Natural Rubber Research, 20 (1&2): 32-38, 2007

EVALUATION OF YIELD POTENTIAL OF *HEVEA BRASILIENSIS* CLONES OVER TEN YEARS OF TAPPING IN ASSAM

G.C. Mondal, R.P. Singh, D. Mondal, T. Gohain, D. Chaudhuri, M.A. Nazeer* and Ramesh B. Nair*

Rubber Research Institute of India, Regional Research Station, Housefed Complex, Guwahati – 781 006, Assam, India

* Rubber Research Institute of India, Rubber Board, Kottayam – 686 009, Kerala, India

Submitted: 15 December 2005 Accepted: 12 September 2007

Mondal, G.C., Singh, R.P., Mondal, D., Gohain, T., Chaudhuri, D., Nazeer, M.A. and Nair, R.B. (2007). Evaluation of yield potential of *Hevea brasiliensis* clones over ten years of tapping in Assam. *Natural Rubber Research*, 20 (1& 2): 32-38.

The yield potential of 18 *Hevea brasiliensis* clones were evaluated over the first ten years of tapping under continuous tapping system (without rest) in Assam, North East India. Secondary attributes like TPD, clear bole volume, wind damage and tolerance to powdery mildew disease of these clones were also evaluated. RRIC 102 showed the highest girth in immature stage, closely followed by RRIC 105, while the lowest girth was observed in Gl 1. RRIC 102 exhibited the highest girth increment after the commencement of tapping and during mature stage. RRIM 600 had the highest yield (33.91 g) over the first ten years of tapping followed by PB 311 (31.08 g). Yield was less for all the eighteen clones during winter months (December to March) characterized by low temperature, combined with wintering and refoliation stresses. High dry rubber content (DRC) of latex was observed in all the clones from May to August, while it was low in December and January. Yield got stabilized by six years of tapping. The projected commercial yield (kg/ha/year) over the first ten years of tapping indicated that RRIM 600 ranked first (2034 kg) followed by PB 311 (1864 kg). The potential yield of RRII 105, (the popular clone in the traditional tract) was only 1680 kg/ha/year in the experimental location.

Key words: Assam, Clones, Growth, *Hevea brasiliensis*, India, Yield, Yield stabilization.

INTRODUCTION

There is a growing demand for natural rubber in India and non-availability of potential land for further expansion of this crop in the traditional rubber growing region of South West India, the cultivation has been extended to the non- traditional areas of North East (NE) India. The north-eastern region has been identified as one of the most potential non-traditional tracts suitable for rubber plantation, the major agro-climatic constraint for growth and productivity of rubber here is the low temperature during winter (December to February) which affects the growth and increases the gestation period by one or two years as compared to the traditional zone. Therefore, it is necessary to evolve location-specific clones for North East India. Very limited information is available on the effect of agro-climate on growth and yield of rubber (*Hevea brasiliensis)* clones in this region (Sethuraj *et al.*, 1989; Vinod *et al.*, 1996; Mondal *et al.*, 1999). The present study was taken up to evaluate the growth and yield of 18 *H. brasiliensis* clones under the prevailing agro-climatic conditions of Assam in NE India.

Correspondence: G.C. Mondal (Email: gopalchandra@rubberboard.org.in)

MATERIALS AND METHODS

The study was conducted in 18 *Hevea* clones (RRII 105, RRII 118, RRII 203, RRIM 600, RRIM 605, PB 86, PB 235, PB 5/51, GT 1, Gl 1, RRIC 102, RRIC 105, RRII 208, RRII 5, PB 260, PB 310, PB 311 and PR 255) in two clone trials planted in single-tree-plot, with completely randomized design during 1985 and 1986 with 40 replications at the Regional Research Station of the Rubber Research Institute of India at Sorutari Farm (Lat: 26° 35'N, Long: 90° 52'E, Alt: 50 to 105 m above msl) in Kamrup district of Assam.

