Indian J. Nat. Rubb. Res. 4(2): 107–113, 1991

GROWTH, YIELD AND FLOW CHARACTERS AND THEIR CORRELATIONS WITH BROWN BAST INCIDENCE IN TEN *HEVEA* CLONES

D. Premakumari, A. O. N. Panikkar,
M. R. Sethuraj and Joseph G. Marattukalam

Premakumari, D., Panikkar, A. O. N., Sethuraj, M. R. and Joseph G. Marattukalam. (1991). Growth, yield and flow characters and their correlations with brown bast incidence in ten *Hevea* clones. Indian J. Nat. Rubb. Res. 4(2): 107–113.

Ten popular clones were evaluated for growth, latex flow characters, yield and brown bast incidence. Clones differed for initial rate of flow, duration of flow, plugging index, dry rubber content, girth, total volume of latex and dry rubber yield. Girth increment on tapping and incidence of brown bast were not statistically significant.

Brown bast incidence was positively correlated with total volume of latex and dry rubber yield. Positive relationships of this trait with initial rate of flow, duration of flow and dry rubber content and its negative relationships with girth increment on tapping and plugging index were not significant. It was indicated that high latex volume at the initial years of tapping contributed to occurrence of brown bast during subsequent years. Among medium to low yielding clones more interference of other factors was apparent.

Key words:- *Hevea brasiliensis*, Dry rubber content, Brown bast, Latex flow, Yield.

D. Premakumari (for correspondence), A. O. N. Panikkar, M. R. Sethuraj and Joseph G. Marattukalam, Rubber Research Institute of India, Kottayam-686 009, Kerala, India.

INTRODUCTION

Brown bast is recognised as a physiological disorder affecting the laticiferous system of *Hevea* often related to exploitation (Rands, 1921; Taylor, 1926; Ng *et al.*, 1969) whether the level of exploitation of a tree or a clone is over or otherwise depends largely on its capacity to replenish the latex drained on tapping (Sethuraj, 1988) under the exploitation system followed. Morphological, anatomical and biochemical changes occurring the affected region have been demonstrated well (Bealing and Chua, 1972; Chua, 1965; Paranjothy *et al.*, 1975; Gomez, 1982) but the causative factors triggering this physiological disorder are unknown. In general when the level of exploitation, by any means such as increasing the length of tapping panel or frequency of tapping or excess stimulation, exceeds the physiological capacity for regeneration of latex the tree is likely to become affected.

In the present study certain latex flow characters, growth characters and yield of ten *Hevea* clones and the interclonal variations were studied. The influence of these traits on the extent of brown bast incidence was examined by correlation studies.

MATERIALS AND METHODS

The study was conducted in ten clones (RRIC 7, RRIC 36, RRIC 45, RRIC 52, RRIC 100, RRIC 102, RRIC 104, RRIC 105,

Nab 17 and GT 1) of *Hevea brasiliensis* (Willd. ex Adr. de Juss.) Muell. Arg. laid out in a randomised block design with three replications and planted in 1976 at the Central Experiment Station of the Rubber Research Institute of India. The trees were opened for tapping in 1983 and exploited under ½Sd/2 6d/7 system. From each plot ten normal trees were selected for the studies.

Girth, at the height of 150 cm above the bud union, was measured annually from 1984 to 1987 and percentage girth increase over two years (1985 to 1987) was computed. The length of the tapping panel was measured in 1987. Latex volume per tree for the first five minutes of flow was recorded at monthly intervals during the same year. Initial rate of flow per unit length of panel was computed using the formula:

$$\frac{\text{Latex volume for the first five minutes (ml)}}{5 \times \text{Panel length (cm)}}$$

Monthly recordings of plugging index, by the method suggested by Milford *et al.* (1969), were also done. Total volume of latex, rubber yield and dry rubber content were recorded at fortnightly intervals in 1985. Dry rubber content was assessed by estimating the oven dry weight of latex samples collected from pooled latex of the ten trees from each plot. Plot means of the various traits were calculated for variance analysis and correlation studies. All the above observations were taken from panel BO-1. Brown bast incidence, at the stage of partial drying, was also recorded every year and percentage incidence calculated. Square root transformation technique was used for analysing the percentage incidence of brown bast and percentage girth increase. For comparing the clones with grand mean X, standard error was calculated as, $SE = \sqrt{\frac{n-1}{n}\frac{Mse}{r}}$ and CD at 5 per cent was estimated, as suggested by Singh and Choudhary (1979).

