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GENETIC PARAMETERS AND ASSOCIATIONS OF CERTAIN ANATOMICAL CHARACTERS IN HEVEA

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Abstract

In Hevea clones nearly 40% of the total number of latex vessel rows are present in the first millimeter from cambium and hence left uncut on tapping. The range of uncut vessels however depends on the clones. Efforts to utilise this information in an effective way in exploitation are meagre, although the importance of bark thickness and number of latex vessel rows as yield contributing factors have been well elucidated. Hence a detailed study on the variability, associations and genetic parameters of certain bark anatomical characters was made.

High phenotypic coefficient of variability recorded for bark thickness, total number of latex vessel rows, distance of first vessel from cambium, percentage number of latex vessel rows within the first millimeter from wood, percentage of soft bast and thickness of cork tissue showed high involvement of environment in those traits. High genotypic coefficient of variability was recorded for the number of latex vessel rows. High heritability associated with high genetic advance for the number of latex vessel rows showed involvement of additive gene action and hence effectiveness of this trait as a selection parameter. Simple, partial and multiple correlation analysis denoted the influence of total number of latex vessel rows and bark thickness on the number of latex vessel rows in the first millimeter. Both traits maintained an inverse relationship with the number of vessel rows in the first millimeter, both together contributing to nearly 67% in virgin bark and 66% in renewed bark.

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Introduction

In Hevea, bark characters and the nature and distribution of laticifers are important parameters deciding yield, of which number of latex vessel rows and bark thickness have received good attention. The residual bark left uncut on tapping comprises the cambium and adjoining portion of the bark and the laticifers in this region remain unexploited. Distance of the first latex vessel from the wood can be considered as an indicator of the frequency of latex vessel differentiation. The proportion of latex vessel rows present in the first millimeter from wood vary depending on the clone and age of the trees though an estimated average for a mature tree is around 50% (Gomes, 1982). The number of latex vessel rows cut opon on tapping can directly influence the volume of latex obtained in each tapping. In the present study, genetic parameters such as G.C.V., P.C.V., heritability and genetic advance (at 5% selection intensity) of six bark anatomical traits were estimated. An attempt has also been made to study the correlations among total bark thickness, proportion of soft bast, total number of latex vessel rows and proportion of vessel rows in the first millimeter of bark from the wood. The associations both in the virgin and in the renewed bark were examined.

Materials and Methods

For the estimation of genetic parameters bark samples were collected from trees belonging to ten Hevea clones, namely Ch 153, GT 1, Harbel 1, IAN 45-713, IAN 45-873, PB 5/51, PR 107, RRII 105, RRIM 703 and Wagga 6278 from a field trial laid out in a randomised block design with three replications in 1971. Virgin bark samples were collected from one tree per plot at the age of nine years. Association of characters was studied with the data collected from eight other clones nemly, RRII 101, RRII 102, RRII 105, RRII 106, RRII 109, RRII 111, Tjir 1 and PR 107 in a statistically laid out trial at the Central Experiment Station at Chethackal planted in 1966. Virgin bark at a height of 150 cm from the bud union and renewed bark (five years renewal) of the respective trees were collected from five trees per clone at the age of 11 years.

Bark samples were fixed in FAA and sections, at 100 um thickness were cut in the radial plane using a base sledge microtome. Sections were stained with sudan III for microscopical observations.

Bark thickness (x_1), total number of latex vessels (x_2), distance of first vessel from wood (x_3), proportion of latex vessel rows within the first millimeter to the total bark thickness as percentage (x_4), proportion of soft bast thickness to the total thickness of bark as percentage (x_5) and thickness of cork tissue ($_6$) by standard methods (Singh and Chaudhary, 1976 and Johanson et al., 1955).

The associations among characters were studied for (i) total thickness of bark, (2) proportion of soft bast to the total bark thickness given as percentage, (3) total number of latex vessel rows, and (4) proportion of latex vessel rows in the first millimeter to the total numbers, give as percentage. In the table the four traits of virgin bark are denoted as a_1, b_1, c_1 and d_1 and the respective traits of rnewed bark as a_2, b_2, c_2 and d_2.

Results

Components of variance for the six bark anatomical characters are given in Table 1. High variability was observed for the distance of first vessel, thickness of cork tissue and total number of latex vessel rows. The wide difference between P.C.V. values and G.C.V. values showed high involvement of environment in the distance of first vessel and thickness of cork tissue while the least difference was recorded for the total number of latex vessel rows.

The mean, heritability and genetic advance for the anatomical characters are given in Table 2. High heritability was recorded for the number of latex vessel rows. For all other characters heritability was low to medium. Genetic advance was the highest for the distance of first vessel from wood followed by the number of latex vessel rows.

Table 1. Components of variance of six bark anatomical characters.

Characters	Genotypic variance	Phenotypic variance	GCV	PCV
Bark thickness - x_1	0.1634	0.3897	9.08	14.03
Total number of latex vessel rows - x_2	6.8378	9.1060	19.37	22.35
Distance of first vessel (um) - x_3	3850.0000	10153.3333	39.27	63.77
Proportion of L.V.R. in the first millimeter to total L.V.R.	8.2658	32.8539	5.52	11.01
Proportion of soft bast to total bark thickness - x_5	5.5303	11.8672	6.73	9.85
Thickness of cork tissue - x_6	0.0428	0.1385	16.68	30.01

Table 2. Mean, heritability and genetic advance for the six bark anatomical characters.

