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BIOMASS PRODUCTION AND RUBBER YIELD WITH REFERENCE TO EXPLOITATION IN *HEVEA BRASILIENSIS*

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ABSTRACT

The productivity of PR 107 rubber trees (in terms of dry matter increment and rubber yield) was examined at eight different exploitation systems over 3 years. Untapped Hevea brasiliensis *trees had high rates of biomass production reaching upto 50 t ha^{-1} y^{-1}.*

The biomass production decreased while the harvest index (ratio of dry rubber yield to the total dry matter of trees) increased with increasing intensity of tapping. The extent of decrease in dry matter increment due to tapping (factor ' k ') was the least in trees tapped once every week.

When ¼S cuts were stimulated to maintain the yield levels of corresponding ½S cuts, the harvest index and yield were comparable. But the slightly higher values of factor ' k ' with ¼S cuts, under stimulation, than those of ½S cuts, suggested that stimulation by Ethephon involved considerable reduction in biomass.

INTRODUCTION

The yield of rubber is determined by four major components viz. the initial flow rate, length of tapping cut, dry rubber content and the plugging index (Sethuraj, 1981). The length of tapping cut, or the girth is highly variable among and within clones (Paardekooper and Samosorn, 1969 ; Sethuraj and George, 1980). As the length of cut is a component of yield, optimal growth of the tree should be ensured to achieve high sustained yields. It is known that the exploitation of the tree by tapping affects the vigour of the tree. The annual biomass increment in a tapped tree is substantially less than that of an untapped tree (Dijkman, 1951). Such loss in biomass production, due to tapping cannot be competely accounted for by the rubber yields, even if the higher energy content of rubber is taken into consideration (Templeton, 1969). Simmonds (1982) has since suggested that the energy required for rubber production might be much more than that contained in rubber itself. Sethuraj (1982), during his analysis and simulation of yield components in *Hevea* indicated that the extent of such loss in biomass production, termed factor ' k ', is an important aspect of yield potential.

In this Institute, the pattern of biomass production and rubber yield in *Hevea* at different exploitation levels, particularly in RRIM 600 and PR 107 have been studied. Our earlier observations on RRIM 600 were presented elsewhere (George *et al.*, 1982). The effect of intensity of exploitation on biomass production, harvest index and yield is analysed in this communication.

MATERIALS AND METHODS

The experiment was initiated in 1981 at the Central Experiment Station, Chethackal, with clone PR 107 (planted in 1968 ; tapping commenced in 1976). Eightyone trees were selected and randomly allotted to the following nine treatments. A density of 310 plants per hectare was assumed.

1. No tapping
2. ½S d/1 6d/7
3. ½S d/2 6d/7
4. ½S d/3 6d/7
5. ½S d/7
6. ½S d/1 6d/7 ET 5%
7. ½S d/2 6d/7 ET 5%
8. ½S d/3 6d/7 ET 5%
9. ½S d/7 ET 5%

The trees were under ½S d/2 6d/7 system of tapping before these experiments. The tapping was either discontinued or the existing cuts/the frequency of tapping were adjusted according to the above treatments. The stimulant *i.e* 5% (w/v) Ethephon was applied by bark application, monthly. The trees were rainguarded to facilitate tapping all through the year.

Yield recording was done on all tapping days by cup coagulation method. Dry matter increment was calculated from the girth of stem by using the formula of Shorrocks *et al* (1965). Harvest index was calculated by the formula :

$$\frac{(Y \times 2 \cdot 5)}{(Y \times 2 \cdot 5) + G}$$

Where Y is the rubber yield and G, the dry matter increment.

The factor 'k' was calculated following the formula :

$$\frac{W_{ut} - [W_t + (Y \times 2 \cdot 5)]}{W_{ut}}$$

Where W_{ut} is the dry matter increment of the untapped tree and W_t that of the tapped tree.

RESULTS AND DISCUSSION

The rates of biomass production in untapped trees which was 38 and 27 t ha^{-1} Y^{-1} in 1981 – 82 and 1982 – 83, respectively, went upto 50 t ha^{-1} Y^{-1} in 1983 – 84. The average production for all the 3 years was 38·3 t ha^{-1} Y^{-1}. The low level of biomass production in 1982 – 83 might be due to the prevailing drought in that period. The differences in biomass production among various exploitation systems were not statistically significant during the first 2 years *i.e* 1981 – 82 and 1982 – 83. The initial variation in the girth of trees in between replicates of different treatments could be the reason. However, the cumulative effect of these treatments was reflected by the third year (1983 – 84), as evidenced by the statistically significant variation.