RESULTS

Flow characters of the ten clones are presented in Table 1. The duration of flow varied from 94 min to 123 min in different clones. Maximum duration of flow was recorded for RRIC 104 and minimum for RRIC 102. Interclonal variation of this trait was significant at 5 per cent level. Significantly high duration of flow was recorded for RRIC104 and RRIC 36.

Table 1. **Flow characters of ten *Hevea* clones**

Clones	Duration of flow (minutes)	Initial rate of flow (ml/cm)	Plugging index
RRIC 45	97.91	0.12*	5.87*
RRIC 100	114.99	0.11	4.27
RRIC 7	109.10	0.12*	5.11
RRIC 104	123.18*	0.07	4.07*
RRIC 105	94.42	0.09	6.28
RRIC 52	97.79	0.10	5.29
RRIC 36	120.57*	0.10	3.37*
GT 1	102.68	0.08*	4.77*
Nab 17	96.23	0.10	5.45
RRIC 102	94.00	0.12*	5.03
Mean	105.09	0.10	4.95
SE	8.016	0.01	0.565
CD	16.842	0.03	1.187
CD (general mean vs. treatment means)	11.298	0.016	0.797

*Significant 5% level

Initial rate of flow ranged from 0.07 to 0.12 ml. Clonal difference was significant at 5 percent level. Highest rate of flow was recorded for two clones (RRIC 45 and RRIC 102) and lowest for RRIC 104. Plugging index showed significant clonal variation ($P < 0.05$) and the values ranged from 3.37 (RRIC 36) to 6.28 (RRIC 105). The plugging index for RRIC 105 and RRIC 45 were significantly higher. Significantly low plugging indices were recorded for RRIC 36 and RRIC 104.

Data on girth, percentage girth increase and percentage brown bast incidence are summarised in Table 2. Girth at the eighth year of planting varied from 61.69 to 78.58 cm in different clones and the difference was statistically significant at 1 per cent level. Clonal differences in the percentage girth increase was not statistically significant and the means ranged from 6.77 to 10.29. Highest girth increase was recorded for RRIC 104 followed by RRIC 52, while percentage girth increase was the least for GT 1. Among the ten clones the percentage incidence of brown bast showed a range of 00–26.67. However, clonal difference was not statistically significant in this study.

Table 2. **Girth at 8th year, % girth increase over two years and % incidence of brown bast**

Clones	Girth (cm)**	% girth increase	% incidence of brown bast
RRIC 45	61.69*	8.50 (3.00)	16.67 (4.08)
RRIC 100	69.28	8.77 (3.03)	26.67 (5.16)
RRIC 7	62.64*	9.00 (3.08)	10.00 (3.24)
RRIC 104	78.58*	10.29 (3.28)	13.33 (3.67)
RRIC 105	70.31	8.57 (3.01)	20.00 (4.47)
RRIC 52	74.30*	9.33 (3.13)	00.00 (0.50)
RRIC 36	63.36	7.42 (2.81)	26.67 (5.16)
GT 1	62.17*	6.77 (2.69)	10.00 (3.24)
Nab 17	62.64*	9.01 (3.08)	23.33 (4.83)
RRIC 102	65.20	8.07 (2.92)	20.33 (4.51)
Mean	67.02	8.57 (3.00)	16.70 (3.89)
S.E.	2.665	0.120	1.125
C. D.	6.000	—	—

