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FEASIBILITY OF RATOONING IN *HEVEA*: EARLY GROWTH PERFORMANCE

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ABSTRACT

An experiment was carried out to study the feasibility of ratooning as a propagation method in *Hevea brasiliensis*. Sprouting and subsequent growth of the ratoon plants in the first year were compared with conventionally bud grafted plants of the same clone and age grown in polybags. As expected, the sprouting percentage was lower (74.7%) in the tree stumps compared to that in the polybags (88.9%). On the other hand, the growth of the ratoons was superior to that of the polybagged counterparts at the end of the first year, with significantly higher values for girth, height, number of whorls produced and retained, leaf size and weight and specific leaf weight.

INTRODUCTION

The natural mode of propagation of *Hevea brasiliensis*, the source of natural rubber, is through seeds. Under cultivation, bud grafting is usually employed in which desirable clones are grafted onto seedlings. Other methods like rooting of cuttings, micropropagation, *etc.* are possible, though they have not been adopted on a commercial scale. Ratoon cropping, a process by which a second crop (ratoon) is raised from the stubbles remaining in the field after the first crop has been harvested, has not been tried in rubber although it is routinely practised in other crops like rice, sugarcane and banana. In sugarcane, four to eight ratoons are harvested before replanting. Ratooning ability has been found to vary with the variety even within a crop species (Sundara *et al.*, 1992). Some ratoon crops yielded higher than the original plant crop (Sugarcane Breeding Institute, India, 1991a; Saha *et al.*, 1993), while in other cases it was lower (Sugarcane Breeding Institute, India, 1991b). Even in cases where slightly lower yields are obtained, ratooning is still economical. Chapman *et al.* (1996) found that good ratooning cultivars of sugarcane yielded as high in late ratoons as in plant and early ratoon crops, as long as a good plant stand was maintained. Kumar *et al.* (2000) reported higher oil content in the ratoon crop of mint (*Mentha arvensis*) than in the main crop. In marigold (*Tagetes minuta*) too, there was an increase in the composition of some essential oils in the ratoon crop over the main crop (Rao *et al.* 2000, Singh and Singh, 2001).

Stewart *et al.* (1989) reported ratooning in another rubber producing plant, guayule, which is a perennial shrub. The shrub yield was found to increase more rapidly in the ratoon than in the plant crop, and the rubber yield did not show an initial establishment phase. However, there are no reports in the literature of a ratoon crop in perennial trees like *Hevea*.

Under cultivation, trees of *Hevea* are felled after about 30-35 years, after all the productive and exploitable bark has been exhausted. The girth of the trees at this stage usually does not exceed 1 m. However, rubber trees growing wild in the Amazonian forest of Brazil are reported to have girths of more than 3 meters (IRRDB, 1982), which gives an indication of their age. Therefore, at the time of felling the root system, though very well developed, is still comparatively young. It has been observed that plants that sprout from stumps left in the field after wind damage or other reasons, grow quite vigourously. There are no reports of any systematic studies being carried out to compare the growth of this ratoon with that seen in conventionally raised planting material. Hence, an experiment was carried out to compare the sprouting percentage and subsequent growth of a ratoon crop of *Hevea* with that of conventionally budded plants in order to assess the feasibility of ratooning in this crop and to identify the possible bottlenecks. The performance at the end of the first year of growth is presented here.

MATERIALS AND METHODS

The treatment was imposed on an existing germplasm garden of 52 Wickham clones at the Central Experimental Station of the Rubber Research Institute of India, Chethackal, laid out in an RBD in 1977 with five plants per plot. 38 clones were used for this experiment. All the trees were felled at a height of 20 cm from the ground and 'rubber kote' was applied on the cut surface. Care was taken to eliminate the differences due to age and genotype, by multiplying the same 38 clones and planting them in polybags in the same month (May 2000) as the felling of the mature trees in the field. The plants were raised in polybags for one year as is conventionally practised, at the rate of 10 per genotype. While no fertilizer was applied to the tree stumps during the first year, normal fertilizer schedule and plant protection measures were adopted as in the case of polybag plants. Sprouting was monitored at monthly intervals for one year, and further growth parameters recorded at the end of the first year of growth in the polybags as well as in the field stumps.

The following observations on growth and vigour were recorded from the two sets of plants:

1) Girth (cm) : Recorded at a height of 30 cm from the bud union.
2) Height (cm) : Total height of the plants from the bud union.
3) Total number of leaf whorls produced in one year
4) Number of leaf whorls retained at the end of one year
5) Leaf size (cm^2) : Average area of two central leaflets taken from the middle of the topmost mature whorl of each plant, measured using a leaf area meter Li Cor 3100.
6) Fresh weight of single leaflet (g) : Average of the two central leaflets was recorded.
7) Dry weight of single leaflet (g) : The average weight of the two leaflets was recorded after oven drying to constant weight.
8) Specific leaf weight (SLW) (g/cm^2) : On dry weight basis.
9) Dry matter percentage of leaf (%) : The average dry weight of the single leaflet expressed as percentage of the respective fresh weights, which also gives an indication of the moisture content of the leaves.

