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STUDIES ON THE INTRAXYLARY PHLOEM AND ITS ASSOCIATION WITH CERTAIN GROWTH CHARACTERS IN *HEVEA BRASILIENSIS* (WILLD. EX ADR. DE JUSS.) MUELL. ARG.

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Quantitative differences in the number of primary xylem points, number of intraxylary phloem points and the thickness of xylem and phloem in one year old twigs were assessed in eight clones of *Hevea brasiliensis*. The linear relationship of these structural characteristics on the growth characters such as diameter of the twigs of the tapping trees and girth increment on tapping were also examined.

The data revealed marked differences of anatomical and growth characters among clones. The number of intraxylary phloem points had significant association with the number of primary xylem points (r = 0.8158**), twig diameter (r = 0.5067**) and the rate of girth increment on tapping (r = 0.4231*). The number of primary xylem points also was correlated with the twig diameter (r = 0.5258**). This trait also showed a positive relationship with the rate of girth increment on tapping though not significant.

Key words - *Hevea*, Intraxylary phloem, Protoxylem.

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INTRODUCTION

Growth rate during pre-exploitation phase and that after opening the trees for tapping are equally important factors influencing the yield of *Hevea*. Tapping retards girthing and biomass production (Abraham and Taylor, 1967; Templeton, 1969; Sethuraj, 1981 and George *et al*, 1984) for which the disturbance of phloem transport may be one major cause. It takes a few years, after opening the trees for tapping, for collecting information on the clonal variation in girth increment on tapping. An easier method is to exploit the phenomenon that selection pressure on one character brings about changes in other significantly associated characters (Simmonds, 1969).

The occurrence of intraxylary phloem strands associated with the protoxylem groups in the pericentral region has been identified in *Hevea* (Premakumari *et al*, 1985). The present work is an attempt to quantify the intraxylary phloem and a few other structural traits of eight *Hevea* clones. The linear relationship among the anatomical traits and the girth increment on tapping was examined with a view to exploring the possibility of using these traits in clone selection.

MATERIALS AND METHODS

Twig samples of one year's growth were collected from 15 year old trees of eight clones, namely, RRII 101, RRII 102, RRII

105, RRII 106, RRII 109, RRII 111, PR 107 and Tjir 1 of *Hevea brasiliensis* (Willd. ex-Adr. de Juss.) Muell. Arg. planted in a clone trial at the Central Experiment Station of the Rubber Research Institute of India. From each clone, five trees at random were selected and from each tree, three twigs were collected on a random basis.

Transverse sections of twigs, 4–5 cm below the apex, were prepared at 40 μm thickness. Differential staining was carried out using safranin and fast green. The sections were observed under a light microscope and number of primary xylem groups, number of intraxylary phloem groups and thickness of xylem and phloem were assessed. Thickness of xylem and phloem was measured from three distant positions of the section using an eye piece micrometer. The diameter of sections was measured directly with a scale. Five sections per twig were observed for recording the characters and calculating means.

The girth of trees at 150 cm from the bud union was recorded during the 17th, 18th and 19th year after planting and mean girth increment over two years was calculated as percentage increase over the girth during the 17th year.

Clonal differences of the structural traits were assessed and the correlations among the structural traits and girth increment on tapping were examined. The number of trees from which the samples yielded perfect microscopic preparation ranged from three to five. For correlation studies the data from 30 trees were pooled.

RESULTS AND DISCUSSION

The clonal differences of various traits under study are given in Table 1. The diameter of one year old twig at 4–5 cm below the tip varied from 5.3 to 6.3 mm in the different clones studied. The rate of girth increment showed a very wide range, from 0.87 to 3.00 per cent among the clones. This was below 1 per cent for RRII 101 and RRII 105, while the maximum was recorded by RRII 106. Clonal variability in girth increment in tapped trees is a well known phenomenon in this crop (Sethuraj, 1981; Nazeer *et al*, 1986 and Premakumari *et al*, 1986).

Table 1. Clonal differences of the structural traits, twig diameter and girth increment on tapping among eight *Hevea* clones (Mean ± S.E.)

