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371

1510

Research Articles

INFLUENCE OF THE ORIENTATION OF LATICIFERS AND QUANTITY OF LATICIFEROUS TISSUE ON YIELD IN *HEVEA BRASILIENSIS* MUELL ARG.

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ABSTRACT

An attempt has been made to quantify the laticiferous tissue in terms of laticifer area index and the orientation of laticifers in ten *Hevea* clones. Their relationship with the interclonal variation of yield was examined. Laticifer area index had a positive relationship and density and width of phloic rays a negative one with yield. Clonal differences in yield was found to be governed by laticifer area index and the orientation of laticifers. Theoretical basis of such relationship in the light of latex flow characteristics is discussed.

INTRODUCTION

Interclonal variations of yield in *Hevea brasiliensis* is influenced by a large number of direct and indirect factors and their interactions, the extent of their effect varying at different growth phases (Ho, 1975). The role of structural traits in general and the importance of laticifer rows in particular for the selection of high yielding clones have been well elucidated (Gomez, Narayanan and Chen, 1972; Gomez, 1982, Ho, Narayanan and Chen, 1973; Narayanan and Ho, 1973; Narayanan, Ho and Chen, 1974; Ho, 1975 and Sethuraj, 1981). Recently it has been observed that the phloic rays show significant clonal differences (Premakumari, Joseph and Panikkar, 1985) and that they are associated with laticifer characters (Premakumari, 1984). An attempt is made in the present study to ascertain the relationship of phloic ray characters and the running direction of laticifers with the yield of *Hevea* clones.

MATERIALS AND METHODS

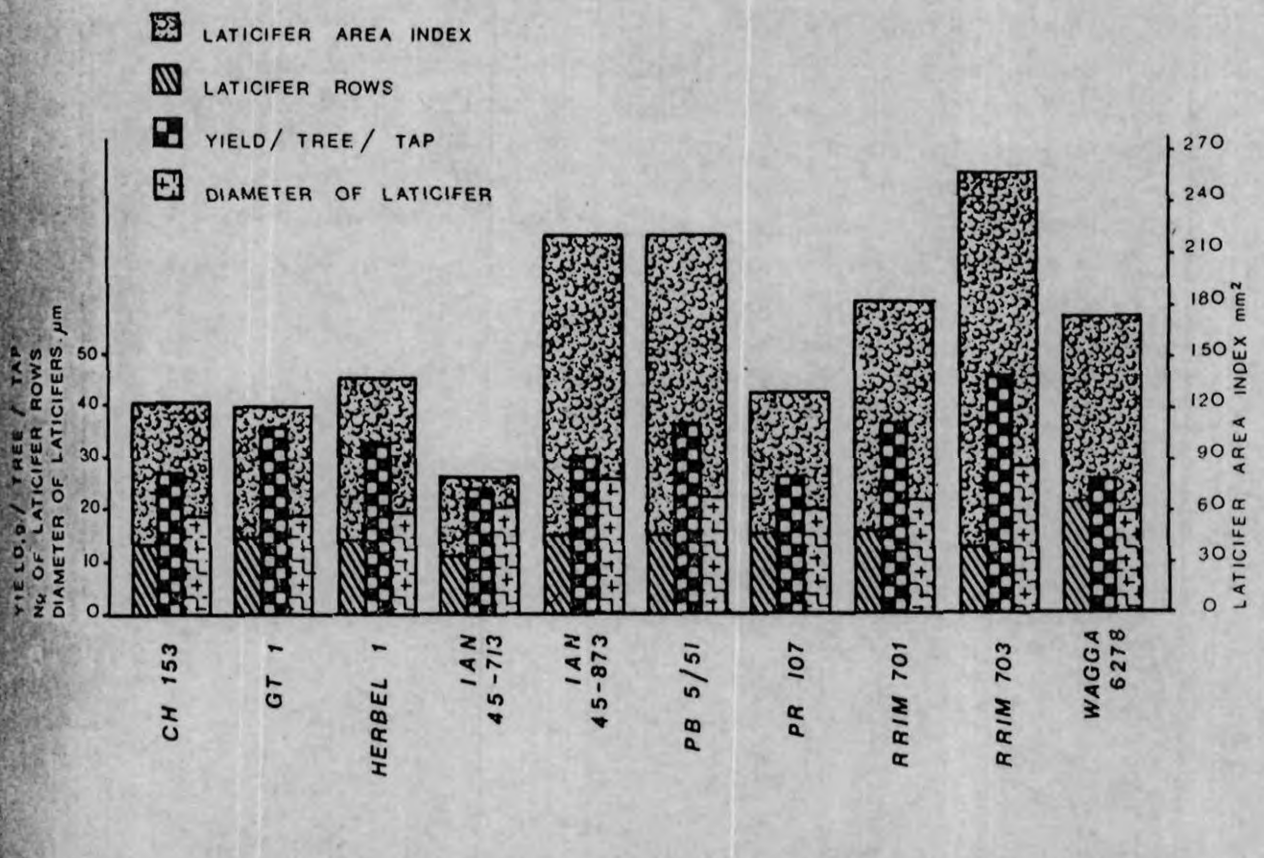
The study was conducted on ten *Hevea* clones, Ch 153, GT1, Harbel 1, IAN 45–713, IAN 45–873, PB 5/51, PR 107, RRIM 701, RRIM 703 and Wagga 6278 planted in a randomised block design with three replications. Conventional planting and cultural methods were followed. The trees were opened for tapping at the age of seven years and S2/d2 (100%) tapping system was followed. The plot yield was assessed twice every month by cup coagulation method and the average yield per tree per tap was assessed for the first three years of tapping. Tree girth was recorded annually, at 150 cm above the bud union. Samples of virgin bark were collected from one tree per plot at a height of 150 cm from the bud union, when the trees were of nine years age. Radial and tangential longitudinal sections of the bark at 120 and 80 μ respectively, were cut with a base sledge microtome. The sections were stained with Sudan III and observed under light microscope. The number of laticifer rows and diameter of laticifers were determined microscopically. The density of laticifers per row per unit girth was also observed. The laticifer area index, *i. e.*, the quantity of laticiferous tissue in terms of the cross sectional area of the bark, was worked out following Gomez, Narayanan and Chen (1972). Height, width and density of phloic ray groups, in the laticiferous layer were also recorded through microscopic observations.

