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# The effect of girth at opening on yield and growth of modern *Hevea brasiliensis* Muell Arg. clones

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## Abstract

*Commencing of tapping at a relatively early growth stage than as at present is believed to benefit the rubber growers, provided that such tapping do not result in significant declines in both yield and growth when compared with current recommendations.*

*In three widely planted clones in Sri Lanka, (i.e. RRIC 100, 121 and 130) trees of lower girth classes (i.e. $G_{17}$ and $G_{18}$) and of currently recommended girth class, (i.e. $G_{20}$.) but of same age, were tapped and the yield and growth after tapping were compared.*

*Within a clone, the depression in girth after commencement of tapping was similar in all girth classes tested. Nevertheless, clonal differences were evident. Girth depression after tapping was less in RRIC 121 than in RRIC 100 though its yield potential is high. Possible reasons for this are discussed.*

*Bark thickness at 150 cm above union in panel BO - 1 and at 90 cm above union in panel BO - 2 increased with the girth and also generally high in the tapped trees than in untapped trees. However, in RRIC 121 bark thickness was significantly less in tapped trees at 150 cm above union in the side of panel BO -1.*

*Yield increased with increase in girth and this was very prominent in RRIC 130, the highest yielding clone among the different clones tested. Yield difference between $G_{18}$ and $G_{20}$ trees was about 21-33% and therefore would affect the cost of production. Further, the yield of less vigorous trees was found to be low compared to vigorous trees in all clones tested.*


**Key words:** bark thickness, girth, growth, tapping, yield

## Introduction

It is commonly believed that commencement of tapping when *Hevea brasiliensis* trees are too young significantly retards the subsequent growth of the tree. Moreover, it is known to lead to a low yield during the entire tapping cycle of a tree as the girth of a rubber tree is positively correlated with yield (Vijayakumar *et al.*, 2000).

Initially the age of a rubber tree was taken as the sole parameter to determine the tappability of a tree. 25 years of age when growing naturally in forests and 10 - 15 years of age when grown in open plantations were the guide-lines used for this purpose. Further, some were of the opinion that it

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is the growth and not the age of the tree that indicates when a tree can be safely tapped. According to them a tree having a girth of 20 - 24", a yard above the ground is tappable.

More recently a girth of 45 - 50 cm at 150 cm above the union for budded plants and a girth of 50 cm at 50 cm above ground level for seedlings were used in different rubber growing countries as criteria for selecting trees for tappability [(Paardekooper (1989); Obouaveba *et al.* (2000); Vijayakumar *et al.* (2000)]. Nevertheless, some are of the view that opening budded plants early, *i.e.* 45 cm at 150 cm from union reduces the immature period and also improves the profitability of estates (Ng, 1972). Genetic improvements made for both yield and growth vigour have paved the way for trees to reach tappable girth in 4 - 5 years. However, it is feared that commencing of tapping when trees are *ca.* 4 years of age could lead to high incidence of Tapping Panel Dryness (TPD) and wind damage (Obouayeba *et al.* 2000). During the juvenile phase of a rubber tree, *i.e.* upto 4 - 5 years (Sonquhan *et al.*, 1990) food produced by the plant is used mainly for biomass production and commencement of tapping during this phase may be associated with physiological and mechanical problems discussed earlier. Therefore attempts are now being made to define an age and a minimum girth for the commencement of tapping of modern *Hevea brasiliensis* clones.

This paper reports the preliminary results of a study carried out using three widely adopted clones for commercial planting. In trees of the same age but of different growth levels, the yield and growth of tapped trees and the growth of untapped trees were monitored during the study period, *i.e.* 5 years.

## Materials and methods

### *Plant material*

The clones, RRIC 100, RRIC 121 and RRIC 130 planted in 1990 at Dartonfield Estate, Rubber Research Institute, Agalawatta, Sri Lanka were selected for the study.

### *Methods*

*Selection of plants*

From each clone trees of girth classes 42 - 44 cm ($GC_{17}$) 44 - 46 cm ($G_{18}$) and 49 - 51 cm ($GC_{20}$) at 120 cm from the union were selected. For trees selected from each girth class in each clone the following treatments were introduced randomly on a single tree plot design. Twenty trees were assigned for each treatment of all three clones.

| *Treatment No.* | *Treatment* |
|---|---|
| $T_1$ | Tapping commenced at $GC_{17}$ |
| $T_2$ | $GC_{17}$ untapped trees |
| $T_3$ | Tapping commenced at $GC_{18}$ |
| $T_4$ | $GC_{18}$ untapped trees |
| $T_5$ | Tapping commenced at $GC_{20}$ |
| $T_6$ | $GC_{20}$ untapped trees |
| $T_7$ | $GC_{17}$ trees to be tapped at $GC_{18}$ |
| $T_8$ | $GC_{18}$ trees be tapped at $GC_{20}$ |