Three years after planting, girth of the trees at a height of 150 cm from the bud union was measured at intervals of three months. Girth of the plants in 20 replications were used to calculate the girth increment in immature and mature phases of growth. The trees were opened for tapping at the age of eight years and tapped under 1/2S d/2 system without any tapping rest. Based on uniform girth ten trees of each clone were selected at random for recording yield (by cup coagulation) and dry rubber content (DRC) at monthly intervals. The commercial yield was calculated and projected based on 400 trees and 150 tapping days over 10 years of tapping. Yield data for the first 10 years of tapping were analyzed to find out the year of yield stabilization using rank correlation method. The timber yield (clear bole volume) was estimated using the values of girth and first forking height at the age of 18 years following the Hoppus method (Chaturvedi and Khanna, 1982). Secondary characters like wind damage, incidence of tapping panel dryness (TPD) syndrome (75 % and above) and the severity of powdery mildew disease were also recorded periodically. The data were statistically analyzed.

RESULTS AND DISCUSSION

The growth performance of the clones in respect of girth during juvenile, immature and mature phases are presented in Table 1. In the juvenile phase, the girth of clones RRIM 600, PB 235, RRII 118, RRIM 605, RRII 203, GT 1 and RRII 105 were statistically on par and above the mean. At eight years after planting, RRIC 102 attained the highest girth (56.6 cm) closely followed by RRIC 105 (55.05 cm), PR 255 (54.66 cm) and PB 311 (54.21 cm) and the least was for Gl 1 (40.18 cm). Girth of clones RRIM 600, PB 235, RRII 208, PB 260 and PB 310 were also above the average at eight years after planting. At 18 years after planting, RRIC 102 showed the highest girth (79.9 cm), RRII 118 (75.7 cm), RRII 203 (75.3 cm), RRIM 600 (74.4 cm) and PB 310 (72.8 cm) also showed high girth with the lowest in PB 5/51 (53.0 cm). There was no significant difference between the clones in girth increment. The highest annual average girth increment was also noticed for RRIC 102 (6.6 cm) followed by PR 255 (6.54 cm), PB 235 (6.09 cm) and RRIM 600 (6.08 cm) with the lowest for PB 5/51 (4.1 cm) at the immature phase of growth. The average rate of girth increment in the mature phase (tapping) ranged from 1.02 to 2.39 cm. Clone RRII 118 showed the highest annual girth increment (2.39 cm) closely followed by RRIC 102 (2.33 cm) and RRII 203 (2.29 cm).

The mean yield over first ten years of tapping was maximum for RRIM 600 (33.91 g/t/t) which was on par with PB 311 (31.08 g). The clones PB 235 (29.09 g),

Table 1. **Variability in annual mean girth, girth increment, yield and other secondary attributes**