A paired t-test (Panse and Sukhatme, 1985) was used to compare the performance of the two sets of plants.

RESULTS AND DISCUSSION

Figure 1 gives an overall view of the ratoons in the field. Table 1 shows the details of the number of stumps available for the study as well as the sprouting observed in each clone in the two sets of plants. The number of tree stumps available ranged from 2 to 10 for each clone, while that for budded stumps planted in the polybags ranged from 6 to 10. Sprouting was more in the budded stumps in the polybags, than in the tree stumps: it ranged from 1 to 8 in the tree stumps, and 6 to ten in each clone in the polybag plants.

The means for the various sprouting and growth parameters in the two sets of plants are given in Table 2.

Fig. 1. Field view of the ratoons

SPROUTING

A total of 168 out of 225 (74.7%) stumps in the 38 clones sprouted in the field, compared to 330 (88.9%) out of 371 budded stumps in the polybags. Therefore, lack of sprouting in the field stumps, which was a major problem anticipated, is not the stumbling block here. Other methods could be devised to increase even this figure. Sharma *et al.* (1999) observed that spraying *Cyperus scariosus* oil (C.S. oil) or santonin (250 mg/litre) increased sprouting by 40.9% and number of tillers/clump by 34% in sugarcane. Most of the stumps had multiple sprouts, which were pruned after six months, retaining only the most vigourous one.

The time taken to sprout was analysed for the 38 clones. The differences were highly significant, with stumps in the polybags sprouting much earlier in 1.27 months, compared with an average of 3.06 months taken by the stumps in the field. In some cases, stumps in the field showed signs of sprouting initially with a number of bulges (Figure 2). However, further development seemed to be arrested. This feature could be investigated further to identify its cause and to find a possible means of overcoming it.

EARLY GROWTH

Many of the ratoon plants had a tendency to grow to a great height without branching, which

Table 1. Details of sprouting on the tree stumps and budded stumps

Sl#	Clone	Tree stumps		Budded stumps	
		No. available	No. sprouted	No. available	No. sprouted
1	AVROS 255	5	4	10	9
2	AVROS 352	2	1	10	9
3	BD 5	6	6	9	9
4	BD 10	8	3	10	10
5	Ch 26	7	6	6	6
6	Ch 29	8	8	9	9
7	Ch 31	5	4	10	9
8	Ch 32	8	8	11	11
9	Ch 153	3	2	10	8
10	CHM 3	7	7	10	8
11	Dj 7	5	5	10	8
12	Gl 1	4	1	8	8
13	GT 1	7	6	10	9
14	HC 28	3	3	10	10
15	LCB 1320	9	5	9	9
16	Lun N	8	7	10	9
17	Mil 3/2	6	5	10	8
18	PB 86	6	4	10	10
19	PB 186	6	5	10	8
20	PB 206	5	3	9	8
21	PB 213	10	7	10	10
22	PB 215	5	3	10	9
23	PB 217	9	5	11	8
24	PB 230	10	6	10	8
25	PB 235	5	5	10	9
26	PB 252	4	4	10	9
27	PB 253	3	2	10	10
28	PB 5/51	8	6	10	8
29	PB 5/60	8	6	10	6
30	PB 5/63	4	2	10	8
31	PB 5/76	7	6	9	6
32	PB 5/139	7	4	10	9
33	Pil B 84	3	2	10	10
34	RRII 105	10	6	10	10
35	Tjir 1	2	1	10	9
36	Tjir 16	5	4	11	9
37	Wagga	4	3	9	9
38	Waring	3	3	10	7

may have an adverse effect on its wind tolerance. The tallest plant had a height of 5.7 m (Figure 3). Branch induction could be attempted here. Natural branching was also observed in some of the ratoons (Figure 4), while obviously no branching occurred in the polybag plants.

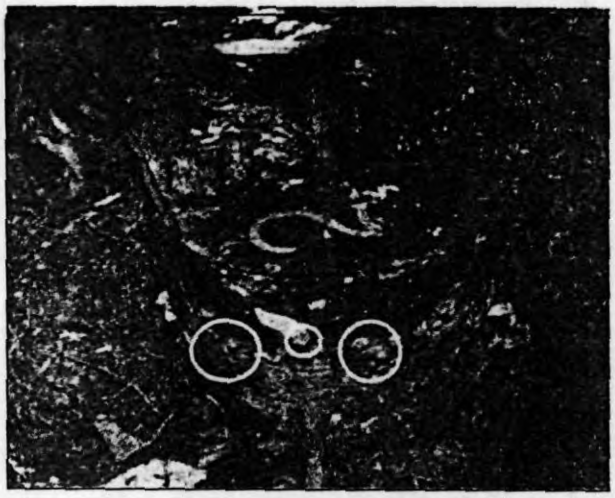

Fig. 2. Stumps showing numerous bulges, but with no further growth

One of the problems expected in this technique was a high degree of wind damage especially in the initial years, when the union between the stock and scion is not expected to be strong enough to support the weight of the rapidly developing heavy scion. During the first year of growth, only 15 plants (9% of the ratoons) were lost due to wind damage in the form of stem snap and complete cleavage from the base at the joint with the stump (Figures 3 & 4), even though no support at all was given up to this stage. This figure is much less than expected. However, it should be possible to circumvent this problem entirely by providing staking or by shoring up the base of the plant, if this technique is otherwise feasible.