Clones	No. of primary xylem points	No. of intraxylary phloem points	Thickness of xylem (μm)	Thickness of phloem (μm)	Diameter of the twig (mm)	Rate of girth increment on tapping (%)	Xylem/phloem ratio
RRII 101 (5)	55.5 ± 3.06	47.2 ± 2.50	554.8 ± 31.22	311.2 ± 38.54	5.7 ± 0.24	0.87 ± 0.14	1.78
RRII 102 (4)	65.9 ± 0.70	54.2 ± 3.90	533.0 ± 49.65	303.7 ± 17.00	6.0 ± 0.36	1.95 ± 0.44	1.76
RRII 105 (5)	51.5 ± 6.36	41.4 ± 5.27	485.9 ± 59.62	294.4 ± 7.04	5.3 ± 0.36	0.90 ± 0.50	1.65
RRII 106 (5)	70.9 ± 6.86	59.2 ± 4.93	489.2 ± 42.96	222.6 ± 26.25	5.9 ± 0.35	3.00 ± 0.53	2.24
RRII 109 (3)	69.6 ± 9.92	55.7 ± 7.48	423.9 ± 52.99	189.2 ± 7.94	5.5 ± 0.15	2.90 ± 0.14	2.24
PR 107 (5)	71.5 ± 3.72	65.2 ± 3.70	520.0 ± 30.51	293.6 ± 25.81	5.9 ± 0.18	2.70 ± 0.38	1.77
Tjir 1 (5)	53.5 ± 3.65	49.5 ± 3.51	477.2 ± 31.54	250.1 ± 33.78	5.5 ± 0.26	1.70 ± 0.12	1.91
RRII 111 (4)	66.1 ± 9.24	56.0 ± 6.49	548.1 ± 58.45	209.5 ± 5.39	6.3 ± 0.46	2.70 ± 0.64	2.62

The number of trees involved is given in parenthesis

The thickness of phloem was the highest for RRII 101 and the lowest for RRII 109, the range being 189.2 to 311.2 μm, whereas the thickness of xylem ranged from 423.9 to 554.8 μm among the eight clones.

The highest number of primary xylem points (72) and also of the intraxylary phloem groups (65) were recorded for PR 107 while the lowest numbers of both traits (52 and 41, respectively) were recorded for RRII 105. The clones RRII 101 and RRII 105 which had fewer numbers of primary xylem groups and intraxylary phloem groups had lower rate of girth increment on tapping. PR 107 followed by RRII 106, RRII 109 and RRII 111 had higher number of primary xylem groups and also the intraxylary phloem groups which had comparatively higher rates of girth increment on tapping. The lower rate of girth increment on tapping for RRII 105 when compared to the other clones mentioned here agrees with an earlier report (Nazeer *et al*, 1986).

The association of the number of intraxylary phloem points with the number of primary xylem points and the influence of both these traits on the other growth parameters are given in Table 2. The number of intraxylary phloem groups had a strong association with the number of primary xylem points (r = 0.8158**) while the thickness of xylem and phloem did not show significant association with any of these traits.

Table 2. Correlations among anatomical characters, diameter of one year old twig and the rate of girth increment on tapping

Character	Number of xylem points	Number of intraxylary phloem points	Xylem thickness	Phloem thickness	Diameter of one year old twigs	Rate of girth increment on tapping
Number of primary xylem points	—	0.8158**	-0.1182	0.1370	0.5258**	0.3122
Number of intraxylary phloem groups	—	—	—	—	0.5067**	0.4231*

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

The number of intraxylary phloem points had a significant association with the diameter of one year old twigs of tapped trees (r = 0.5067**) and with the girth increment on tapping (r = 0.4231*). The number of primary xylem points was also correlated with the twig diameter of trees under tapping (r = 0.5258**). This trait showed a positive relationship with the girth increment on tapping though the correlation coefficient was not significant.

Selection pressure can be profitably exerted on any easily identifiable character having close association with the desired character (Kamalam *et al.*, 1978). The need for and the practicability of this type of indirect selection has been justified by Simmonds (1969).

There are reports on the occurrence of intraxylary phloem in some plant species and its significant role in the translocation

of photosynthates and growth substances, especially in girdled stems (Zamski and Tsivion, 1977; Kuo and Pate, 1981 and Layzell *et al*, 1981). Tapping, a process of controlled partial girdling, may have a similar stimulative effect of activating the intraxylary phloem in *Hevea* to perform the function of the normal phloem tissue compensating the possible detrimental effect of tapping on phloem translocation and reduced root growth. The linear relationships of the number of intraxylary phloem groups with growth characteristics like girth increment on tapping and diameter of one year old twigs of tapping trees thus has a theoretical explanation. Since the intraxylary phloem groups are closely associated with the primary xylem groups, the latter trait can also be used as an indicator of the former one.

The clonal differences of the quantity of intraxylary phloem and the influence of this internal core of transporting tissue on the growth characteristics of *Hevea* trees under tapping are interesting phenomena which may suggest the possibility of predicting *Hevea* clones with high rate of girth increment on tapping. There are several clones of high yield potential and satisfactory vigour, whose girthing is highly retarded by tapping (Abraham and Taylor, 1967). The possibility of exploring the utility of the easily discernible structural characters in breeding and tree improvement deserves more attention.

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