Clone	Girth at various stages (cm)			Mean girth increment (cm)		Mean yield (first 10 years)	Commercial yield projected (kg/ha/yr)	Clear bole volume (m^3/ tree)	TPD (%)	Powdery mildew incidence	Wind damage
	Juvenile (3YAP)	Immature (8YAP)	Mature (18YAP)	Immature (5 years)	Mature (10 years)						
RRII 105	22.33	50.26	63.1	5.59	1.13	28.00	1680 (6)	0.16	10.0	S	13.7
RRII 110	23.94	50.65	75.7	5.80	2.39	27.86	1671 (7)	0.17	12.9	MT	12.5
RRII 203	22.79	49.32	75.3	5.73	2.29	24.10	1446(11)	0.15	2.2	T	4.1
RRIM 600	24.00	52.51	74.4	6.08	1.92	33.91	2034 (1)	0.12	10.0	MT	4.6
RRIM 605	22.93	49.44	68.3	5.68	1.63	24.71	1482(10)	0.11	15.3	MT	4.5
PB 86	22.10	50.23	71.5	5.82	1.85	26.16	1569 (8)	0.12	11.7	T	0.0
PB 235	23.95	52.89	70.0	6.09	1.58	29.09	1745 (3)	0.20	2.7	HS	2.6
PB5/51	21.43	40.78	53.0	4.10	1.02	22.39	1343(15)	0.12	8.5	HS	2.7
GT 1	22.62	47.68	70.7	5.73	1.83	28.59	1715 (5)	0.13	0.0	MT	9.5
Gl 1	18.25	40.18	59.3	5.02	1.50	21.63	1297(16)	0.08	16.2	S	2.2
RRIC 102	18.30	56.60	79.9	6.60	2.33	21.06	1263(17)	0.24	15.7	S	9.5
RRIC 105	20.70	55.05	69.9	5.61	1.48	20.85	1251(18)	0.11	9.5	S	18.5
RRII 5	20.41	51.19	65.7	4.98	1.45	23.84	1430(12)	0.14	0.0	S	0.0
RRII 208	21.64	53.10	69.5	5.22	1.63	24.82	1489(9)	0.12	4.5	MT	12.0
PB 260	19.19	52.83	67.4	5.26	1.46	23.41	1404(13)	0.17	7.6	MT	0.0
PB 310	21.79	53.61	72.8	5.68	1.92	28.77	1726(4)	0.20	4.3	MT	4.1
PB 311	20.83	54.21	69.7	5.82	1.55	31.08	1864(2)	0.14	7.1	MT	3.4
PR 255	18.12	54.66	72.3	6.54	1.77	23.12	1387(14)	0.17	13.3	S	6.2
Mean	21.40	50.84	69.4	5.63	1.70	25.74	1544.2	0.14	8.4	-	6.2
LSD (P≤0.05)	1.74	2.88	3.2	NS	NS	3.17	191.61	0.03	-	-	-

YAP= Years after planting; Figures in parenthesis indicate the relative ranking of individual clone based yield potential; HS=Highly susceptible; S= Susceptible; MT=Moderately tolerant; T= Tolerant.

PB 310 (28.77 g), GT 1 (28.59 g) and RRII 105 (28.0 g) yielded above the average. The minimum yield was recorded for RRIC 105 (20.85 g). The projected productivity of these clones are 2034, 1864, 1745, 1726, 1715, 1680 and 1251 kg/ha/year respectively.

The data of rank correlation over the first ten years of tapping with respect to yield stabilization are presented in Figure 1. The correlation stabilized at 0.95 from sixth year. Hence six years yield is sufficient for identification of yield potential among experimental clones.

The yield recorded in different months are presented in Table 2. Yielding pattern of clones over months in Assam shows a clear delineation of low and high yielding periods. The low yield from January to March