RESULTS

The laticifer area index varied from 72.46 to 253.18 mm² among the ten clones. Highest quantity of laticiferous tissue was recorded for RRIM 703 for which a very high laticifer diameter was a contributing factor (Fig. 1). PB 5/51 and IAN 45-873 also showed high laticifer area index. The lowest area index was recorded for IAN 45-713.

Interclonal variations of the number of laticiferous rows, diameter of laticifers

Fig. 1. **Laticifer area index, laticifer rows, yield, (g. tree^{-1} tap^{-1}) and laticifer diameter of ten clones of *Hevea brasiliensis*. Either the number of rows or the diameter of laticifers, as a single factor, does not keep a clear relationship with yield**



(μm) and the yield/tree/tap (g) are also furnished in Fig. 1. None of these laticifer characters, as a single factor, showed high relationship with the yield variations among the clones.

The influence of interclonal variations of laticifer area index and density of ray groups on yield are shown in Fig. 2. The laticifer area index had a positive relationship and ray density had negative relationship with yield except GT1 and IAN 45-873. In Fig. 3 the yield/tree/tap (g) and the ray width (μm) are plotted. The ray width showed a very clear negative relationship with yield with RRIM 703 alone showing exception. GT 1, where medium density and medium width of ray groups had combined, gave fairly good yield though its laticifer area index was not very high.

IAN 45-873 was comparable to PB 5/51 for the laticifer area index although its yield was not as high. RRIM 703 the highest yielder had the highest rank for laticifer area index though no ray width was not very low. In IAN 45-713 the yield was very low associated with a very low laticifer area index and high ray width (Figs. 2 and 3).

