

**THE CORRELATION BETWEEN BRANCHING AND THE TREE  
GROWTH OF *HEVEA BRASILIENSIS* (MUELL. ARG.)**

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*(Accepted 1 November 1995)*

**ABSTRACT**

The main objective of the present study was to see whether there is a correlation between the number of branches and the tree growth in *Hevea brasiliensis*. Considerable variation in branching habits is observed among the trees of different clones. Also, some clones such as RRIC 121 show less branching when compared to other clones such as RRIC 100 indicating branching is also a clonal characteristic. Canopy architecture too, shows differences among trees within a clone. Highly significant positive correlation was observed between the number of branches and the tree girth for all clones tested for trees aged from one year to seven years. The correlation between the canopy distribution (grouped as very good, good or poor) and the tree girth was also positive.

**Key words:** branching, growth, *Hevea*, rubber

**INTRODUCTION**

Though the growth of *Hevea* seedlings during the first 1-1½ years is monopodial they branch well naturally in later years. As far as buddings are concerned, a higher percentage of trees of certain clones tend to grow very tall before they branch and some times results in small crowns. It is evident that girthing is slower in such trees and therefore takes relatively more years to reach the recommended girth for tapping.

A well balanced canopy is of vital importance for the tree as leaning, bending, branch-break, trunk-snap and even falling of the tree can happen due to asymmetric canopies. The undesirable branching habits and corrective pruning measures to be carried out at an early stage of growth have been discussed in detail by Yoon *et al.* (1976). Heavy one sided branches, V-fork branching, multiple branches without a leader *etc.* have all been categorized as unsuitable branching which cause problems later (Anon, 1974). An ideal branching system may consist of

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the main stem persisting into the upper part of the tree giving rise at short vertical intervals to many relatively light branches evenly spaced around the trunk at wide angles to the trunk.

Branch induction and pruning can be carried out to correct some undesirable features which commonly occur. For instance, if the main stem divides to form a V-fork, one branch can be removed. Also when heavy branches develop only on one side of the tree, some of them can be removed. Further, if a number of branches emerge closely and grow suppressing the growth of the terminal, only the most vigorous one should be left to become the leader.

Planting distance and density may also influence the canopy architecture, though there are some clones which show poor branching. Therefore, it seems branch induction is as important as corrective pruning. Both these operations, should be done in two or three rounds, by tree-to-tree inspection, during the immature phase. Various techniques have been tested for branch induction; the leaf folding method and leaf cap method described by Samaranayake (1984) are effective, easy to carry out and cause least disturbance to the tree. It is important to note that the terminal shoot or the leader should never be injured as it seems to affect the branching habit of the tree directly.

The basic pattern of growth and branch form are inherently controlled by the tree's genetic potential but however it should be realized that trees are continually exposed to a wide range of environmental conditions during their development. Photosynthesis is one of the most obvious factors determining the rate of growth. Only a small fraction of total dry weight seems to be represented by mineral elements. Among the numerous factors which possibly influence the photosynthesis, the factors related to the plant seems to be more important than the environmental factors.

The present report is on the effect of the number of branches and their distribution on the growth of the tree as measured by their girth. The main objective is to emphasise on the value of inducing branches where necessary during the immature phase, while discussing the other advantages of a balanced canopy. If the girth of the trees can be increased by means of inducing branches, not only the growth of the trees will be uniform but also the clearing will be productive after a shortest possible immature period.

**MATERIALS AND METHODS**

Clearings belonging to clones RRIC 100, RRIC 102, RRIC 110, RRIC 121 and RRIC 130 at Dartonfield group were used for this study. Trees used for collecting data for this report have not been subjected to branch induction or corrective pruning except the clearing of RRIC 130 planted in 1987. Normal pruning has not been done in this clearing and therefore branches are found at relatively lower heights from the union. Further, the clearing of RRIC 100, planted in 1988 had not been opened for tapping until they were about 6 years and therefore these trees show higher girthing than the trees planted in 1987 which have been tapped for about 1¼ years when data were collected. From each clone, clearings aged 1-7 years were used. The details of the clearings used are summarized in Table 1. Planting materials that have been used for clearings aged below 3 years belong to clones RRIC 100 and RRIC 121 were young buddings. For all other clearings bare root budded stumps have been used. Other cultural practices such as land preparation, manuring, weeding *etc.* are similar for all clearings.