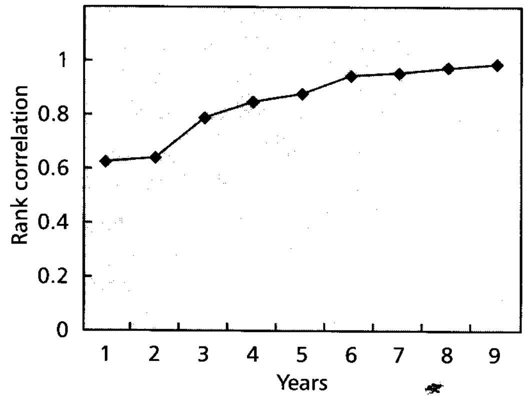

Fig. 1. Stabilisation of yield over ten years of tapping

Table 2. **Yield pattern in different months (mean of 5 years)**

Clone	Dry rubber yield (g/t/t)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
RRII 105	24.68	17.43	13.40	21.68	19.39	19.28	18.00	19.89	29.08	44.90	44.89	43.03
RRII 118	19.05	18.36	18.41	23.14	21.13	14.79	16.06	18.95	28.00	36.86	39.34	33.51
RRII 203	16.24	13.91	12.25	19.24	16.18	14.71	18.63	19.17	22.73	30.44	34.79	28.56
RRIM 600	31.09	23.85	20.21	27.46	22.61	22.20	21.42	28.52	31.46	45.10	55.68	50.85
RRIM 605	19.56	16.88	9.33	14.67	14.69	13.58	11.26	15.30	19.04	34.55	41.35	37.93
PB 86	19.06	13.09	12.35	18.31	17.48	15.51	16.09	20.35	21.78	32.35	33.49	36.83
PB 235	22.97	20.48	16.50	24.07	19.13	13.33	14.38	20.85	31.07	42.72	51.38	40.17
PB5/51	25.11	18.07	13.60	18.02	15.18	13.68	13.78	18.54	20.88	29.28	36.80	34.51
GT 1	24.82	21.57	15.24	20.73	18.72	17.06	16.13	20.58	25.06	32.89	41.09	37.22
Gl 1	18.41	14.80	12.12	17.92	13.29	13.32	12.50	15.16	17.78	29.86	32.72	30.79
RRIC 102	15.46	12.41	10.82	15.03	14.05	14.66	14.19	19.34	23.40	27.52	32.74	26.31
RRIC 105	15.90	10.59	10.40	16.26	16.58	13.23	8.50	12.87	20.51	25.01	34.40	25.60
RRII 208	11.93	11.12	11.48	17.02	14.60	18.24	13.32	21.41	25.23	34.47	33.34	27.89
RRII 5	17.69	13.11	13.89	18.64	16.45	17.25	17.42	22.16	27.92	34.13	38.23	30.29
PB 260	14.82	11.23	11.47	16.02	15.68	16.68	13.56	19.91	25.58	28.70	38.34	29.41
PB 310	19.71	17.71	18.45	22.40	19.40	20.61	18.32	25.44	31.51	39.18	42.98	33.37
PB 311	20.73	21.65	19.80	24.63	25.10	22.32	24.31	33.48	37.54	45.32	45.23	35.82
PR 255	17.82	12.90	10.21	14.81	16.40	13.50	13.77	19.19	20.54	26.90	30.00	29.54

for all the clones can be attributed to low winter temperature from the middle of December, which leads to defoliation. Factors like utilization of reserve foods for refoliation and flowering along with moisture stress may result in the low yield during February to March. With the rise in temperature from March onwards, a substantial increase in yield was noticed in April. This may probably due to refoliation (Chua, 1970; Hu Yaohua and Xie Haishing, 1985) which starts by the first or second week of February and the new flushes become mature by March/April (Mondal *et al.,* 1998). Thereafter, a slight decline in yield was noticed in all the clones which remained low till July. The marked reduction in yield in summer months as reported here could be due to low level of soil moisture and high vapour pressure deficits (Sethuraj and George, 1976; Sethuraj and Raghavendra, 1984; Chandrasekhar *et al.,* 1990). It is well established that temperature and availability of water are the two major factors influencing growth and yield of rubber plants (Rao *et al.,* 1993). The mean monthly maximum and minimum temperature recorded at Sorutari Farm were in the range of 23.6 to 32.8 °C and 11.0 to 24.9 °C, respectively. This could also be due to low latex flow rate and reduced duration of flow (Devakumar *et al.,* 1988). The fall in temperature during October and November stimulates yield as the atmospheric conditions are most ideal for latex flow and production (Priyadarshan *et al.,* 2000).

The timber obtained from a rubber tree comprises mainly of the clear bole volume which is dependent on the height at first forking and the girth of the tree. The clear bole volume (m^3/tree) ranged from 0.08 (Gl 1) to 0.29 (RRIC 102) among the clones (Table 1). The timber production potential along with high yield assumes much significance in maximizing the economic returns from rubber plantation. However, clone

PB 235 is reported as potential clone for latex and timber production (Arshad *et al.*, 1995). Clones with high girth along with a high branching nature are preferred for use as timber clones (Viswanathan *et al.*, 2002).

