PERFORMANCE OF SOME *HEVEA* CLONES UNDER THE DRY SUB-HUMID CLIMATE IN ODISHA

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The growth and yield performance of three natural rubber *(Hevea brasiliensis)* clones were evaluated in dry sub-humid climate in Odisha in eastern India. In this region, crop experiences severe drought in summer months. Prolonged high summer temperature and soil moisture stress are the major environmental constraints. Analysis of growth performance of the clones revealed that GT1 had the highest girth and girth increment. Clone RRII 105 (32.8 g t^{-1} t^{-1}) had superior yield over other clones like RRIIM 600 and GT1, over eight years of tapping. Highest yield contribution for all three clones was recorded in winter season. More incidence of tapping panel dryness was noticed in RRIM 600. Wind damage was the highest in RRII 105. Comparatively higher timber bole volume was estimated in clone GT1 (0.09 m^3 per tree). Growth, yield and other secondary characters of three popular *Hevea* clones in the drought prone region are discussed.

Keywords: Clone evaluation, Girth, Yield, Stress environment, Odisha

The growth of the Indian rubber plantation industry has been mainly through the expansion of rubber cultivation (Thomas and Panikkar, 2000) and the major area of rubber growing region in India is confined to west coast of the country (8 to 12^0 North). Growing demand for natural rubber coupled with the limited scope for area expansion in the traditional region has necessitated an increase in production from the non-traditional region of rubber cultivation (Sethuraj *et al.*, 1989). In the dry sub- humid region of Odisha high summer temperature and severe moisture deficits are the major constraints curtailing the growth and productivity of the crop.

Such plantations are being established in an environment grossly different from the traditional rubber growing area to which the species is best adapted. The yield and growth performance of even recommended clones in traditional regions are often different from yield and growth in different locations. Performance evaluation studies in dry sub-humid conditions begin only in early nineties (Sethuraj *et al.*, 1989; Mohankrishna *et al.*, 1991; Sanjeeva Rao and Vijayakumar, 1992; Chandrashekar *et al.*, 1996, 97). Preliminary studies on the performance of *Hevea* clones have also been reported in dry sub-humid climate of Odisha (Meenatoor *et al.*, 2000; Gupta *et al.*, 2001, 2002). The present

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comprehensive study has been carried out on the performance of yield and growth of the popular rubber clones over the years to identify the most suitable clone in the drought prone region of Odisha.

The experiment was laid out in 1987-88 in the Regional Research Station of the Rubber Research Institute of India at Kadalipal, Dhenkanal (20° 49′ 40" N Latitude, 85° 30′ 45" E longitude and altitude of 100 m MSL) a dry sub-humid region of Odisha. The soil is Alfisols order with pH 5.5 sandy loam type and lateritic in nature. In this experiment three elite clones RRIM 105, RRIM 600 and GT1 (Table1) were laid out in randomized block design with 36 plants per plot in eight replications and field planted at a spacing of 4.6 m x 4.6 m. In the initial years, partial life saving irrigation of 20L per week was provided in summer months. Growth was recorded as girth of the trunk at a height of 150 cm. Girth was recorded at regular intervals. Tapping was commenced in 1997 under 1/2 S d/2 6d/7 tapping system. Dry rubber yield ($gt^{-1}t^{-1}$) was recorded twice a month following cup coagulation method. The yield data over eight years (2003-04 to 2010-11) were used for evaluating the clones. In order to assess the seasonal performance, a year has been grouped into three seasons, as rainy-moist (June to September), winter-cold (October to January) and summer – hot (February to May). Incidence of tapping panel dryness and wind damage was also recorded for entire field plants. The trunk height up to the main fork was measured and the clear bole volume per tree was estimated in the thirteenth year after planting following the quarter girth method (Chathurvedi and

Table1. **Parentage and country of origin of clones**

Clone	Parentage	Country of origin
RRII 105	Tjir1 x Gl 1	India
RRIM 600	Tjir 1 x PB 86	Malaysia
GT 1	Primary clone	Indonesia