Table 1. *Details of the clearings used for collecting data*

Clone	Year of planting	Age (Years)	Planting distance	Period in tapping
RRIC 100	1987	7	26' X 10'	1¼ years
	1988	6	18' X 12'	3 months
	1989	5	18' X 9'	0
	1990	4	18' X 8'	0
	1991	3	27' X 8'	0
	1992	2	27' X 8'	0
	1993	1	27' X 8'	0
RRIC 102	1988	6	27' X 8'	6 months
	1990	4	27' X 8'	0
	1993	1	24' X 8'	0
RRIC 110	1987	7	22' X 10'	3 months
	1991	3	27' X 8'	0
RRIC 121	1987	7	18' X 10'	1¼ years
	1988	6	18' X 12'	6 months
	1989	5	27' X 8'	0
	1990	4	24' X 8'	0
	1991	3	27' X 8'	0
	1992	2	27' X 8'	0
RRIC 130	1987	7	(16' X 10')	1 year
	1988	6	(27' X 8')	6 months
	1990	4	30' X 8'	0

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Girth measurements were taken during the wintering period in 1995, at about 1 m from the ground level. When recording data the branches were categorized into three groups according to the size.

Group I - branches of about  $\frac{1}{2}$  of the size of the main trunk.

Group II - branches of about  $\frac{1}{3}$  of the size of the main trunk.

Group III- branches of about  $\frac{1}{4}$  of the size of the main trunk.

The sizes of the branches were not measured, in fact this was not practical in older trees, but was an eye estimation. The canopies too were divided into three classes according to the number of branches and their distribution, again justified visually and arbitrarily. The description is as follows and it is shown in Fig 1 also.

Very good - Well branched and well spread branches, starting from low level (about 2.5-3.5 m).

Good - Less number of branches and unevenly spread, mostly high level branches only.

Poor - No or very few number of large or medium size branches and mostly group III branches.

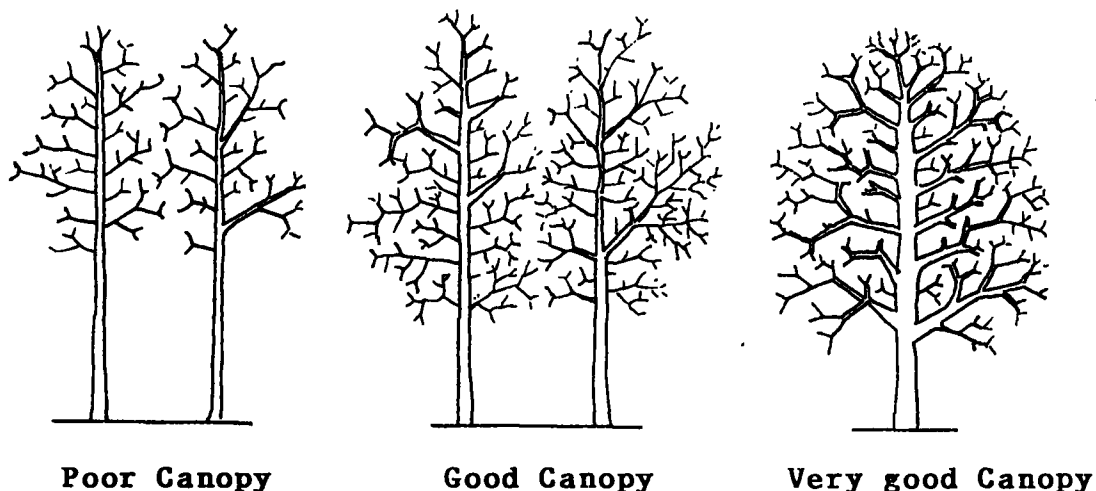


Fig. 1 Grouping of canopies according to the number of branches and the canopy architecture

One hundred trees were measured from each clone of each planting year. The number of branches in each tree was recorded along with the canopy distribution for individual trees. Data on girth for each clone of a particular year were summarized first according to the number of branches in each group and then according to the canopy distribution.

Data on the girth and the number of branches were analyzed in order to obtain Pearson correlation coefficients by using the SAS statistical program. Means of the trees grouped according to the canopy distribution were compared with SEM values.