The data on secondary attributes like the incidence of tapping panel dryness, (TPD) wind damage and powdery mildew disease caused by *Oidium heveae* are shown in Table 1. Incidence of TPD was noticed in all the clones evaluated except GT 1 and RRII 5. Clone Gl 1, though a relatively low yielder was most susceptible to TPD (16.2 %). All the high yielders except GT 1 showed TPD in the ranges between 2.7 to 10 per cent. Tapping panel dryness, generally considered to be a physiological disorder associated with excessive exploitation (Chrestin *et al.*, 1985) is reported to occur in varying intensities among clones (Sivakumaran *et al.*, 1986; Mydin *et al.*, 1999).

The incidence of wind damage till the eighteenth year after planting was recorded. Three clones *viz.*, PB 86, PB 260 and RRII 5 were not affected by wind. RRIC 105 was the most prone to wind damage (18.5%). Among the promising rubber yielding clones (ranked from 1st to 5th), the damage by wind was less (3.4 to 9.5 %).

All the clones were affected by powdery mildew disease with varying intensity (Table 1). Among the clones assessed, the disease severity was above the grade 3.5 for PB 5/51, PB 235, RRII 105, Gl 1, RRIC 102, RRIC 105, RRII 5 and PR 255, indicating their susceptibility to powdery mildew. For the promising rubber yielding clones *viz.*, RRIM 600, PB 311, PB 310 and GT 1 the infection grade ranged from 1.5 to 2.5 which indicated that these clones are moderately tolerant. Clones PB 86 and RRII 203 showed tolerance with infection grades below 1.5.

The dry rubber content (DRC) of latex of *H. brasiliensis* clones in different

Table 3. **Dry rubber content in different months (mean of 5 years)**

Clone	Dry rubber content (%)												Mean
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	
RRII 105	21.60	25.33	25.59	26.93	30.86	30.20	30.48	31.57	33.1	32.18	29.93	26.18	28.66
RRII 118	23.35	27.17	28.28	28.66	33.81	31.10	31.08	34.24	34.29	32.66	29.43	26.18	30.00
RRII 203	22.99	27.54	25.42	24.65	32.01	31.47	30.05	29.84	30.10	30.49	26.68	23.78	27.91
RRIM 600	21.73	25.13	27.27	26.27	32.09	32.05	31.81	35.40	34.78	33.69	30.00	25.75	29.66
RRIM 605	25.12	27.36	27.05	26.06	28.62	29.41	30.50	34.19	32.62	33.17	31.20	27.67	29.41
PB 86	18.99	22.97	24.91	25.20	31.77	30.46	30.94	31.28	30.97	30.80	28.20	22.67	27.43
PB 235	26.86	30.39	27.64	29.06	30.30	29.90	31.44	33.31	32.40	32.29	30.46	27.83	30.15
PB5/51	22.45	25.89	27.44	24.86	30.39	32.44	32.15	33.52	32.80	32.64	30.47	26.09	29.26
GT 1	24.04	28.00	27.90	27.83	32.65	30.91	30.58	34.21	32.21	31.73	29.80	27.06	29.74
Gl 1	21.98	24.77	27.45	26.05	28.73	30.0	29.08	30.52	30.69	29.79	30.47	25.66	27.93
RRIC 102	23.21	24.89	26.75	29.22	30.09	33.76	30.13	33.26	33.66	33.87	33.18	27.41	29.95
RRIC 105	22.86	23.57	25.63	29.39	28.96	29.80	28.17	32.75	31.81	30.50	29.59	27.19	28.35
RRII 208	22.20	23.86	25.48	31.11	29.81	30.76	30.53	33.66	31.90	30.42	29.91	27.00	28.80
RRII 5	23.67	25.96	28.68	32.07	30.60	32.98	30.68	34.20	33.10	31.57	30.39	25.51	29.95
PB 260	23.35	25.08	27.31	31.24	29.65	30.10	28.79	32.39	31.15	30.86	30.52	25.10	28.70
PB 310	22.74	25.55	26.81	31.27	31.88	31.82	31.11	34.99	33.41	32.04	30.42	26.30	29.86
PB 311	25.35	25.45	26.94	31.57	31.14	30.55	30.53	32.06	29.94	29.41	30.39	27.03	29.19
PR 255	24.85	25.70	28.19	28.26	29.96	30.46	31.20	34.24	30.46	30.30	30.82	26.90	29.27

months are presented in Table 3. Low DRC was recorded from December to March (with the lowest in January) for all the clones (Fig.2). Maximum DRC was recorded in August with highest annual average in PB 235 (30.15 %) followed by RRII 118 (30%). Lower DRC observed in all the clones from December to February was probably due to fall in minimum temperature below 15 ^{0}C (Sethuraj, 1992) which might