Table 2. **Meteorological parameters of the site during the study period (1991-2011)**

Month	Temperature (°C)		Relative humidity (%)		Rainfall	Rainy	Sunshine	Evaporation
	Tmax	Tmin	RHmax	RHmin	(mm)	days	hours	(mm day^{-1})
January	27.8	13.9	86.2	55.4	6.6	0.5	7.3	2.9
February	31.2	17.2	86.0	50.3	7.4	1.0	8.2	3.7
March	35.7	21.1	85.4	47.0	14.0	1.3	8.4	4.9
April	39.5	24.5	85.0	49.7	35.7	3.2	8.9	6.3
May	39.4	25.7	84.9	54.0	82.0	4.5	8.5	6.3
June	35.4	25.9	86.6	68.0	193.3	11.5	5.4	4.5
July	32.1	25.1	89.3	77.8	346.8	17.6	4.2	2.5
August	31.7	25.0	90.7	79.0	275.3	15.0	4.3	2.5
September	31.8	24.6	90.1	77.1	185.7	10.4	5.0	2.4
October	31.4	22.8	89.9	70.1	109.9	6.0	7.1	2.8
November	29.4	17.3	87.3	59.7	13.5	1.1	7.0	2.8
December	27.7	13.6	88.6	57.3	7.5	0.4	7.3	2.7
Total/mean	32.7	21.3	87.5	62.1	1277.7	72.5	6.8	3.6

Khanna, 1982). The data were statistically analyzed according to the standard procedure (Sukhatme and Amble, 1989).

The study site is having dry sub-humid climate with stressful climatic condition. This region experiences high temperature and low rainfall. Daily minimum temperature was low in November, December and January and in the remaining months temperature was fairly high. Maximum temperature exceeds 35 °C during March to June. During summer, in the month of April and May the mean maximum temperature was recorded 40 °C. The region received an annual rainfall 1277 mm during the study period and the rainy period was 72 days mainly confined to June to September. The distribution of satisfactory rainfall resulted in long dry period extending from mid October to May. The sun shine hours (SSH) during July and August were low and moderate in June and September. The SSH was more than seven hours daily in the remaining months. Evaporation was low during July, August and September and high during the summer months (Table 2).

Clone RRIM 600 recorded mean average girth of 42.8 cm followed by GT 1 (40.6 cm) and RRII 105 (38.1 cm). At the commencement of tapping, number of trees attain tappability was highest in GT1 (30%), followed by RRIM 600 (27.2%). Mean girth at the fourth year and the thirteenth year after commencement of tapping was recorded in the rubber clones and found that the highest girth increment was in the clone GT 1 (Table 3).

The yield over eight year of regular tapping (2003-04 to 2010-11) revealed that RRII 105 recorded the highest yield (32.8 g t^{-1} t^{-1}) followed by RRIM 600 (31.7 g t^{-1} t^{-1}) and GT1 (27.9 g t^{-1} t^{-1}). The projected yield (Kg ha^{-1} yr^{-1}) of the clones RRII 105, RRIM 600 and GT1 were 1239, 1108 and 1054, respectively (Table 4). Comparable yield of RRIM 600 and RRII 105 has been also observed in other studies (Mondal *et al.*, 1999; Gupta *et al.*, 2002; Reju *et al.*, 2002).

The yield of the clones varied in different season. Highest yield for all three

Table 4. **Yield performance of popular clones under the dry sub humid region**

Clone	Mean annual yield (g t^{-1} t^{-1})*	Projected yield (kg ha^{-1} yr^{-1})**
RRII 105	32.8	1239
RRIM 600	31.7	1198
GT 1	27.9	1054
Mean	30.8	1165
CD (P=0.05) 3.4		

* 2003-04 to 2010-11 ** Based on 350 trees per ha in 108 tapping days per year

Table 3. **Growth performance of popular clones in a dry sub-humid climate**

Clone	Mean girth (cm) at commencement of tapping (1997)	Tappability (%)	Mean girth (cm) (2001)	Mean girth (cm) (2011)	Mean annual girth increment (cm) (1997 to 2011)
RRII 105	38.1	12.3	52.7	67.2	3.2
RRIM 600	42.8	27.2	56.8	71.3	3.5
GT 1	40.6	30.0	57.6	74.5	3.8
Mean	40.5	23.1	55.7	71.0	3.5
CD (P=0.05)	3.0	—	2.5	3.1	NS