Fig. 2. The influence of laticifer area index and density of phloic rays on yield. Density of phloic rays (in the laticifer layer) laticifer area index and yield ($g.\ tree^{-1}\ tap^{-1}$) of ten *Hevea* clones are plotted

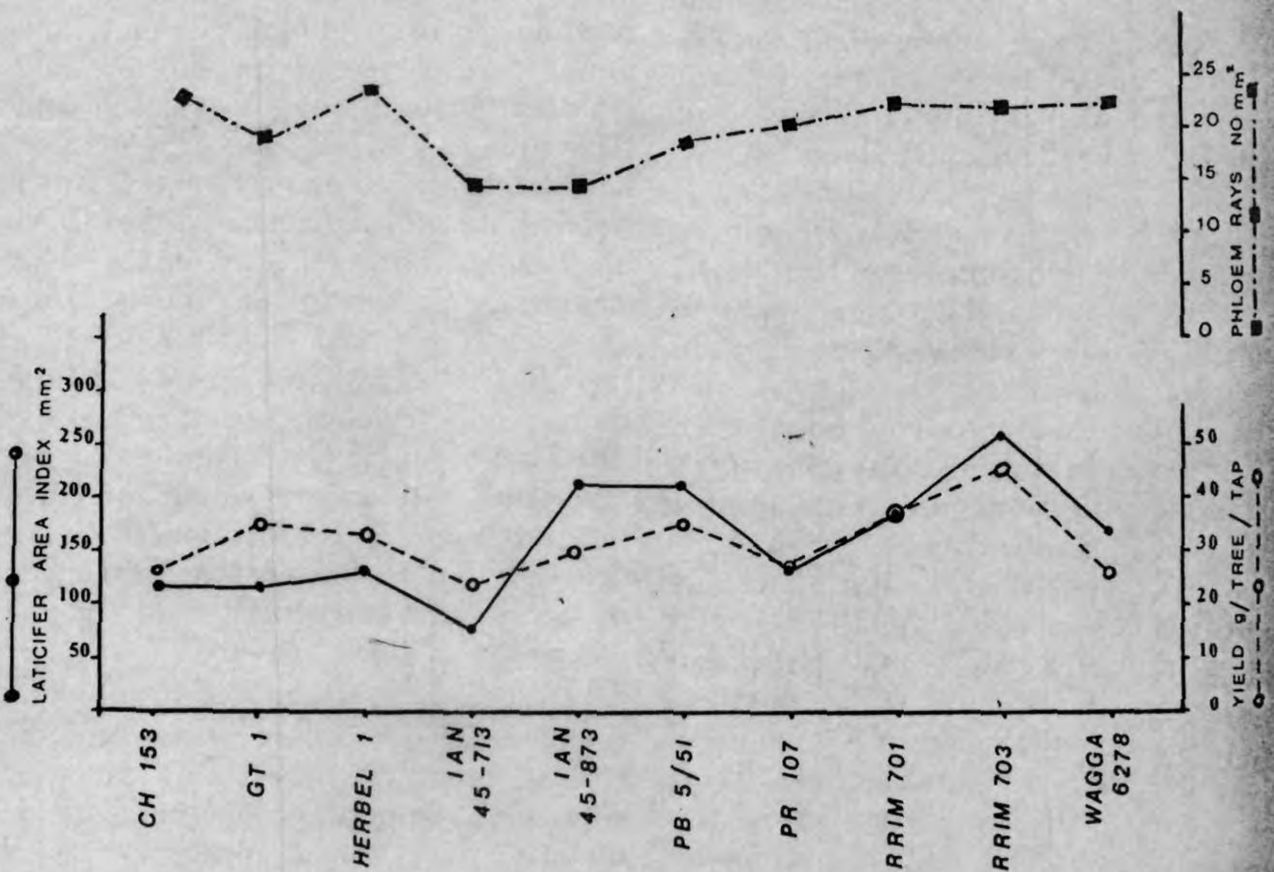
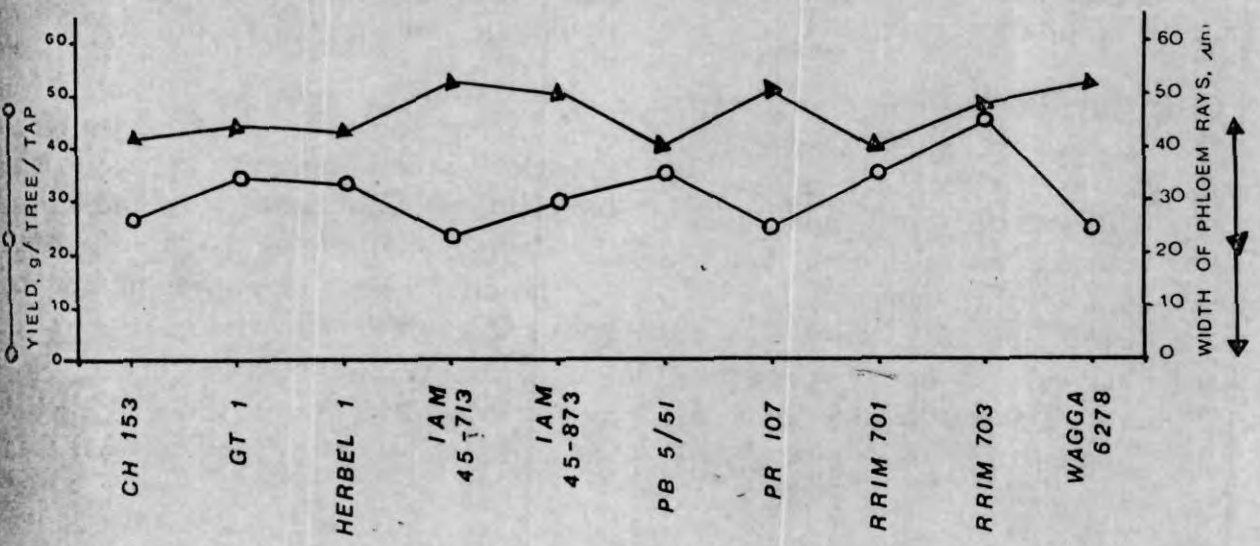