## RESULTS

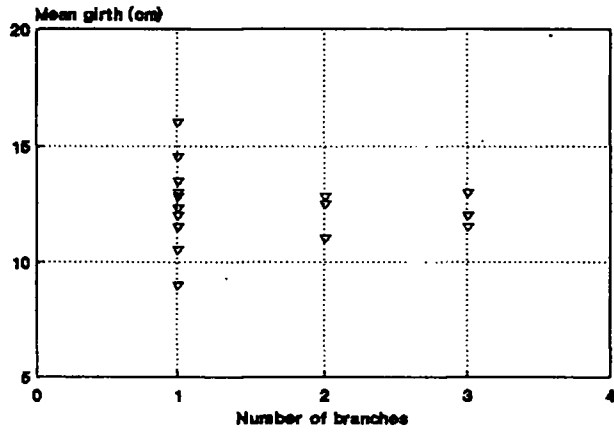
### Correlation between the number of branches and the tree girth

The number of branches and the tree girth showed a high positive correlation. There were differences in the number of branches between the clones and also between the age of trees of the same clone. For all the clones and their age classes examined, the number of  $\frac{1}{2}$  size branches were the least and  $\frac{1}{4}$  size branches were the highest with a few exceptions (Table 2). A higher number of trees contained  $\frac{1}{2}$  size branches but in clones such as RRIC 121, a low % of trees contained even this size branches.

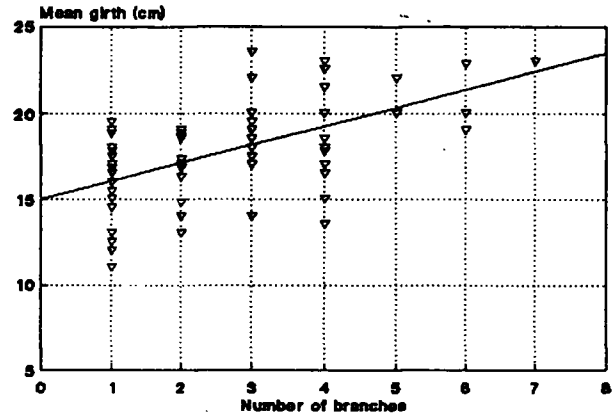
Table 2 shows the percentage of trees of clone RRIC 100 consisting of branches of different sizes. Group III or  $\frac{1}{4}$  size branches were present in almost all of the trees of clones RRIC 102, RRIC 110 and RRIC 130, but in RRIC 100 only the trees older than 4 years showed a higher percentage of trees with group III branches. In general, clone RRIC 121 shows a higher number of trees without even group III branches, irrespective of their age.

Figs 2.1 - 2.7 show the correlation distribution between the number of branches and the girth of the trees of clone RRIC 100. The Pearson correlation coefficients on data for the trees are summarized in Table 3.

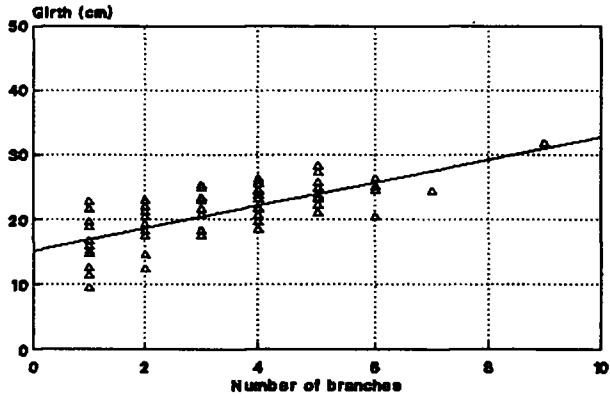
As it can be seen from Table 3, the correlation between the number of branches and the tree girth is low for the trees of RRIC 100 when the trees are one year old. In fact, 72% of the trees were without even a  $\frac{1}{4}$  size branch. From the second year onward, a higher correlation is observed and also it is highly significant ( $p > 0.01\%$ ). However, three year old trees show the highest correlation of 0.84593. For the clone RRIC 102 also,  $r$  values are low when the trees are only a year old. But it is higher than 0.5 and highly significant for both 4 and 6 year old trees. Clone RRIC 110 also shows similar results. However  $r$  values are relatively lower and variable with age for the clone RRIC 121. The number of branches is also low in



