YIELD PERFORMANCE OF ELITE POLYCROSS SEEDLINGS OF *HEVEA BRASILIENSIS* GROWN IN A DRY SUB-HUMID CLIMATE OF INDIA

B. Krishan

Regional Research Station, Rubber Research Institute of India,
Dhenkanal-759 001, Odisha, India

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The performance of ten elite seedling trees of polyclonal origin as evaluated in the region of Odisha State, which has a sub-humid climate with high temperature and low rainfall as the major constraints for the growth and yield. The study revealed that seedling population is highly heterogeneous, and the selected elite genotypes over the years are outstanding performers for latex yield which recorded two to three times higher yield than the mean of a popular clone in the region. Out of the ten elite seedlings, the highest mean dry rubber yield was recorded in O7 (82.3 g t^{-1} t^{-1}) followed by O8 (80.2 g t^{-1} t^{-1}) and O1 (73.5 g t^{-1} t^{-1}) over ten years of tapping. Highest yield contribution was recorded during cold months for all elite seedlings. Highest girth since tapping and girth increment has been recorded in elite seedling O 4. In addition to the yield, the population was assessed for incidence of tapping panel dryness and wind damage. The present study, in dry sub-humid region of Odisha of eastern India, reveals the scope for selection of promising genotypes from poly cross progeny for stressed environment.

Keywords: Breeding, Poly cross seedlings, Selection, Yield

Plantations raised from seeds are having high genetic variation in growth and yield. These polyclonal seedling populations have several advantages such as ease in establishment; vigorous growth and good survival in adverse conditions. Therefore these plants may be the ideal material to circumvent biotic and abiotic stresses. Screening of these plantations helps to identify potential high yielders that may become future clones; and the potential of poly cross population for outstanding genotypes in any new environment have been widely accepted (RRII, 2002). Selection of promising trees from existing seedling populations and their vegetative multiplication is one of the most important methods adopted for evolving new clones (Marattukalam *et al.*, 1990). Many such clones (GT 1, PB 86, Tjir 1) are still under cultivation in different rubber growing countries (Fernando, 1974). In view of the limited scope for further expansion of area under rubber in traditional zone (8^0 15′ N and 12^0 52′ N latitude), cultivation of the crop was extended to less congenial but potential areas (Sethuraj *et al.*, 1989). One of the regions selected was the Odisha state of

Correspondence: B. Krishan (Email: balakrishan@rubberboard.org.in)

eastern India (17° N and 87° E). High temperature, low rainfall and strong winds are the major constraints curtailing the growth and productivity of the crop in the region (Table 1). This is the first comprehensive report covering yield performance over the several years and elite mother tree selection of poly cross seedlings under the prevailing dry climate of Odisha; though a preliminary study on polyclonal population initial mean yield with comparison to other rubber clones in the region also has been attempted (Gupta *et al.*, 2001).

Table 1. **Meteorological parameters of the study site during the period (1991-2011)**

Parameter	Mean values
Temperature (°C)	
T max	32.8
T min	21.4
Relative humidity (%)	
RH morning	87.5
RH evening	62.1
Total rainfall (mm)	1278
Rainy days	72
Sunshine hours	6.7
Evaporation (mm)	3.7

This study was conducted at the Regional Research Station of Rubber Research Institute of India at Kadalipal, Dhenkanal (20° 49′40″ N, 85° 30′ 45″ E, altitude 100 m above msl)) in Dhenkanal district of Odisha. The polyclonal population of *Hevea* was raised from seeds obtained from specially maintained polyclonal seed gardens. The seedlings were field planted in 1989. Single tree single plot completely randomized design was used with a spacing of 4.6 m x 4.6 m. In the first two years of crop management the plants were given life saving irrigation of about 20 liters per plant, once a week during the dry hot months of March to May.

The population size was 776 trees. Tapping was started eight years after planting in 1997 under 1/2S d/2 6d/7 tapping system. Girth of seedlings at height of 110 cm and dry rubber yield of individual trees was recorded by cup coagulation method twice a month. Data were recorded from the entire population of 776 trees with special emphasis on selected elite trees. Ten numbers of elite polyclonal seedlings were selected, based on yield and secondary attributes. Data on growth and yield over ten years of tapping from the fourth year to fourteenth year were utilized for evaluating the performance of elite trees. In order to understand seasonal contribution to total yield in three different seasons *viz.* monsoon or rainy season (June to September), winter or cold (October to January) and summer or hot season (February to May). Recording on the tapping panel dryness, diseases and wind damage was also undertaken. The selected elite seedling trees were compared with almost similar aged population size of 280 numbers of the popular clone RRIM 600 in the adjoining region.