Biomass production decreased with increasing frequency of tapping with or without stimulation (Table 1). Such decrease due to exploitation was drastic in daily tapped trees. There was a marked fall in dry matter production in all the treatments during 1982 – 83 and productivity increased during 1983 – 84 in all treatments, except in daily tapped trees. Among the tapped ones, the trees with ¼S d/7 with Ethephon had the highest rates of biomass increase during the entire period of experimentation. The biomass production as well as dry rubber yield from trees was highest in 1983-84 and the least in 1982 – 83. The reasons might be that there was a severe drought spell in 1982 – 83 while the rainfall was moderate and well distributed in 1983 – 84.

Table 1. *Biomass production (t ha $^{-1}$ y $^{-1}$), harvest index and factor 'k' in relation to exploitation system during 1983 – 84.*

Exploitation systems	Biomass production	Harvest index	Factor 'k'
No tapping	49·9	—	—
½S d/1 6d/7	20·8	0·28	0·425
½S d/2 6d/7	25·9	0·15	0·387
½S d/3 6d/7	27·5	0·14	0·362
½S d/7	29·0	0·06	0·383
¼S d/1 6d/7 ET 5%	20·4	0·28	0·430
¼S d/2 6d/7 ET 5%	23·1	0·19	0·426
¼S d/3 6d/7 ET 5%	24·8	0·14	0·425
¼S d/7 ET 5%	31·2	0·06	0·333
C. D. (P = 0·05)	12·5	0·12	0·092

The rates of biomass production in *Hevea* in untapped trees were in the higher range reported on tropical rain forests (Hall, 1976). Therefore, with marked capacities of biomass production and additional yields of a commercially important product like rubber, *Hevea brasiliensis* can be a suitable species for agro-social forestry, an agronomic practice which gained global attention (Nair, 1980).

Exploitation is known to retard drastically the girthing of the tree and the biomass production (Dijkman, 1951 ; Templeton, 1969). Table 1 establishes that increased frequency of tapping irrespective of stimulation or length of tapping cut, markedly decreases biomass production. A steep decrease in biomass production even in trees with quarter spiral cut, suggests that it is the extent of latex extracted out, but not the length of cut, which affects the vigour of the tree.

The differences in yield with varying exploitation systems were as expected. The maximum yield was obtained with d/1 systems, even in the third year of tapping (Table 2). Application of Ethephon on a quarter spiral system resulted in good yields, almost equalling those corresponding to a half spiral system. A consistent increase in the yield of stimulated trees during all the 3 years suggested that the response to stimulation was steady in trees with quarter spirals (Table 2).

Table 2. *Dry rubber yield ($t\ ha^{-1}\ y^{-1}$) in relation to exploitation system during 1981 – 84*

Exploitation systems	1981 – 82	1982 – 83	1983 – 84
No tapping	—	—	—
½S d/1 6d/7	2·53	3·02	3·15
½S d/2 6d/7	1·81	2·20	1·87
½S d/3 6d/7	1·69	1·72	1·73
½S d/7	0·69	0·79	0·72
¼S d/1 6d/7 ET 5%	2·36	3·03	3·22
¼S d/2 6d/7 ET 5%	1·45	1·92	2·22
¼S d/3 6d/7 ET 5%	1·04	1·50	1·56
¼S d/7 ET 5%	0·47	0·70	0·84
C. D. (P = 0·05)	0·31	0·48	0·31

The different exploitation systems altered not only the rubber yield and dry matter production but also the harvest index (Table 1). Maximum values of harvest index on d/1 systems and minimal harvest index values at d/7 tappings suggested that at higher, tapping intensities, assimilate partitioning towards rubber biosynthesis was also enhanced. Despite shortening the length of the cut, harvest index was not much lowered in quarter spiral systems, due to Ethephon stimulation of latex flow.

The loss in biomass due to tapping (Table 1) was pronounced in high intensity systems and this factor was very low on a ¼S d/7 system, irrespective of stimulation. A steep increase in the biomass loss was evident in daily tapped trees. The extent of reduction in biomass could be expressed by factor ' k ' as suggested by Sethuraj (1982). But stimulation treatments resulted in higher 'k' values indicating a direct effect of stimulation on biomass loss.