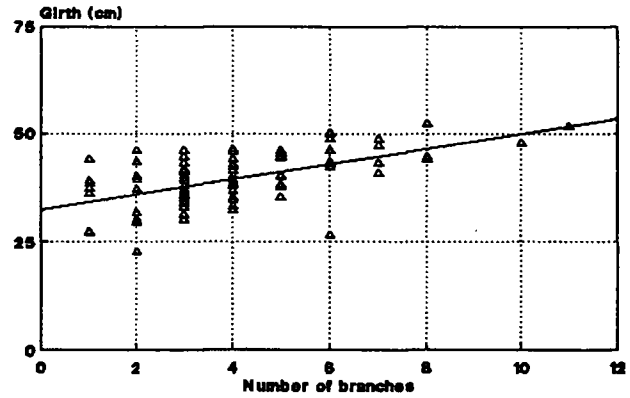
2.1



2.2



2.3



2.4

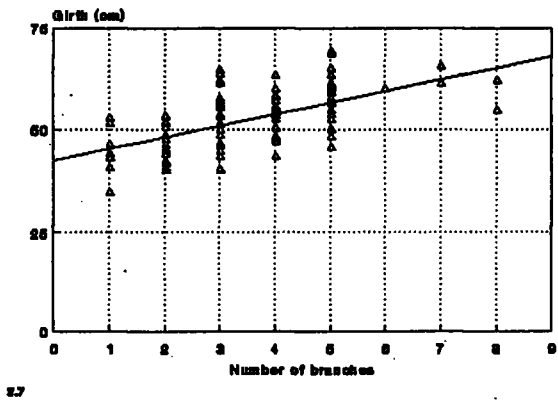
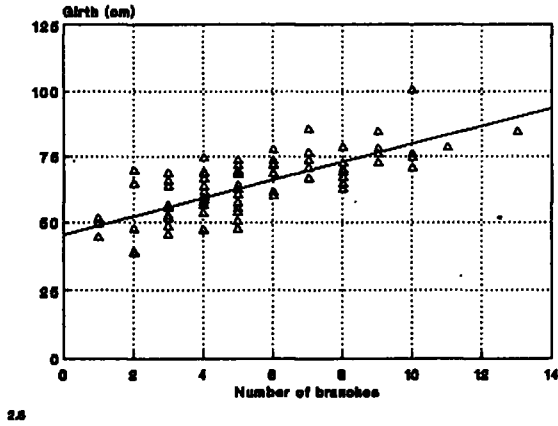
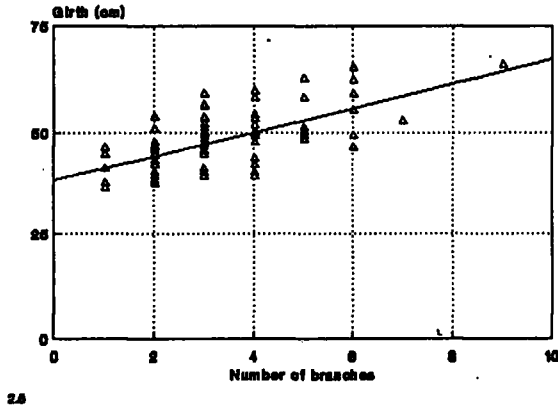


Fig. 2. The correlation between the number of branches and the tree girth, 2.1 - 1 year old, 2.2 - 2 years old, 2.3 - 3 years old, 2.4 - 4 years old, 2.5 - 5 years old, 2.6 - 6 years old and 2.7 - 7 years old, trees of clone RRIC 100

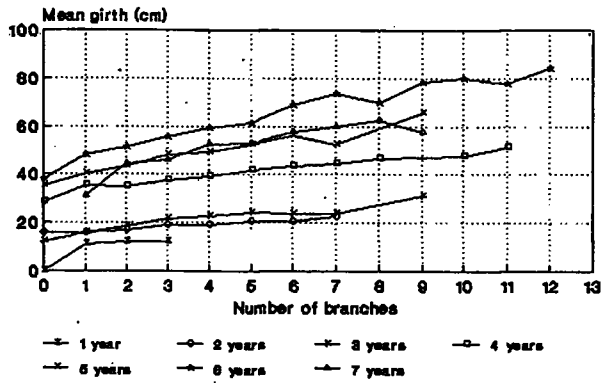
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RRIC 121 trees except for 4 year old trees. Figures 3.1 to 3.5 show the distribution of number of branches and the mean girth of the trees of different clones.