In this region, rainfall is received during the months of June to September. An annual average rainfall of 1278 mm, mean maximum temperature of 32.8 °C and average sun shine hours of 6.7 were recorded during the study period (Table 1).

Yield evaluation of the seedling population over the years revealed that certain genotypes are good performers, such elite seedling mother trees were closely monitored for growth, yield and secondary attributes.

Table 2. **Growth performance of poly cross elite trees**

Elite trees	Girth (cm) At panel opening 1997	Year of tapping 01-02	03-04	05-06	07-08	10-11	Annual increment*
O1	47.5	78.7	84.8	87.9	96.5	99.5 (9)	2.3(6)
O2	51.6	83.0	91.7	96.3	105.5	110.5 (6)	3.0(3)
O3	62.0	90.2	99.0	103.2	113.5	119.2 (2)	3.2(2)
O4	72.6	93.6	101.8	108.6	122.5	129.1 (1)	3.9(1)
O5	62.0	84.7	90.3	95.0	104.0	111.1 (5)	2.9(4)
O6	63.7	86.2	90.5	98.2	108.0	114.0 (3)	3.0(3)
O7	54.7	84.6	92.7	97.3	107.5	113.6 (4)	3.2(2)
O8	64.0	77.3	79.8	82.0	87.0	91.0 (10)	1.5(8)
O9	54.6	86.4	95.5	98.0	106.5	109.5 (7)	2.7(5)
O10	72.6	86.8	91.7	95.4	102.5	106.0 (8)	2.1(7)
SE	2.6	1.5	2.0	2.3	2.9	3.2	0.2
CV	13.8	5.6	6.9	7.6	8.9	9.3	24.1

* Over 10-year of tapping; figures in parenthesis depicts ranking of elite trees

Among the ten selected elite seedlings highest girth at the time of commencement of tapping was attained by O10 (72.6 cm) and O4 (72.6 cm) followed by O8 (64.0 cm). However, in advance stage during the year 2010-11, highest girth was attained by O4 (129.1 cm), O3 (119.2 cm) and O6 (114.0 cm). Highest and lowest girth increment since commencement of tapping was recorded in O4 and O8 elite seedlings, respectively (Table 2).

Rubber yields increased gradually with the onset of monsoon particularly in the month of August, peaked in subsequent period, sustained up to December and started slight decline thereafter (Table 3). Yields were comparatively low during the period from April to July, high during October to December and moderate during the remaining months (Table 3). The general trend observed is in agreement with the results published both for traditional (Joseph and Haridasan, 1991) and the non-traditional regions (Chandrasekhar *et al.*, 1990, Birari *et al.*, 1998). The contribution of cold months (October to January) to total yield was 48 per cent, while that of dry months (February to May) and wet months (June to September) seasons were similar (Fig.1). The mean performance of these selections was very good and better than that of popular clone RRIM 600 (Table 3). The dry rubber yield contribution of the elite selections showed that there is scope for selection for promising genotypes.

The mean annual dry rubber yields of the ten elite seedling mother trees over the ten years of tapping was two to three folds higher than that of the popular clone RRIM 600. The mean annual yield was recorded highest in the elite seedling O7 (82.4 $g\ t^{-1}\ t^{-1}$), followed by O8 (73.5 $g\ t^{-1}\ t^{-1}$) and O4 (73.4 $g\ t^{-1}\ t^{-1}$) (Table 4). Satisfactory polyclonal population mean yield in Odisha region has been also reported earlier (Gupta *et al.*, 2001). The combined mean variability in yield observed

Table 3. **Monthly dry rubber yield among elite poly cross trees**

Elite trees	Mean monthly rubber yield ($gt^{-1}t^{-1}$)*											
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
O1	49.3	44.6	51.9	94.2	122.1	106.0	82.5	69.3	80.6	60.5	55.3	56.5
O2	45.5	34.8	53.1	64.9	75.9	97.8	115.0	86.3	72.7	66.0	56.4	55.7
O3	40.8	40.1	71.7	78.9	93.3	130.0	94.0	62.5	65.9	56.2	36.3	34.6
O4	22.0	28.4	35.9	69.9	113.8	163.3	120.0	96.4	65.6	67.6	34.7	29.8
O5	21.8	36.7	55.2	92.4	97.3	118.7	90.6	71.7	49.5	55.5	42.5	33.7
O6	28.7	39.1	54.7	85.2	128.3	156.5	103.0	67.0	72.0	66.3	36.7	36.8
O7	52.3	63.6	66.7	85.1	103.9	150.6	146.0	88.1	72.4	53.7	50.0	57.2
O8	71.9	58.1	91.2	128.3	89.7	119.7	85.1	61.2	65.2	59.1	51.6	78.5
O9	34.2	44.2	56.5	80.0	89.4	112.4	89.6	55.1	42.8	44.7	42.7	41.5
O10	37.4	31.4	43.8	64.0	109.9	122.9	108.5	67.2	55.4	69.8	44.1	54.3
RRIM 600**	19.1	21.8	22.5	28.9	39.0	52.5	49.6	39.5	31.8	30.6	23.5	19.3
Mean*	40.3	42.1	58.0	84.2	102.3	127.7	103.4	72.4	64.2	59.9	45.0	47.8
CV	37.8	26.6	26.5	22.1	15.9	17.2	18.9	18.4	18.1	12.9	17.6	31.6