CD (general mean vs. clone mean) 3.756

The means and S E given in parantheses are of transformed figures

* Significant at 5% level ** Significant at 1% level

The data pertaining to latex volume, rubber yield and D R C are presented in Table 3. The total volume of latex per tree/tap varied from 70.02 ml to 162.87 ml among the ten clones, of which RRIC 100 recorded the highest volume of latex followed by RRIC 36, whereas RRIC 52 recorded the lowest value. For total volume of latex clonal difference was significant at 1 per cent level. Dry rubber content of latex ranged from 29.4 to 35.86 per cent. Highest DRC was recorded for RRIC 105 followed by RRIC 102 and RRIC 52 which were significantly higher than the grand mean. RRIC 100 was the highest yielder which recorded 75.63 g dry rubber per tree per tap. Clonal difference in yield was statistically significant at 1 per cent level. RRIC 45, RRIC 105, RRIC 52 and GT 1 recorded significantly lower yield than the general mean.

Table 3. **Total volume, dry rubber content and yield**

Clone	Total volume ** (ml)	DRC (%)	Dry rubber yield** $g^{-1}\ t^{-1}$
RRIC 45	103.93	33.49	41.91*
RRIC 100	162.87*	34.23	75.63*
RRIC 7	126.73	31.51	53.27
RRIC 104	130.68	30.17*	52.57
RRIC 105	88.36*	35.86*	41.95*
RRIC 52	70.02*	34.74*	33.42*
GT 1	103.54	30.92	40.65*
RRIC 36	151.24*	29.40*	59.42
Nab 17	130.46	32.59	59.90
RRIC 102	135.66	34.79*	57.37
Mean	120.35	32.77	51.61
SE	16.433	1.273	6.617
CD	34.525	2.676	13.903
CD (general mean vs. clone mean)	23.160	1.795	9.326

* Significant at 5% level. **Significant at 1% level

Simple correlations of flow characters, growth characters, yield and DRC. with percentage incidence of brown bast are presented in Table 4. Total latex volume and yield per tree per tap had significant positive correlations with percentage incidence of brown bast. Plugging index, girth and percentage girth increase on tapping indicated negative correlations with percentage incidence of brown bast though the relationship was not statistically significant. Brown bast incidence indicated a positive relationship with DRC, initial rate of flow and duration of flow at non-significant level. Performance of clones as regards to total volume of latex, dry rubber yield and percentage incidence of brown bast are shown in Fig. 1. The clones which recorded significantly high latex volume (RRIC 100 and RRIC 36) recorded high incidence of brown bast. Out of the two clones which recorded significantly low latex volume, one had no brown bast incidence (RRIC 52) and the other one (RRIC 105) recorded average incidence. In none of the six clones which gave average latex volume, brown bast occurrence was as high as in RRIC 100 and RRIC 36.

DISCUSSION

Among the ten clones studied, significant clonal differences were observed for the rate of flow, duration of flow, plugging index, girth, total volume of latex, dry rubber content and dry rubber yield. The flow characters and dry rubber content were significant only at 5 per cent level.

Table 4. **Simple correlations of growth characters, flow characters and yield on % incidence of brown bast**

Growth characters		Flow characters		Yield and DRC	
Source	r	Source	r	Source	r
Girth	-0.0586	Duration of flow	0.1828	Total volume	0.4620*
		Initial rate of flow	0.2714	Dry rubber content	0.2724N.S.
% girth increase over two years	-0.1673	Plugging index	-0.1179	Dry rubber yield	0.3812*

* Significant at 5% level

For girth, total volume of latex and dry rubber yield clones differed at 1 per cent level while the differences for percentage girth increase and percentage incidence of brown bast were not statistically significant. However high incidence of dryness occurred for the clones which recorded high latex volume. This result obtained for the 30 trees per clone taken for this study was reflective of all the trees in the experimental blocks (Joseph and Premakumari, 1987).