*Girth depression*

Just prior to introducing the treatments ($G_p$) and at the end of each year after introducing the treatments ($G_a$). girth measurements were made at 150 cm from the union in each tree selected for the study. Using these data the percentage girth increment, *i.e.* $G_a - G_p/G_p \times 100$ [$G_i$] was calculated for each tree and then the mean for each treatment $[G]_i$. In the same girth class, the difference in percentage girth increase between tapped and untapped trees was taken as the girth depression for that treatment, [*i.e.* $G_{i(untapped)} - G_{i(tapped)}$] due to tapping.

*Yield*

In all clones, trees in treatments $T_1(G_{17})$, $T_3(G_{18})$ and $T_5(G_{20})$ were tapped at ½S d/2 system. Trees in treatments $T_7$ and $T_8$ were tapped when growth level of treatments $T_3$ and $T_5$ were reached respectively. Once in every month during the study period, *i.e.* 1996 - 2000, a test tapping was done and the latex volume of each tree was measured. Thereafter, the latex of all trees in a treatment was pooled and the dry rubber content (DRC) was determined using a metrolac. The latex volume of individual trees and the DRC of the treatment were used to determine the yield per tree per tap, *i.e.* g/t/t of individual trees.

*Bark thickness*

In the test plants of all treatments, $T_1$ to $T_8$ the bark thickness was measured using a bark guage. In each tree, measurements were made at two points, *i.e.* 150 and 90 cm above the union in panels BO - 1 and BO - 2 respectively.

**Results**

*Girth depression*

In all three clones tested tapping depressed the girthing of trees. Further, in all three clones tested the percentage depression in girthing within a clone was similar in all girth classes tested, *i.e.* $G_{17}$, $G_{18}$ and $G_{20}$ (Table 1). However, clonal differences were evident with regard to girth depression due to tapping. It was high in clones RRIC 100 and RRIC 130 compared to clone RRIC 121. The percentage depression in girth after commencement of tapping showed a gradual reduction with time in clone RRIC 100. However, in clones RRIC 121 and 130, the decline in girth did not show such a pattern during the five year period of the study (Table 1).

*Yield*

The variation in g/t/t due to the commencement of tapping at different girths, *i.e.* $G_{17}$, $G_{18}$ and $G_{20}$ differs with clones.

In RRIC 100 from the initial year of tapping, the trees opened at $G_{20}$ gave marginally higher yields than the lower girth classes tested, *i.e.* $G_{17}$. In clone RRIC 121, from the third year of tapping, $G_{20}$ trees recorded significantly higher yields than $G_{18}$ and $G_{17}$ trees. $G_{20}$ trees yielded significantly higher than $G_{17}$ and $G_{18}$ trees from the first year of tapping in clone RRIC 130 (Fig. 1 and Table 2).

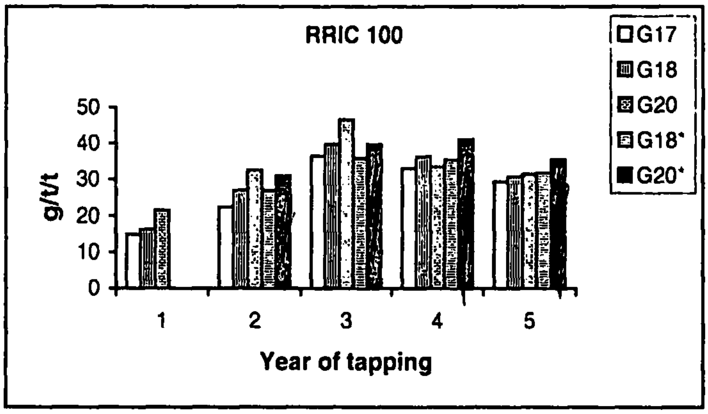
**Table 1**. *Effect of commencing tapping different growth stages on the subsequent girthing in clones RRIC 100, 121 and 130*