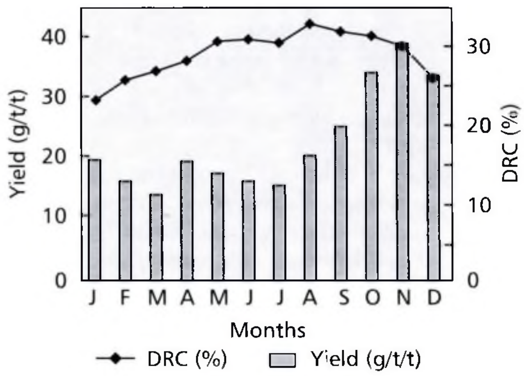

Fig. 2. Variability in yield potential and DRC in different months over 10 years (Mean of 18 clones)

have affected the rate of rubber synthesis.

The performances of the five clones *viz.*, RRIM 600, PB 311, PB 235, PB 310 and GT 1 out of 18 *H. brasiliensis* clones in terms of high yield and better growth suggests their potential as efficient clones for future planting in north east regions. Since the promising clone, PB 235 is susceptible to powdery mildew disease, it may be recommended for future planting only in NE regions when the disease occurrence is absent. The yield was observed to stabilize in six years and yield potential can be identified. Besides the clones RRIM 600 and GT 1 already recommended for large scale planting in the non-traditional regions, PB 311 and PB 310 are also potential yielders with moderate tolerance to powdery mildew disease in Assam. However, the adaptability of these clones to different locations of variable ecological conditions in north east region under commercial scale planting needs to be assessed.

ACKNOWLEDGEMENT

The authors are highly grateful to Dr. N.M. Mathew, Director, RRII for necessary facilities and encouragement for conducting this study. Thanks are also due to Dr. C.K. Saraswathyamma, Deputy Director, Botany Division for valuable suggestions during preparation for the manuscript and to Dr. C.P. Reghu, Botanist, Germplasm Division, RRII, Kottayam, Kerala for the assessment of timber yield potential of the clones.

REFERENCES

Arshad, N.L., Othman, R. and Yaacob, A.R.W. (1995). *Hevea* wood availability in Peninsular Malaysia. *Planter's Bulletin,* 224 & 225: 73-83.

Chandrasekhar, T.R., Jana, M.K., Thomas, J., Vijayakumar, K.R. and Sethuraj, M.R. (1990). Seasonal changes in physiological characteristics and yield in newly opened trees of *Hevea brasiliensis* in North Konkan. *Indian Journal of Natural Rubber Research,* 3 (2): 88-97.

Chaturvedi, A.N. and Khanna, L.S. (1982). Forest mensuration. International Book Distributors, Dehradun, 310p.

Chrestin, H., Jacob, J.L. and d'Auzac, J. (1985). Biochemical basis for cessation of latex flow and occurrence of physiological bark dryness. *Proceedings of International Rubber Conference,* Kuala Lumpur, Malaysia, 3: 20-42.

Chua, S.E. (1970). Physiology of foliar senescence and abscission in *Hevea brasiliensis* Muell. Arg., Ph.D. Thesis, University of Singapore.

Devakumar, A.S., Rao, G.G., Rajagopal, R., Rao, P.S., George, M.J., Vijayakumar, K.R. and Sethuraj, M.R. (1988). Studies on soil-plant-atmosphere system in *Hevea*: 2. Seasonal effects on water relations and yield. *Indian Journal of Natural Rubber Research,* 1 (2): 45-60.