Monthly mean of elite polycross trees* and RRIM 600** over ten years (2001-02 to 2010-11) of tapping

Table 4. **Pattern of average annual rubber yield in different years of tapping**

Elite trees	Average rubber yield ($g\ t^{-1}\ t^{-1}$) over year of tapping*										Annual mean
	01-02	02-03	03-04	04-05	05-06	06-07	07-08	08-09	09-10	10-11	
O1	59.3	50.9	69.8	69.4	90.1	76.5	58.6	96.4	96.8	67.5	73.5 (3)
O2	54.8	57.6	71.3	81.5	75.2	83.5	61.6	60.8	76.3	61.0	68.3 (9)
O3	56.5	52.4	58.4	55.6	82.1	74.4	75.9	73.2	89.9	74.1	69.2 (6)
O4	58.7	41.2	61.3	52.5	110.0	91.6	46.7	71.8	114.2	86.2	73.4 (4)
O5	68.6	42.1	47.8	48.4	69.8	52.3	60.0	121.7	106.0	72.7	68.9 (7)
O6	48.0	47.0	52.6	74.8	81.3	78.6	42.3	82.0	100.0	96.3	70.3 (5)
O7	78.3	76.4	85.8	97.0	104.6	81.4	66.4	78.2	78.9	76.7	82.3 (1)
O8	89.0	64.0	76.4	90.2	97.8	105.4	56.4	60.8	84.5	78.3	80.2 (2)
O9	65.4	62.1	69.7	63.4	68.6	56.7	55.3	74.9	84.1	44.5	64.4 (10)
O10	74.0	55.7	70.3	73.4	79.5	99.3	27.2	54.8	82.2	71.8	68.8 (8)
RRIM 600	25.7	29.8	38.0	28.9	31.5	32.0	28.6	31.5	33.2	32.6	31.1
Base population											
Mean	35.9	29.4	32.6	35.6	36.6	35.5	22.8	27.6	31.6	32.4	
T-stat (P=0.05)	7.4	7.5	9.3	6.8	10.9	8.4	7.5	8.0	15.0	9.1	

*Annual mean for ten years (2001-02 to 2010-11) of tapping; figures in parenthesis depicts ranking of elite trees

Table 5. **Incidence percentage of tapping panel dryness (TPD) and wind damage**

Category	Poly cross population	RRIM 600
Partial TPD	4.9	5.0
Complete TPD	8.4	9.1
Wind damage	3.9	4.1

in this study is comparable to the results reported for the trees raised from seeds (Cherian, 1968; Senanayake, 1975; Chandrasekhar *et al.*, 2002). After about fourteen years of tapping since commencement, tapping panel dryness (TPD) was found to be 8.4 per cent (Table 5). The incidence to the occurrence of TPD is comparable, as also reported in other study on performance of yield of thirteen year age polyclonal population (Chandrasekhar *et al.*, 2002). The damage due to wind was low (3.9%) in the seedling population (Table 5). No up rooting of seedling trees was recorded which indicates the development of a stronger tap root system for the seedling trees.

The narrowing down of genetic base due to direct selection for yield has resulted in the erosion of valuable genes for adaptability thus diminishing the return from breeding in the recent years than in the early phase (Schultes, 1977, Simmonds, 1989). The selection of poly cross progenies can be a useful component to the normal hand pollination programme (Tan *et al.*, 1996). Clone RRII 5 and RRII 51 are two such primary clones evolved and released in India (Marattukalam *et al.*, 1990). The polyclonal seedlings exhibit very good yield and growth. Similar performance of seedlings also has been reported from Konkan region of Maharastra (Birari *et al.*, 1998, Chandrasekhar *et al.*, 2002) and from north eastern region (Sasi kumar *et al.*, 2001; Mondal *et al.*, 2006). Polyclonal population mean yield at an early stage of tapping also showed satisfactory performance in Odisha region (Gupta *et al.*, 2001). The present study reveals the importance of maintenance of genetic variability through planting of polyclonal seedlings and evolvement of new clones in drought prone areas in the non-traditional rubber growing areas in Odisha.

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