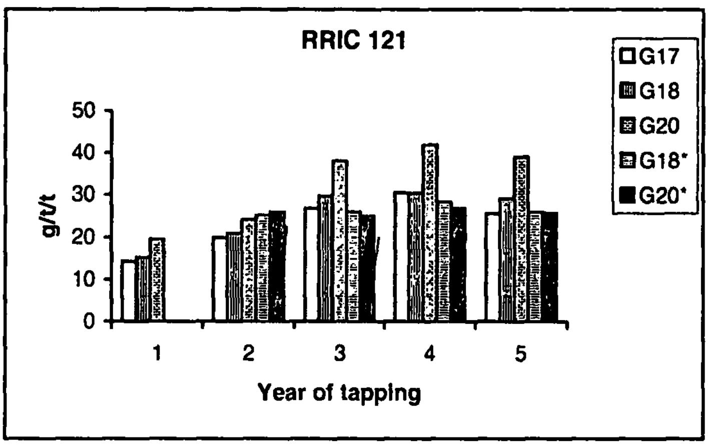
| Clone | Girth | Year of tapping and girth depression (%) | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | Mean |
| RRIC 100 | $G_{17}$ | 45.1 | 45.6 | 37.0 | 38.8 | 36.5 | 39.8 |
| | $G_{18}$ | 45.5 | 47.2 | 41.9 | 36.9 | 37.9 | 41.9 |
| | $G_{20}$ | 59.8 | 48.6 | 41.9 | 36.5 | 37.9 | 44.7 |
| | Mean | 50.1 | 47.1 | 39.9 | 36.1 | 37.4 | - |
| RRIC 121 | $G_{17}$ | 19.1 | 20.1 | 18.6 | 18.3 | 20.3 | 19.1 |
| | $G_{18}$ | 21.2 | 20.0 | 18.7 | 23.5 | 22.9 | 21.3 |
| | $G_{20}$ | 18.4 | 20.2 | 16.0 | 14.2 | 19.3 | 17.7 |
| | Mean | 19.6 | 20.1 | 17.4 | 18.7 | 20.8 | - |
| RRIC 130 | $G_{17}$ | 39.5 | 36.3 | 37.8 | 38.0 | 41.2 | 38.6 |
| | $G_{18}$ | 35.2 | 28.6 | 33.7 | 29.5 | 34.5 | 32.3 |
| | $G_{20}$ | 40.6 | 37.5 | 44.3 | 40.4 | 38.5 | 40.3 |
| | Mean | 38.4 | 34.1 | 38.6 | 36.0 | 38.1 | - |

When yields of $G_{17}$ and $G_{18}$ trees are compared with the same of $G_{18*}$ and $G_{20*}$ trees, it was apparent that yields are higher with $G_{18*}$ and $G_{20*}$ trees in the first year of tapping. No significant yield differences were evident during the subsequent years of tapping. Further the yields of $G_{18*}$ and $G_{20*}$ trees tend to be marginally less than the yields of $G_{18}$ and $G_{20}$ trees respectively and it was more prominent in clone RRIC 130.

**Table 2**. *Effect of commencement of tapping at different girths on yield per tree per tapping (g/t/t/) in clones RRIC 100, 121 and 130*

| Clone | Treatments | Year of tapping and yield (g/t/t) | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| RRIC 100 | $G_{17}$ | 14.9[a] | 22.4[a] | 36.6[a] | 33.2[a] | 29.4[b] |
| | $G_{18}$ | 16.3[a] | 27.0[a] | 39.9[a] | 25.5[a] | 30.1[ab] |
| | $G_{20}$ | 21.5[a] | 32.6[a] | 46.7[a] | 36.3[a] | 31.5[ab] |
| | $G_{18*}$ | - | 27.0[a] | 36.1[a] | 41.2[a] | 31.8[ab] |
| | $G_{20*}$ | - | 31.1[a] | 39.9[a] | 33.5[a] | 35.6[a] |
| RRIC 121 | $G_{17}$ | 14.3[a] | 19.9[a] | 26.8[b] | 30.4[b] | 25.6[b] |
| | $G_{18}$ | 15.2[a] | 21.0[a] | 29.7[b] | 28.2[b] | 29.1[b] |
| | $G_{20}$ | 19.5[a] | 24.2[a] | 38.0[a] | 30.3[b] | 39.0[a] |
| | $G_{18*}$ | - | 25.2[a] | 25.9[b] | 26.8[b] | 25.9[b] |
| | $G_{20*}$ | - | 26.0[a] | 25.0[b] | 41.9[a] | 25.7[b] |
| RRIC 130 | $G_{17}$ | 39.1[b] | 45.2[a] | 45.9[b] | 52.9[ab] | 43.6[b] |
| | $G_{18}$ | 44.2[ab] | 47.7[a] | 53.7[b] | 38.0[b] | 44.5[b] |
| | $G_{20}$ | 56.9[a] | 56.8[a] | 66.2[a] | 56.7[a] | 76.6[a] |
| | $G_{18*}$ | - | 44.8[a] | 42.9[b] | 56.2[a] | 32.2[c] |
| | $G_{20*}$ | - | 51.1[a] | 52.7[b] | 67.3[a] | 53.2[b] |