As brown bast is considered a physiological disorder caused by over exploitation (Chua, 1965; Ng *et al.*, 1969), tapping intensity is an important factor deciding its incidence. Over stimulation also leads to higher incidence of brown bast (Chrestin *et al.*, 1985). Morphological, anatomical and biochemical changes occurring in a brown bast affected tree at the affected portion and the consequences are well demonstrated but the real cause which trigger the disorder is still a contro-

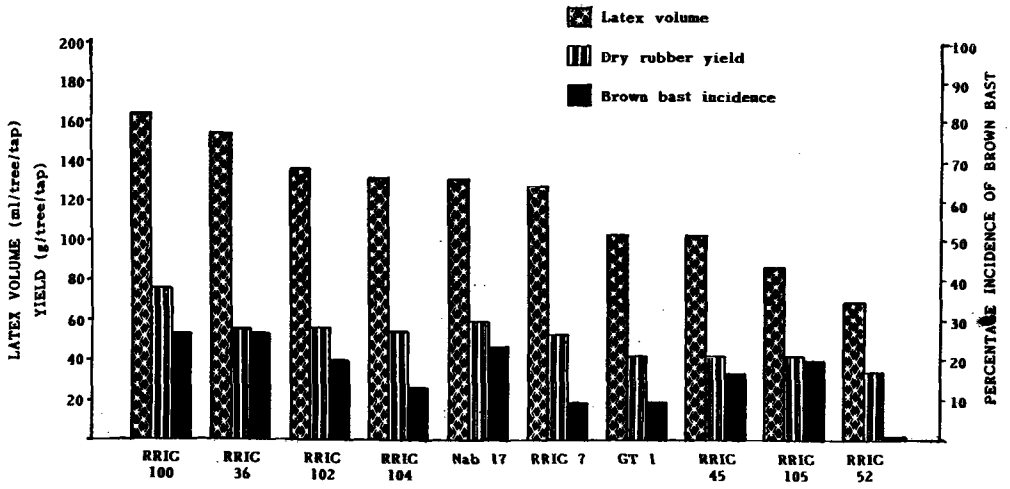

Fig. 1. Total volume of latex, dry rubber yield and percentage incidence of brown bast of ten *Hevea* clones

versial subject though it is variously suggested as disturbed water balance (Sharples and Lambourne, 1924), impairment of phloem transport (Horne, 1925), a reaction of wound healing (Rands, 1921; Rhodes, 1930) and a wound reaction leading to a reduction in the permeability of the wall of latex vessels (Bealing and Chua, 1972). The crux where there is a general agreement is that further investigation related to brown bast and its control should stress the physiology of the laticiferous system as detectable histological symptoms are seen in the laticifers (Jacob and Prevot, 1989; Paranjothy *et al.*, 1975), as no report provides sufficient evidence to demonstrate what are the factors directly correlated with brown bast incidence and if any to what extent.

In the present study total volume of latex was the most important single factor significantly correlated with brown bast incidence followed by rubber yield. Hence, brown bast incidence cannot be considered as a mere wound reaction, although the effect of wounding mediated through disturbance in phloem translocation and abnormal growth reactions cannot be totally ruled out. The latex volume was positively correlated with brown bast incidence. Positive correlations of initial rate of flow and duration of flow and negative relation of plugging index with brown bast incidence might be mediated through volume yield to a major extent. When the yield of dry rubber is taken into consideration it should also be considered that total volume has a very high correlation with dry rubber yield (Markose, 1984) and hence the effect of dry rubber yield will overlap with the effect of total volume, a character which is governed by the rate and duration of flow.

There is a general concept that high yielding clones are usually more susceptible to tapping panel dryness (Sivakumaran *et al.*, 1988) and it is attributed to genetic variation. From the data it is evident that the clones which recorded high yield during initial period caused high incidence of brown bast during subsequent years. However, among the medium and low yielding clones greater interference of some other traits than the latex volume and yield is evident in deciding the occurrence of this syndrome.

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