Characters	Mean (mm)	Heritability (%)	Genetic advance (%)
x_1	4.45±0.27	41.98	12.12
x_2	13.50±0.87	75.09	34.58
x_3	158.00±45.84	87.92	49.82
x_4	52.08±2.86	25.16	5.71
x_5	34.96±1.45	46.60	9.46
x_6	1.24±0.18	30.90	19.10

The clones recorded a mean bark thickness of 4.5 millimeters and a mean number of about 13 latex vessel rows. Nearly 35% of the bark consisted of soft bast (unseclerifies) and 52% of the total number of latex vessel rows were in the first millimeter. The first row of latex vessels was formed at an average distance of 158 um from the wood. A mean thickness of 1.24 millimeters, i.e., nearly 28% of the total bark thickness was cork portion.

Associations among the total bark thickness, proportion of latex vessel rows in the first millimeter and the total number of latex vessel rows are shown in Table 3. In virgin bark and renewed bark, the proportion of soft bast was not significantly associated with the total bark thickness. In both cases the proportion of vessel rows in the first millimeter was negatively associated with total bark thickness and total number of latex vessel rows at 1% level.

In further analysis for partial and multiple correlations, association of the proportion of vessel rows in the first millimeter with bark thickness was not significant when the total number of latex vessel rows was kept constant with respect to the virgin bark but this partial correlation was significant with respect to renewed bark (at 5% level). In both cases negative association of the proportion of vessel rows in the first millimeter with the total number of latex vessel rows was maintained when bark thickness was kept constant. Multiple correlation of the proportion of latex vessel rows in the first millimeter with the other two traits was very close for virgin bark and renewed bark which could explain 67% and 65% variations respectively.

Discussion

Bark thickness and number of latex vessel rows have been exploited from the very beginning of tree selection in Hevea and the influence of those traits on yield is well elucidated (Bobilioff, 1923; Gomez and Chen, 1967; Gomez, Narayanan and Chen, 1972; Narayanan, Ho and Chen, 1974; Panikkar, 1974). The effect of the distance of

Table 3. Associations among structural traits.

	Simple correlation		Partial correlation		Multiple correlation		R^2
	Source	r	Source	r	Source	r	
Virgin bark	$a_1\ b_1$	-0.28	$d_1\ a_1 \cdot c_1$	-0.27	$Rd_1 \cdot a_1\ c_1$	0.82**	67.24
	$a_1\ d_1$	-0.59**	$d_1\ c_1 \cdot a_1$	-0.71**			
	$c_1\ d_1$	-0.81**					
Renewed bark	$a_2\ b_2$	-0.12	$d_2\ a_2 \cdot c_2$	-0.49*	$Rd_2 \cdot a_2\ c_2$	0.81**	65.61
	$a_2\ d_2$	-0.69	$d_2\ c_2 \cdot a_2$	-0.59**			
	$c_2\ d_2$	-0.74**					

* P 0.05
** P 0.01

a) Total bark thickness
b) Proportion of soft bast
c) Total number of L.V.R.
d) Proportion of L.V.R. in the first millimeter to total numbers.

first vessel on yield is mediated through the total number of latex vessel rows. Even though the total amount of variability was very high for the distance of first vessel, involvement of environment in this character is very high when compared to the total number of latex vessel rows. High heritability associated with high genetic advance for the total number of latex vessel rows indicates additive gene action and confirmed the suitability of this trait as a selection parameter. High G.C.V. value recorded for the thickness of cork tissue indicates that this trait is genetically controlled. It showed high genetic advance though the heritability was comparatively low.

Premakumari et al. (1984) have reported the genetic parameters of certain other bark anatomical traits of the same clones. The characters reported were height, width and density of phloic rays, density and diameter of latex vessels and also the intensity of anastomosing of latex vessels. Heritability of these traits ranged from 47.67% to 94.40% with the maximum for ray density and minimum for ray width. Ray height and latex vessel diameter showed high heritability values (78.36% and 82.93% respectively combined with high genetic advance (30.83% and 28.15% respectively). For the intensity of anastamosing, heritability value was medium (58.4%) and showed fairly good genetic advance (20.51%) at 5% selection intensity. Hence certain anatomical traits such as the height of phloic rays, diameter of latex vessels, number of latex vessel rows and intensity of anastamosing have predominant influence of additive genetic variance. The other traits showed predominant influence of non-additive genetic variance for which it would be advisable to exploit heterosis or utilise recombination breeding for improvement. Gomez (1982) in a review of various work on the total number of latex vessel rows in different sets of clones, selected over a period of 41 years (from 1924 to 1965), has emphasised that selection based on yield during this period has resulted in a corresponding increase in the number of latex vessel rings and hence the reverse would also be effective. The average number of latex vessel rows present in the first millimeter is reported as 40% of the total numbers while the ten clones in the present study recorded an average of 52% of the total numbers. Since this trait is highly associated with the total bark thickness and total number of latex vessel rows and both traits together can contribute to 67-68% variations, a more judicial approach to the depth of tapping would be of much practical significance.

The latex in the vessels very near to the cambium is more cytoplasmic in nature and contain less amount of rubber particles and hence the drc of latex drained from this portion would be comparatively less. At the same time injury to the functional phloem may lead to more loss of water and other resources from the transporting stream. Hence a rational approach to the depth of tapping to cut maximum number of latex vessels at minimum risk is very important in exploitation of the tree. A very significant and high negative association of the proportion of uncut vessels with the total bark thickness and total number of latex vessel rows can be exploited for a more efficient tapping. Combined effect of the two bark characters is very high in the virgin bark as well as in the renewed bark. Hence it is suggested that characterisation of all the popular clones for these traits and recommendation of the optimum depth of tapping for each clone may solve some critical problems, especially in many high yielding clones, without causing considerable reduction in yield. However, various related aspects will also have to be studied in depth to rationalise clone specific approach in tapping.

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