Fig. 3. Relationship between the interclonal variation of yield and the width of phloic rays



DISCUSSION

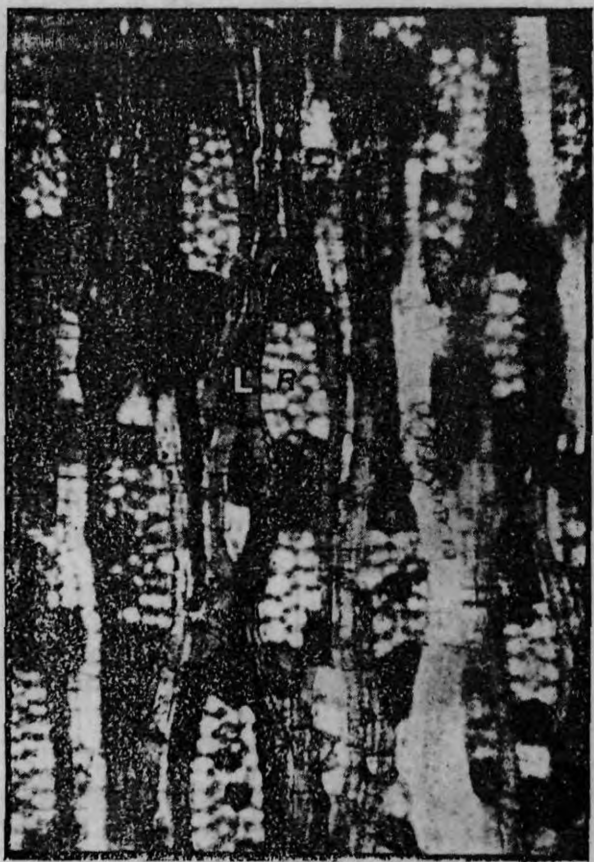
Figures 2 and 3 showed that the yield variation among *Hevea* clones is highly influenced by the laticifer area index and the density and width of phloic rays in the laticifer layer.