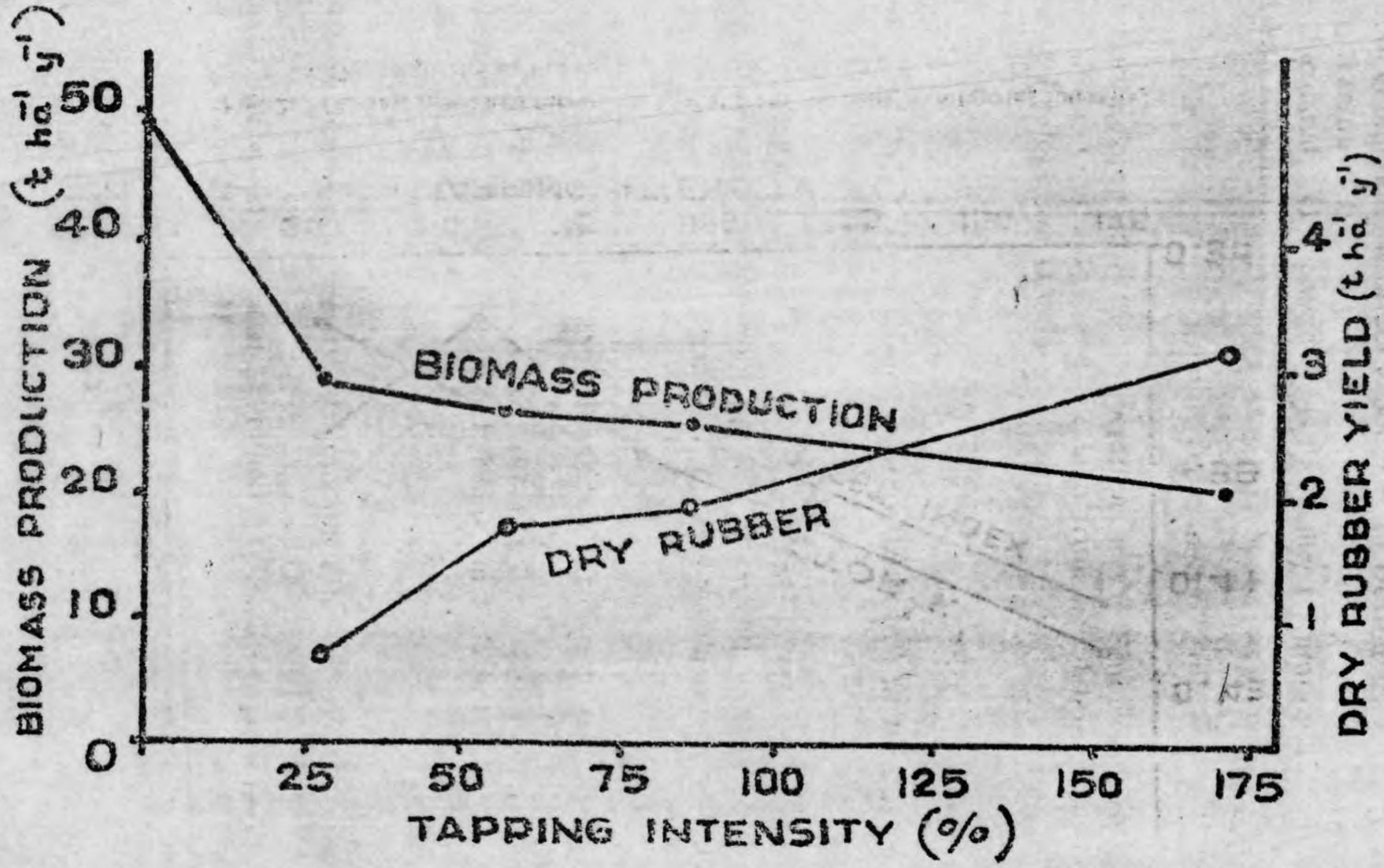

Fig. 1. Biomass production and dry rubber yield of PR 107 in relation to tapping intensity. The trees were tapped once in 1, 2, 3 or 7 days on a half spiral cut, as indicated in Materials and Methods.

