross progenies can be a useful complement to the normal hand pollination programme (Tan *et al.*, 1996). An earlier evaluation of planting materials under commercial plantings in Kerala revealed that some of the primary clones and seedling plantations performed better than hybrid clones (Krishnakutty and Sreenivasan,1984). Clones RRII 5 and RRII 51 are two such primary clones evolved and released in India (Marattukalam *et al.*,1980, 1990).

Conclusions

All the 10 promising selections of polyclonal seedling origin exhibited early attainment of tappability, high girth and girth increment on tapping and high DRC in comparison with the popular clone RRIM 600. Yield evaluation of the seedling population over the first 11 years of tapping revealed that two selections, S2 and S1 were outstanding performers two times higher yield than RRIM 600. Moreover, these two genotypes were free from TPD, wind damage and moderately tolerant to powdery mildew disease. However, the performance of the selections under the non-traditional and traditional rubber growing regions needs to be confirmed with further field experiments.

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