Mondal, G.C., Sethuraj, M.R. Potty, S.N. and Sinha, R.R. (1998). Influence of wintering pattern on the incidence of Oidium SLF disease in different cloens of *Hevea* rubber in Assam. *Rubber Board Bulletin,* 27 (3): 18-24.

Mondal, G.C., Das, K., Singh, R.P., Mandal, D., Gupta, C., Gohain, T., Deka, H.K. and Thapliyal, A.P. (1999). Performance of *Hevea* clones in Assam. *Indian Journal of Natural Rubber Research,* 12 (1&2): 55-61.

Mydin, K.K., John, A., Marattukalam, J.G., Saraswathyamma, C.K. and Saraswathy, P. (1999). Variability and distribution of tapping panel dryness in *Hevea brasiliensis. Proceedings of IRRDB Symposium,* Breeding and Selection, China, 1999, pp.83-90.

Mydin, K.K., John, A., Nazeer, M.A. Prem, E., Thomas, V. and Sarawathyamma, C.K. (2005). Promising *Hevea brasiliensis* clones evolved by ortet selection with emphasis on latex – timber traits and response to stimulation. *Journal of Plantation Crops,* 33 (1) : 18-28.

Priyadarshan, P.M., Dey, S.K., Sudhasowmyaltha, M.K., Sasikumar, S., and Varghese, Y.A. (2000). Evaluation of *Hevea brasiliensis* clones for yielding trends in Tripura. *Indian Journal of Natural Rubber Research,* 13: 56-63.

Rao, P.S., Jayarathnam, K. and Sethuraj, M.R. (1993). An index to assess acreas hydrothermally suitable fo rubber cultivation. *Indian Journal of Natural Rubber Research,* 6 (1&2): 80-91.

Sethuraj, M.R. (1992). Yield components in *Hevea brasiliensis.* In: *Natural Rubber: Biology Cultivation and Technology* (Eds. M.R. Sethuraj and N.M. Mathew). Elsevier, Amsterdam, pp. 137-163.

Sethuraj, M.R. and George, M.J. (1976). Drainage area of the bark and soil moisture content as factors influencing latex flow in *Hevea brasiliensis. Indian Journal of Natural Rubber Research,* 19: 12-14.

Sethuraj, M.R. and Raghavendra, A.S. (1984). The pattern of latex flow from rubber tree (*Hevea brasiliensis*) in relation to water stress. *Journal of Cellular Biochemistry,* 8B: S-236.

Sethuraj, M.R. Potty, S.N., Vijayakumar, K.R., Rao, P.S., Thapliyal, A.P., Mohankrishna, T., Rao, G.G., Chaudhuri, D., George, M.J., Soman, T.A. and Meenattoor, J.R. (1989). Growth performance of *Hevea* in the non-traditional regions of India. *Proceedings, RRIIM Rubber Growers' Conference,* 1989, Malacca, Malaysia, pp.212-227.

Sivakumaran, S., Chew, O.K. and Gan, L.T. (1986). Incidence and development of dryness in some modern *Hevea* cultivars. *Proceedings, Rubber Research Institute of Malaysia, Rubber Growers Conference,* Perak, Malaysia, pp.104-128.

Vinod. K.K., Meenattoor, J.R., Priyadarshan, P.M., Pothen, J., Chaudhuri, D., Krishnakumar, K., Sethuraj, M.R. and Potty, S.N. (1996). Early performance of some clones of *Hevea brasiliensis* in Tripura. *Indian Journal of Natural Rubber Research* 9(2):123-129.

Viswanathan, P.K., Reghu, C.P. and Tharian George, K. (2002). From latex to timber: The Indian perspective. In: *Global competitiveness of Indian rubber plantation industry* (Ed. C. Kuruvilla Jacob), Rubber Research Institute of India, Kottayam, pp. 252-266.

Yaohua Hu and Xie Haisheng. (1985). A study on growth of new plant body and the low of growth and decline of stored matter in the plant body during the sprouting of the first leaf storey of *Hevea. Chinese Journal of Tropical Crops,* 6: 29-38.