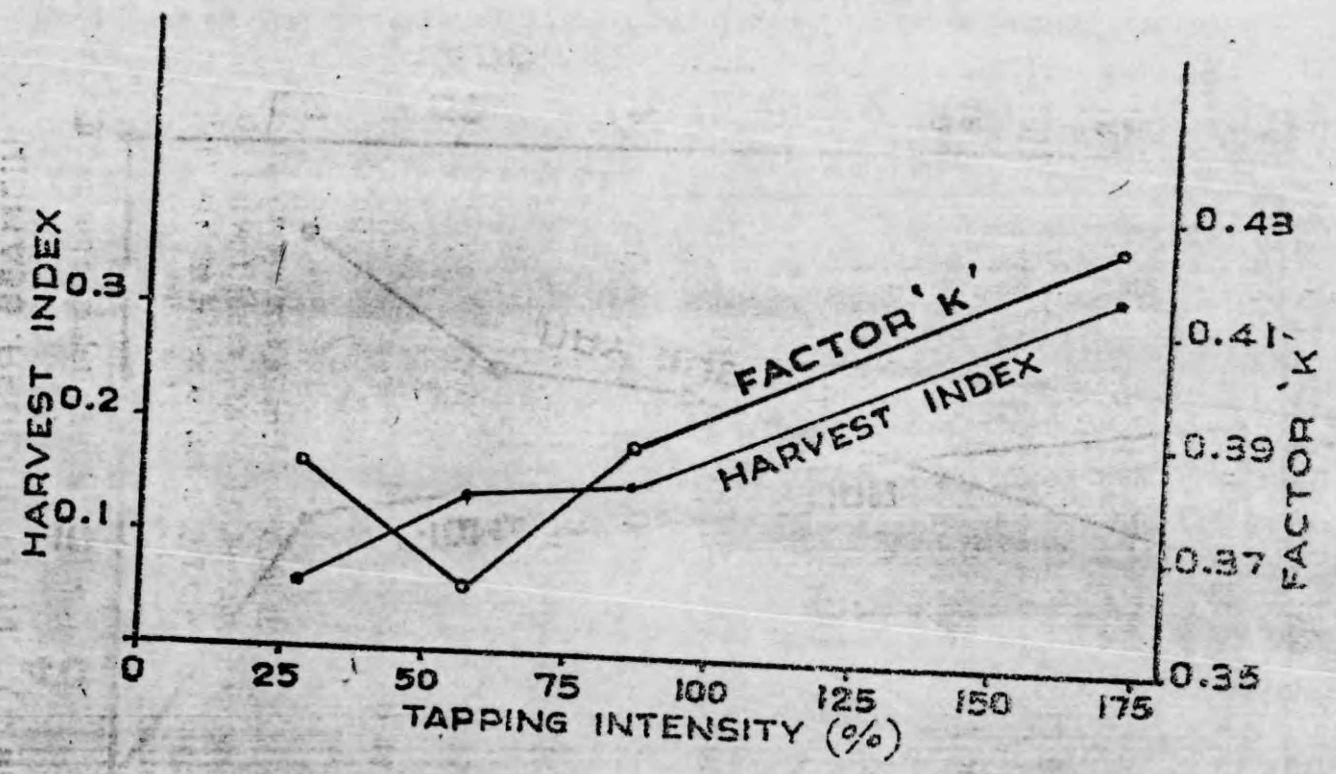

Fig. 2. Harvest index and factor 'k' of PR 107 in relation to tapping intensity. The details are as in Fig. 1.

It can be concluded from our observations that an increase in tapping intensity decreases biomass production (Fig. 1) but raises the harvest index and factor 'k' (Fig. 2). The depressing effect of tapping on biomass production is usually reduced by shortening the cut. But when ¼S cuts were stimulated to maintain the yield levels of corresponding ½S cuts, biomass loss was slightly higher. This is evident from higher values of 'k' factor in treatments with ¼S cuts and stimulation, in spite of the fact that harvest index and yield were comparable with corresponding ½S treatments. The reason for the loss of biomass as a result of latex extraction, not accountable by the yield of latex obtained, is yet to be elucidated. One possibility is the higher respiration induced by tapping and stimulation with Ethephon.

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DISCUSSION

Q — BARLOW, Australia : Explain the means of measuring of biomass and your definition of biomass.

A — M. J., GEORGE, India : It was based on annual girth recording. The girth of a tree was recorded 15 inches high and from that annual biomass increment was calculated by following the formula of Shorrocks 1965.

Q — SAMSUDDIN, RRIM : In your calculation of the biomass do you estimate dry matter attributed by the leaf fall throughout the year.

A — M. J. GEORGE, India : As mentioned, biomass was calculated on the formula by Shorrocks 1965. Definition of biomass is dry matter increment or dry matter production.