A number of plants succumbed to severe incidence of *Phytophthora* in that particular year. An interesting fact noticed was that in spite of the severity of the disease, many of the ratoon plants were able to recover to a large extent from the effects of disease, probably due to their greater vigour. Since ratoons of four clones in the field were lost completely, only 34 clones were used for the remaining analyses.

Highly significant differences between the two sets of plants were observed for all the growth parameters except leaf dry matter %. The total number of leaf whorls produced and those retained at the end of the first year in the ratoons were almost double than that of the polybag plants. Extremely large leaves were produced in the ratoon plants compared to the corresponding polybag plants. The leaves of the former were about 2.5 times larger and four times heavier (both on fresh and dry weight bases), than those of the latter. The specific leaf weight (on dry weight basis) in the ratoons was about 1.5 times greater than that of the polybags. However, there was no difference for dry matter content of leaves on a weight by weight basis, with leaves of both sets of plants having about 45% dry matter or 55% moisture content. The superiority of the ratoons

Table 2. Mean values for sprouting and morphological traits in the ratoon and polybag plants.

Trait	Ratoons	Polybag plants	t value
Time taken to sprout (months)	3.06	1.27	11.144**
Girth (cm)	12.02	2.77	23.222**
Height (cm)	359.21	87.17	23.912**
Total number of leaf whorls produced	7.35	3.42	15.397**
Number of whorls retained at the end of the first year	4.05	2.41	7.625**
Fresh weight of single leaflet (g)	2.60	0.62	13.688**
Dry weight of single leaflet (g)	1.18	0.27	13.929**
Leaf size (cm2)	122.72	47.44	12.187**
Specific leaf weight (g/cm2) (dry weight basis)	0.96	0.57	20.984**
Dry matter (%) of single leaf	45.80	44.64	1.759

for most values was reflected in the height and girth of the plants, with the ratoons showing four times greater girth and height. Chalapathi *et. al.* (1999) found that the ratoon crop of stevia was significantly superior to the plant crop in respect of higher daily leaf yield, leaf to stem ratio and harvest index. In okra, Miranda and Rasco (1991) observed significant differences in plant vigor after ratooning and rate of shoot emergence. The ratoon crop flowered much earlier and had a longer harvest duration, while its yield ranged from 33.6% to 200% of the first crop depending on genotype.

Soil differences could not be accounted for in this analysis. However, it is obvious that this vigourous growth of the ratoons in spite of the little care given to the plants, is due to the well-developed root system. Stewart *et al.* (1989) have also attributed increase in shrub yield of the guayule ratoon over the original planted crop to the presence of an established root system. In the present experiment, the performance seen in the first year is sufficient to warrant continuation of the experiment. It remains to be seen whether this superiority is sustained in the next few years also, after the polybags are planted in the field. Since a fairly high percentage of sprouting was obtained, it is only a question of maintaining this stand by giving adequate aftercare.

Clonal response to ratooning could not be meaningfully assessed as the plot size for each clone was too small. A larger plot size will also not be possible with so many clones. If the performance of the ratoons over the next two - three years is sustained, a large-scale experiment on a single clone, RRII 105, may be taken up. Besides reducing initial planting costs by reducing the number of pits to be prepared and polybag plants to be raised, the greater vigour of the ratoons can be made use of either to reduce the total immaturity period or to increase the output of the plantation if one decides to go by the growth of the budded plants alone. A pure ratoon stand in *Hevea*, however desirable, is not feasible, as by the time the plantation is ready for felling, the vacancies due to wind damage will be high. These, as well as those stumps that have not sprouted in one year, will have to be planted with normal budded plants. This will cause a certain amount of variability in the field. However, as discussed earlier, this kind of variability is only desirable, since it implies an increase in girth of the plants, ultimately leading to higher returns. However, it remains to be seen whether the more rapid growth of the ratoon will adversely affect the growth of the nearby budded plant. Even in that case, it may be possible to provide for this effect by raising advanced planting materials like two year old

Fig. 3. The tallest ratoon in the field

Fig. 4. Branching in a ratoon plant in the first year of growth

Fig. 5. Wind damage from the base of the ratoon

Fig. 6. Stem snap in a ratoon due to wind

polybags, maxistumps, *etc.* The performance of the ratoons up to the end of the first year is encouraging. The experiment will be continued until the bottlenecks in this technique, if any, are identified.

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