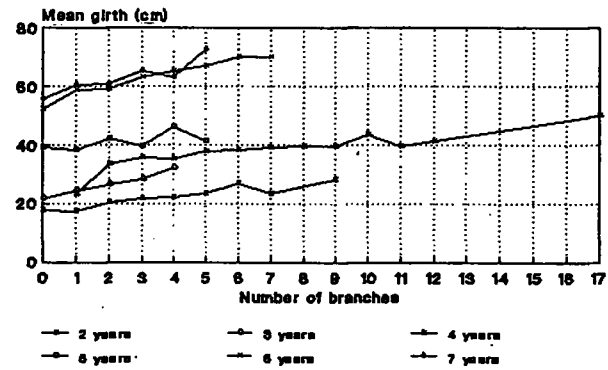
Table 2. *Percentage of trees consisting of branches of different sizes, Mean = mean number of branches*

Clone	Age	% of trees with branches				Mean
		½ size	⅓ size	¼ size	0 branches	
RRIC 100	1	1	1	26	72	0.37
	2	3	18	56	34	1.72
	3	16	26	55	39	2.11
	4	48	50	86	6	3.73
	5	7	59	86	5	3.04
	6	70	70	94	2	5.2
	7	13	48	96	2	3.56
RRIC 102	1	0	8	64	32	1.27
	4	48	79	100	0	7.19
	6	35	66	100	0	6.49
RRIC 110	3	50	25	88	2	3.02
	7	30	71	100	0	5.98
RRIC 121	2	7	14	74	20	2.4
	3	7	6	44	49	0.8
	4	44	58	99	0	6.1
	5	4	24	69	23	1.5
	6	45	30	83	6	2.6
	7	17	16	49	31	1.3
	7	17	16	49	31	1.3
RRIC 130	4	75	94	100	0	9.7
	6	48	67	100	0	5.2
	7	44	61	98	1	4.5

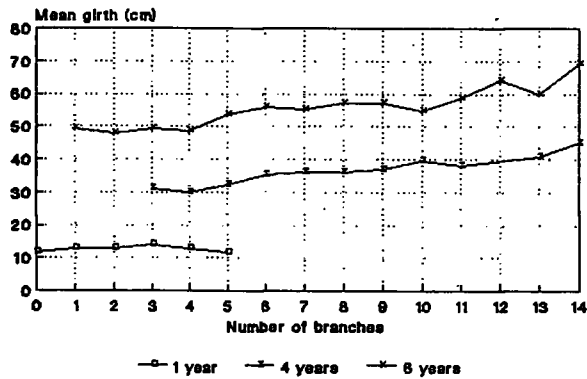
As it can be seen by the Fig 3, the mean girth increases with the increasing number of branches in the trees. As stated earlier also, this effect is not very clear in young trees of about 1-2 years. However, the correlation between the number of branches and the tree girth is positive and highly significant for almost all the clearings except for 5 year old RRIC 121 clearing of which the  $r$  value is 0.2097. Though the trees of RRIC 121, in general, show poor branching and better girthing, the correlation between the number of branches and the tree growth is positive and highly significant for the rest of the clearings of RRIC 121. RRIC 121 trees of 5 year old are undergirthed and also the number of ½ size branches is 4% compared to 44% in 4 year old trees (Table 2).



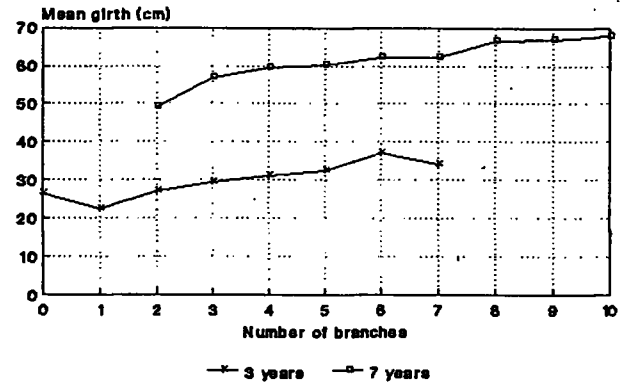
3.1 RRIC 100



3.4 RRIC 121

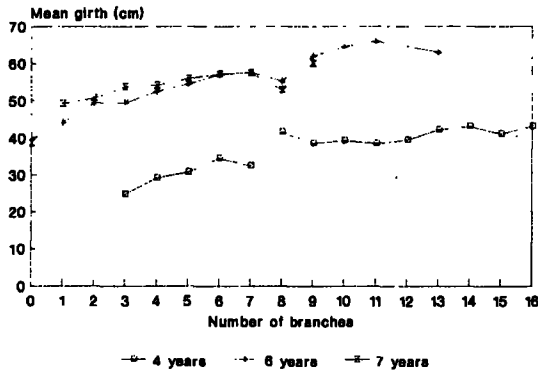


3.3 RRIC 102



3.3 RRIC 110

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3.5. RRIC 130

Fig. 3. The number of branches and the mean girth of the trees, 3.1 - RRIC 100, 3.2 - RRIC 102, 3.3 - RRIC 110, 3.4 - RRIC 121 and 3.5 - RRIC 130