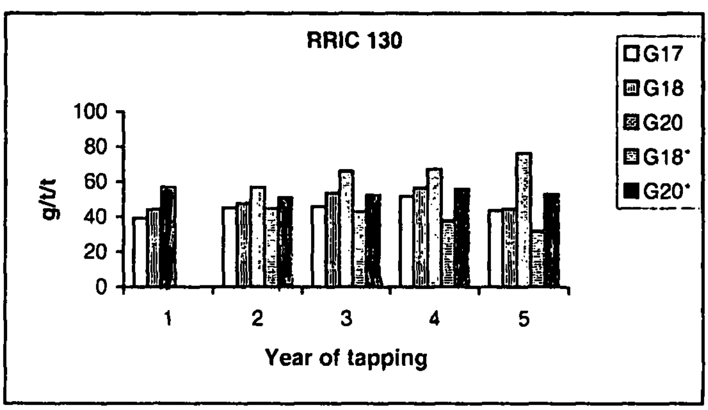




Fig. 1. Annual mean g/t/t for different girth classes and years of tapping for clones tested

### *Bark thickness*

In all clones tested the bark thickness increased with girth in both tapped and untapped trees (Table 3). Nevertheless, the response of bark thickness to tapping varies with the clone. At both points of measurement, *i.e.* 150 and 90 cm above the union in panels BO-1 and BO-2 respectively, it is either marginally or significantly higher in tapped trees in clones RRIC 100 and 130 (Table 3). But in clone RRIC 121, the bark thickness is significantly low in tapped trees when measured at 150 cm above union whilst it is significantly high at 90 cm above union in the untapped panel BO - 2 (Table 3).

### Discussion

As shortening of the immature period is believed to be economically more beneficial the use of advanced planting materials and early exploitation through puncture tapping or through conventional excision tapping commencing at lower girths are being looked into. Among these possibilities conventional tapping at relatively lower girths is widely studied. Nevertheless, if conventional tapping at an early growth stage results in relatively low yields or growth or both it will not bring about the intended advantage.

This study reveals that in all clones tested, the percentage depression in girth after commencement of tapping is similar in trees tapped at either $G_{17}$, $G_{18}$ or $G_{20}$. However, though girth differences existed in the test plants the age of trees was similar, *i.e.* 6 years. It is reported that depression in girth to be more significant at the juvenile phase of the trees where energy is mainly utilized for biomass production (Obouayeba *et al.*, 2000).

Clonal differences are evident with regard to the depression of girth due to commencement of tapping. The mean percentage depression in girth for all girth classes tested was 42.1, 19.4

**Table 3.** *The effect of commencement of tapping at different growth levels on bark thickness of genotypes RRIC 100, 121, and 130. a) Bark thickness at 150 cm above union in the side of panel BO - 1 and b) Bark thickness at 90 cm above union in the side of panel BO - 2*

| | Clone | Girth class and bark thickness (mm) of tapped (T) and untapped (UT) trees | | | | | |
|---|---|---|---|---|---|---|---|
| | | $G_{17}$ | | $G_{18}$ | | $G_{20}$ | |
| | | T | UT | T | UT | T | UT |
| a) | RRIC 100 | $6.8^a$ | $6.4^a$ | $6.8^a$ | $6.5^a$ | $7.2^a$ | $6.8^a$ |
| | RRIC 121 | $6.2^b$ | $7.3^a$ | $5.9^b$ | $7.7^a$ | $6.5^b$ | $7.7^a$ |
| | RRIC 130 | $8.3^b$ | $7.4^a$ | $8.8^b$ | $7.9^a$ | $8.8^a$ | $8.6^a$ |
| b) | RRIC 100 | $7.8^a$ | $7.3^a$ | $7.8^a$ | $8.1^a$ | $8.5^a$ | $8.2^a$ |
| | RRIC 121 | $6.0^a$ | $5.2^b$ | $6.3^a$ | $6.4^b$ | $6.9^a$ | $5.7^b$ |
| | RRIC 130 | $8.4^a$ | $8.2^a$ | $9.3^a$ | $9.2^a$ | $9.4^a$ | $9.7^a$ |

(For each clone and girth class means with same letters are not different significantly) and 37.1 for clones RRIC 100, 121 and 130 respectively. Templeton (1969) has reported that girth loss due to tapping varies with clone, age and tapping intensity and it ranges between 9.6 to 44.3 percent In this study as the age and tapping intensity were similar, the variation in girth depression evident may have been due to genotypic differences.