Table 5. **Seasonal yield of popular clones in dry sub-humid climate (2003-04 to 2010-11)**

Clone	Season ($g\ t^{-1}\ t^{-1}$)		
	Monsoon (Jun-Jul-Aug-Sep)	Winter (Oct-Nov-Dec-Jan)	Summer (Feb-Mar-Apr-May)
RRII 105	21.6	48.1	26.0
RRIM 600	23.0	44.1	25.6
GT 1	18.7	39.8	25.4
Mean	21.1	44.0	25.6
CD (P=0.05)	NS	5.6	NS

Table 6. **Monthly yield ($g\ t^{-1}\ t^{-1}$) of clones over eight years (2003-04 to 2010-11)**

Clone	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Mean
RRII 105	19.1	19.3	21.6	26.6	42.2	59.3	54.9	35.7	28.4	31.1	24.3	20.2	32.8
RRIM 600	19.0	21.8	22.5	28.9	39.0	51.5	48.7	37.0	30.5	30.5	22.1	19.1	31.7
GT 1	17.5	17.8	18.1	21.4	32.4	47.2	45.8	33.9	28.9	25.9	21.0	25.9	27.9
Mean	18.5	19.6	20.7	25.6	37.8	52.6	49.8	35.5	29.2	29.1	22.4	21.7	30.2
CD (P=0.05)	NS	NS	NS	5.1	6.6	8.2	6.2	NS	NS	3.8	NS	4.8	3.4

popular clones was recorded during winter. Mean summer yield over eight years was highest in RRII 105 followed by RRIM 600 and GT 1. The lowest yield was recorded during the monsoon season (Table 5 & 6). Comparable performance of clones in Odisha has been reported by Gupta *et al.*, 2002. Reduction in the yield of rubber during summer season was mainly due to high temperature and other adverse climatic conditions as reported in other studies in Konkan, Maharastra and other north eastern states (Chandrasekhar *et al.*, 1997; Reju *et al.*, 2001). The marked reduction in yield in summer months as observed here could be due to low soil moisture and high vapor pressure deficits (Sethuraj and Raghavendra, 1984; Chandrasekhar *et al.*, 1997). The lower yield in dry months could be also the result of low latex flow rate and reduced duration of flow (Devakumar *et al.*, 1988).

There was clonal variation for the clear bole volume which ranged from 0.07 to 0.09 m^3 per tree. Clone GT1 recorded the highest clear bole volume of 0.09 followed by RRIM 600 (0.08) and RRII 105 (0.07). The timber production potential along with

Table 7. **Timber traits of popular clones**

Clone	Branching height (m)	Bole volume ($m^3\ tree^{-1}$)
RRII 105	2.98	0.07
RRIM 600	3.00	0.08
GT 1	3.04	0.09
Mean	3.00	0.08
CD (P=0.05)	NS	NS

Table 8. **Tapping panel dryness and wind damage**

Clone	Tapping panel dryness (%)	Wind damage (%)
RRII 105	7.2	5.6
RRIM 600	9.1	2.8
GT 1	8.4	2.8

yield assumes much significance for maximizing the economic returns from rubber plantation. The yield of timber obtained from rubber tree comprises mainly of the clear bole volume (Najib *et al.*, 1995) which is dependent on the height at first forking and the girth of the tree. The growth attributes especially girth increment under tapping thus have a bearing on the volume of the timber (Mydin *et al.*, 2005) (Table 7). Incidence of tapping panel dryness ranged from 7.2 percent to 9.1 per cent (Table 8). Highest wind damage incidence was recorded in RRII 105 (5.6%) (Table 8). In the present study clone RRII 105 and RRIM 600 recorded comparable yield while GT 1 recorded comparatively higher girth and girth increment.

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