Table 3. *The Pearson Correlation Coefficients for the number of branches and the girth of individual trees*

Clone	Age years	r	Probability level
RRIC 100	1	0.326	0.09%
	2	0.581	0.01%
	3	0.845	0.01%
	4	0.648	0.01%
	5	0.705	0.01%
	6	0.768	0.01%
	7	0.649	0.01%
RRIC 102	1	0.304	0.21%
	4	0.601	0.01%
	6	0.542	0.01%
RRIC 110	3	0.590	0.01%
	7	0.553	0.01%
RRIC 121	2	0.617	0.01%
	3	0.572	0.01%
	4	0.453	0.01%
	5	0.209	3.63%
	6	0.611	0.01%
	7	0.488	0.01%
	RRIC 130	4	0.577
6		0.619	0.01%
7		0.459	0.01%

**The clonal difference and the growth of the trees**

Mean girth, minimum girth (min), maximum girth (max), standard error of the mean (SEM) and the % of tappable trees of clones RRIC 100, RRIC 102, RRIC 110, RRIC 121 & RRIC 130 measured in all clearings are given in Table 4.

Table 4. *The growth of the trees of clones RRIC 100, RRIC 102, RRIC 110, RRIC 121 & RRIC 130 at different ages, (%\* - % of tappable trees = girth  $\geq$  49 cm)*

Clone	Age	Girth (cm)					% *
		Min	Mean	Max	SEM		
RRIC 100	1	6	11.34	16	0.18	0	
	2	11	17.02	23.5	0.28	0	
	3	7.2	17.78	31.5	0.58	0	
	4	22	38.65	51.9	0.65	4	
	5	28.5	47.02	65.5	0.69	41	
	6	34.5	63.22	100	1.21	87	
	7	30.5	52.19	68.6	0.77	68	
RRIC 102	1	7.5	12.58	16.0	0.18	0	
	4	21.0	35.43	45.0	0.48	0	
	6	35.6	54.39	72.6	0.70	83	
RRIC 110	3	15.0	28.84	39.5	0.54	0	
	7	39.5	61.72	74.0	0.66	97	
RRIC 121	2	12	20.2	29	0.39	0	
	3	13	23.71	32	0.38	0	
	4	23	38.17	52	0.52	2	
	5	27	39.7	54	0.57	8	
	6	39	61.7	79.5	0.64	97	
	7	39.5	59.96	78	0.76	94	
RRIC 130	4	22.4	37.94	51	0.52	2	
	6	39.5	53.91	67	0.55	89	
	7	38.5	54.57	67.5	0.50	90	

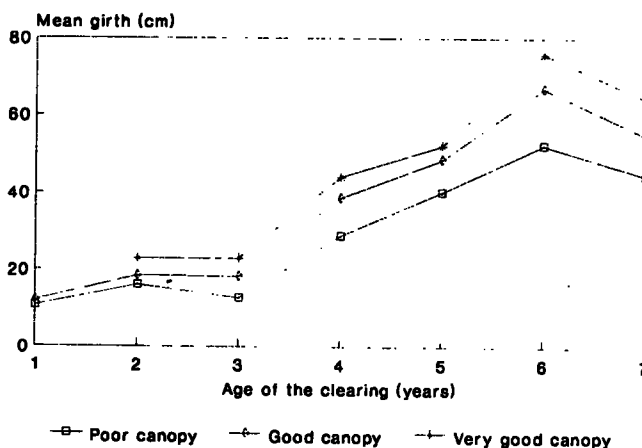
### Correlation between branching and tree growth

An increase in the SEM values is observed with the increasing age of the clearing of all clones except for RRIC 130 trees, where all 3 SEM values are in the range of 0.51 - 0.54 for the trees aged 4, 6 and 7 years. The increase in the SEM value with the age of the clearing indicates the high variation in girth among trees. The highest SEM value was obtained for 6 year old RRIC 100 trees. As said earlier, these trees had not been opened for tapping until very late and some trees had girth as high as 100 cm making the SEM value large. As far as the growth is concerned, both RRIC 110 and RRIC 121 show a little higher girthing than the other clones. However, direct comparisons among clones cannot be done as the planting materials, agromanagement practices, age of commencement of tapping *etc.* may have been different from clearing to clearing.