In general higher the yield the greater the loss in shoot dry weight increment and hence the girth increment (Paardekooper, 1989). However, though the loss in girth increment is less in RRIC 121 its early yields are much higher than in RRIC 100 (Attanayaka, 2001) where the loss in shoot dry weight is much higher than in RRIC 121. Clonal differences in the efficiency in which dry matter is converted into rubber, dry matter partitioning between crown and stem also influences shoot dry weight incremental (Paardekooper, 1989). Further it is reported that clones with a high plugging index to have a better post-tapping girth increment. Comparative studies indicate plugging index of clone RRIC 121 to be greater than in RRIC 100 (Gunasekera, 1998).

In all clones tested trees having a lower girth, *i.e.* $G_{17}$ and $G_{18}$ yielded less than the higher girth trees, *i.e.* $G_{20}$. Further, among the clones tested yield decrease with lower girth is more significant in relatively higher yielding clones, *i.e.* RRIC 130 (Fig. 1 and Table 2). Moreover, even in relatively lower yielding clones, *i.e.* RRIC 100, the yield differences between lower and higher girth trees became more apparent with the increase in number of years of tapping and hence the yield. The mean yield during the initial 5 years of tapping for different girth classes of each clone tested (Table 4) indicate that when tapped at $G_{18}$ instead of $G_{20}$, the yield per tree per tapping is less by 21, 26 and 33 percent for clones RRIC 100, 121 and 130 respectively. Therefore, the tapping cost which is about 40% of the total cost of production will increase by similar percentages if tapping is commenced at $G_{18}$.

When tapping is delayed until a higher girth is reached, *i.e.* $G_{18*}$ and $G_{20*}$, the yield of such trees were higher than in $G_{17}$ and $G_{18}$ trees respectively, only in the first year in all three clones tested. No yield differences were evident in subsequent years. Therefore, it is evident that vigorous trees yield higher than less vigorous trees in all clones tested. Further, yields of $G_{18*}$ and $G_{20*}$ trees are relatively less than in $G_{18}$ and $G_{20}$ trees respectively (Fig. 1 and Table 2). The above yield trends are more apparent in the relatively high yielding clone RRIC 130. With regard to yield potential of clones tested, experimental and commercial yields indicate that it is highest in RRIC 130, followed by RRIC 121 and RRIC 100 (Attanayaka, 2001).

Effect of girth at opening on yield

**Table 4.** *The mean yields (g/t/t) of different treatments during the study period*

| Treatment | | Clone mean yield (g/t/t) | | |
|---|---|---|---|---|
| | | RRIC 100 | RRIC 121 | RRIC 130 |
| 1 | $G_{17}$ | 27.3 (100) | 23.4 (100) | 45.3 (100) |
| 2 | $G_{18}$ | 27.8 (102) | 24.0 (103) | 47.5 (105) |
| 3 | $G_{20}$ | 33.7 (123) | 30.2 (129) | 62.6 (138) |

Bark thickness of tapped trees tend to be higher than in untapped trees of clones RRIC 100 and 130 when measurements were done 150cm above union, *i.e.* 30 cm above panel BO-1. This may be due to the effect of tapping on phloem translocation. Nevertheless, in RRIC 121 bark thickness 30 cm above panel BO -1 was significantly less in tapped trees. In order to test whether effect on food translocation through tapping, had any influence on bark thickness of tapped trees, measurements were done 90 cm above union on the untapped BO - 2 panel. At this position of the trunk bark thickness was generally high in tapped trees of all three clones tested. Bark thickness of clone RRIC 121 is generally lesser than in other clones (Table 3). Therefore, for the fear of wounding, tappers tend to carry out shallow tapping in this clone. If so, effect on phloem translocation could be less and this may be the reason for clone RRIC 121 to behave differently from other clones with regard to bark thickness of tapped trees.

This study reveals that the extent of girth depression after tapping varies with the clone. But in all clones tested, within a clone, the depression in girth after tapping was similar in different girth classes tested, *i.e.* $G_{17}$, $G_{18}$ and $G_{20}$. It is evident that trees tapped at $G_{18}$ yields about 21 - 33 percent less than those tapped at $G_{20}$. This will result in similar increases in cost of tapping and hence will be economically less viable. In clearings that have reached tappability, delaying of tapping the under girth trees until currently recommended tappable girth is reached will only marginally improve the yield (g/t/t). It is evident that trees that reach tappable girth earlier, *i.e.* vigorous trees tend to yield better than those that reach tappable girth later, *i.e.* less vigorous trees.

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