After nursery evaluation studies, vigour of the tree, number of latex vessel rows and plugging index were reported as the major factors controlling the yield capacity of *Hevea* clones. It was also noticed that these accounted only for 40 per cent yield at full maturity (Ho, 1975). According to various authors the number of laticiferous rows hold a very important position as a single factor influencing the yield. (Ho, et al., 1973; Ho, 1975; Narayanan and Ho, 1973 Narayanan et al., 1974 and Sethuraj, 1981). But there are instances where effect of this principal yield determinant vary between clones (Ho, 1975). In the present study also such instances were evident as may be seen in Fig. 1. This indicated the involvement of other factors controlling yield.

According to the structural alignment of *Hevea* bark, the laticifers are running from the base of the trunk upward, weaving the ray groups, and are distributed in rows alternating with sieve tube layers (Fig. 4). The density, height and width of rays in the laticiferous layer will influence the pathways of laticifers, *i. e.*, the extent of their waviness. To what extent the laticifers are wavy is a clonal character. Higher the density of rays higher will be the number of deviations in the running direction of laticifers. Likewise, higher ray width will lead to wider angles of the deviations. Thus broad rays in higher density will cause the most wavy direction of laticifers (Premakumari et al, 1985).

Laticifers in *Hevea* are just like an interconnected capillary system and the tree is exploited by opening them by controlled wounding of the bark at definite intervals, a process termed 'tapping'. The latex flow is initiated due to a sudden release of the turgor pressure within the laticifers and the

Fig. 4. Orientation of laticifers in *Hevea brasiliensis* as observed in the tangential longitudinal section of the bark. Laticifer (L) Phloic rays (R) × 354



contraction of laticifer wall. (Boatman, 197c; Buttery and Boatman, 1976; Gomez, 1982 and Southern, 1969).

The rate of latex flow is controlled by the pressure variations inside the laticiferous system till the laticifer ends are sealed by plug formation (Boatman, 1966 and Milford, Paardekooper and Ho 1969). Theoretically it should be assumed that clonal variation in the rate of flow will considerably affect the yield variation of *Hevea* clones. The rate of flow *i. e.*, the volume of latex coming out per unit length of panel per unit time, has been described as major component factor influencing the yield of *Hevea* clones (Sethuraj, 1981). This has high bearing on the total volume of latex per tapping. The seasonal variations of total volume of latex as influenced by soil moisture and other environmental factors are also related to the turgor pressure variations in the laticifers (George et al., 1980; Sethuraj and George, 1976).

The rate of fluid flow through a wavy tube will naturally be lower than that through a straight tube under constant pressure. Such an effect can certainly be expected in the rate of flow of *Hevea* clones according to the extent of waviness of the laticifers. The quantity of laticifer tissue will naturally be an indication of yield potential of the tree. These theoretical considerations support the relationship among yield and structural features as obtained in this study (Figs. 2 and 3). Deviations from such relationships among these traits as shown by certain clones as GT 1 and IAN 45-873 in Fig. 2 and RRIM 703 in Fig. 3 can be attributed to mutual interference of these parameters in expressing their effect on yield. The results revealed that the combined effect of laticifer area index and the orientation of laticifers has high bearing on the interclonal variation of yield in *Hevea brasiliensis*.

The influence of phloic rays, in the laticifer layer, on the density of laticifers was a very interesting phenomena, where the ray width and laticifer density showed very significant negative association at genotypic and phenotypic levels. (Premakumari et al., 1984). Highly significant negative correlation between ray width and vessel density will give additive contribution for high yield. The same study revealed that the ray height had a very significant negative correlation with ray density at the genotypic level. Similar relationship of ray density with ray width was evident though it was not statistically significant.

This study indicated that the laticifer area index and the running direction of laticifers should be considered as important parameters when selection is made for high yielding *Hevea* clones. The phloic ray characters have high bearing on the component factors of laticifer area index. The height, width and density of the phloic rays will control the extent of waviness in the running direction of laticifers, also. Since the laticifer area index and the running direction of laticifers depend on a number of component traits and as they are inter related as already explained, breeding programmes should be aimed at bringing desirable combination of these structural traits. These two traits, the laticifer area index and the orientation of laticifers will govern yield potential and rate of flow of latex, respectively in *Hevea* tree.

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