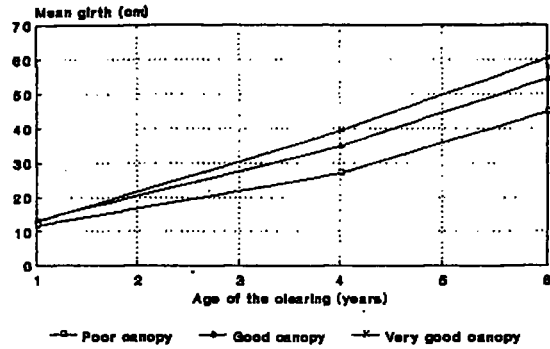
### Correlation between the canopy distribution and the girth of the trees

Results on the mean girth of the trees clones RRIC 100, RRIC 102, RRIC 110, RRIC 121 and RRIC 130, grouped according to the canopy distribution are shown in Figure 4.

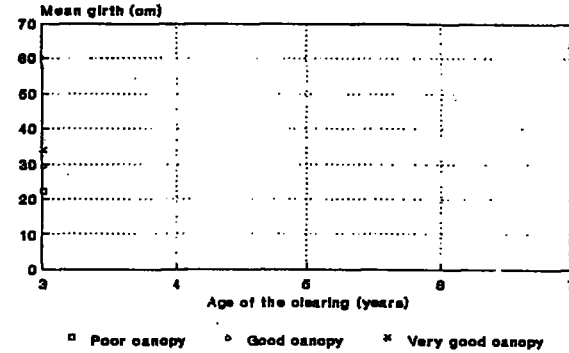
A clear effect of the canopy distribution on the girth of the trees is seen from Fig. 4. Though there is an increase in the girth with the age of the trees, it is not gradual as the measurements were taken from different clearings. The agromanagement practices, planting materials and the other cultural conditions may be slightly different from one clearing to the other. The effect is more clear for the clones RRIC 100, RRIC 102 and RRIC 121. The reason for the higher mean girth of the trees of 6 years is that they had not been opened for tapping until very late. However, it should be mentioned that this grouping was done only arbitrarily.



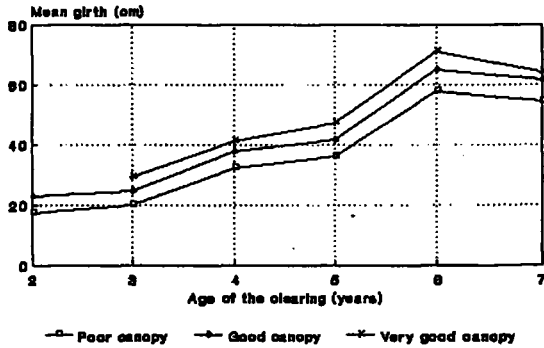
4.1. RRIC 100



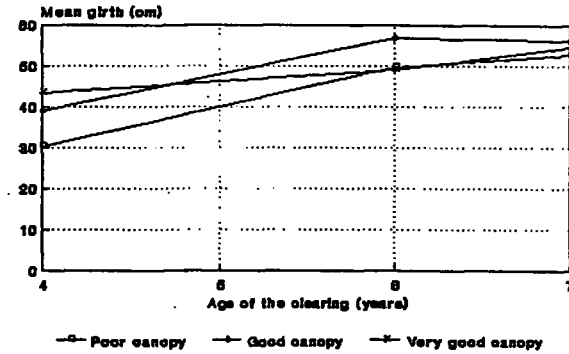
4.2. RRIC 102



4.3. RRIC 110



4.4. RRIC 121



4.5. RRIC 130

Fig. 4. The mean girth of the trees grouped according to the canopy distribution, 4.1 - RRIC 100, 4.2 - RRIC 102, 4.3 - RRIC 110, 4.4 - RRIC 121 and 4.5 - RRIC 130

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### DISCUSSION

Higher girthing of trees correlating with a higher number of branches was not unexpected, though there are many other reasons which possibly contribute and control the growth of a tree. The main concern here is whether branching can effectively be used to cut down the long immature period of rubber plantations and also whether the uneven growth of the trees (Senanayake, 1975), often referred to as a result the stock-scion interaction, can be reduced by improving the growth by means of inducing branches. The removal of unsatisfactorily grown branches is important for the survival of the remaining branches or even the tree, rather than the growth of the tree.

Though, there are evidence to assume that the branching of a tree is a clonal characteristic, in all the clones studied, there are trees of which the number of branches vary from zero to about 10 (as far as the  $\frac{1}{2}$  size of branches are concerned). But, in some clones such as RRIC 130 the number of trees with a reasonably higher number of branches is higher.

Apart from the timber value, the value of a rubber tree depends, first, whether it is grown up to the tappable girth and then the yield. A tappable tree is selected by the girth, *i.e.* 50 cm measured at 120 cm from the graft union). To commence tapping, about 60% of the trees in a clearing should be of tappable girth. Therefore, the high variation in growth may delay the opening of trees. On the other hand, the amount of latex or the yield per tree per tapping is a clonal characteristic but again it seems that this has a positive correlation with the girth of the tree, perhaps due to the higher number of latex vessels that can be accommodated in a tree with a bigger trunk. An extensive study carried out by Westgarth & Buttery (1965) on the effect of density of planting on the growth and yield has revealed higher yields on larger trees of clone AVROS 50. A study done by Rodrigo *et al.*, again to see the effect of tree density on the yield, has indicated a positive relationship between the tree girth and the yield of clones RRIC 101, RRIC 103 and PB 86 (Personal communication).

The results of the present report suggest that the girth of the trees has improved with the increasing number of branches. Yoon (1973) also showed that the growth of late-branching trees could be improved by inducing branches at a lower height. A detailed study conducted by Yoon *et al.* (1976) has shown not only branch induction but also corrective and controlled pruning of undesirable branches would result in higher tree girth. About 6% increase in the tree girth has been gained in 3 year old RRIM 600 trees by controlled pruning. The details of this procedure is described by Yoon *et al.* (1976).

The results show that some clones have greater number of trees with a higher number of branches on them. As branch induction has not been practised, this may be due to differences between individual trees of any clone. The clone RRIC 121 is a poor branching clone but known to be a vigorous grower. The correlation values between the number of branches and the tree girth show a highly significant positive correlation for all clearings except for 5 year old trees of which the  $r$  value was low. Trees of this clearing show very poor branching compared to the other clearings of the same clone. Among the possible reasons for this, poor quality planting materials, poor agromanagement practices specially fertilizer applications *etc.* during the early years of the establishment, may be important. In fact, only 4 trees contained  $\frac{1}{2}$  size branches where as 4 year and 6 year old trees contained 44% and 45% of the trees with  $\frac{1}{2}$  size branches (Table 2)). As far as the mean girth is concerned, 5 year old trees had only 39.7 cm while 4 year trees had 38.17 cm. Six year old trees showed mean girth of 61.7 cm (Table 4). This clearly shows that the 5 year old trees of clone RRIC 121 are undergirthed and the reason for the low correlation may be the same. This also supports that branching influences the growth of the tree of this clone.

The canopy distribution, arbitrarily grouped as very good, good and poor also shows a good relationship with the girth of the trees. As the basis of this grouping was also the number of branches and their distribution, the information is similar to that of number of branches.

The present report is in agreement with the findings of the others on the effect of the number of branches and their distribution on the growth of the trees. However, our objective here was to see whether the number of branches and the tree girth show a significant correlation. The results of the present study suggests that inducing branches may be used as an effective method to improve the girth and thereby to obtain a more uniform growth of trees where the tapping of the entire population can be commenced at one time. This will eventually reduce the immature period.

Development of a balanced canopy by inducing branches followed by corrective pruning is important for the survival of the tree rather than girthing, as the effects of imbalanced or improper canopies can be as bad as loosing of the tree due to trunk snap or uprooting.

It is also important that, any corrective pruning required, carried out as soon as practicable. Pruning of undisarable branches even at a later stage is advisable as they can cause more damages to the tree than the benefits of having them. In this case, pruning the branches to an appropriate length has been recommended as a better method than completely removing them or leaving them as the former may depress girthing and yield. Anyhow, as pointed out by Webster (1989) there is no

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advantage in such pruning as the yield decrease due to pollarding prevails for about five years minimum and by that time branches have regenerated to a level that they are prone to wind damage again. Therefore it is always beneficiary to the tree that branch induction and/or corrective pruning carried out as early as possible so that the crown will be growing well distributed and balanced.

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(Received 28 August 1995)