

## A NURSERY PROGENY TEST OF SALB RESISTANT HYBRIDS OF INTERSPECIFIC CROSSES OF *HEVEA*<sup>1</sup>

By

PAULO DE SOUZA GONCALVES,<sup>2</sup> DERRICK M. FERNANDO<sup>3</sup> AND ALDROALDO  
GUIMARAES ROSSETTI<sup>2</sup>

### SUMMARY

The South American Leaf Blight resistant dwarf *Hevea* species, tentatively classified as *H. camargoana*, has been hybridized at the Centro Nacional de Pesquisa da Seringueira (CNPSe), Manaus, with four other clones in 1978. Early indices of yields, growth and resistance to *Microcyclus ulei* were measured. Promising progeny were selected for further field experimentation.

### INTRODUCTION

Numerous interspecific crosses have been attempted among several species of *Hevea*. However, there is little descriptive information about the progenies from these crosses. The question of relationship among species in the genus *Hevea* is not a new one, but it has generally been assumed that the species are freely intercompatible (Seibert 1974, Baldwin 1947). Representatives of the genus are indigenous to the Amazon region, and several of its species are geographically isolated from each other.

Pires (1980) first observed natural hybrids in the range of the dwarf species and classified the dwarf parent as *H. camargoana*. The classification of the species as *H. camargoana* is subject to further clarification and is therefore tentative, but the resistance of the dwarf plants is obvious at Manaus. Schultes (1980) feels that the specific position of *H. camargoana* is still uncertain.

Paiva (1977), registered the occurrence of *Hevea marajoensis*, now *Hevea camargoana* Pires in Villa de Joanes, Marajo Island (Fig 1). Goncalves (1979) described the habitat of the species with slightly distended stems growing naturally in transition areas of prairies and "igapos" (seasonal flooded areas).

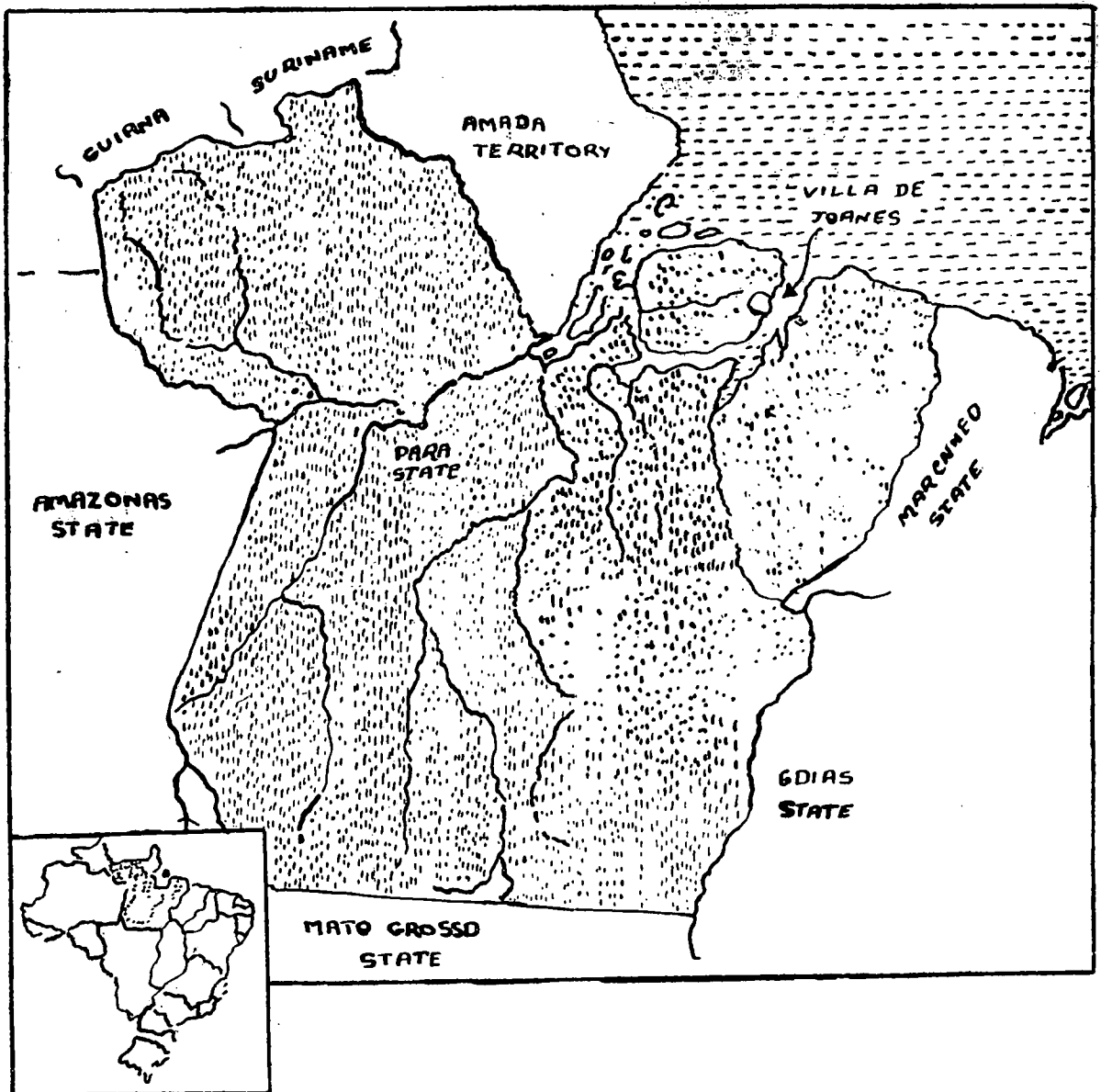
The species has been described as a small tree-like shrub up to 3m tall. Non deciduous leaves and mature leaflets are horizontal to slightly reclinate, oblanceolate, shortly acuminate, swollen at the bases. Flowers yellowish with hairy calyx. Staminate flowers are purplish red at the calyx bases. The anthers are normally seven in two regular whorls. Pistilate buds bigger than staminate, disk very conspicuous, ovary glabrate. Immature fruit green in colour, and small capsules ligneous, explosive valves, thick seeds, very small but bigger than in *Hevea camporum*.

---

(1) This research has been supported by SUDHEVEA/EMBRAPA agreement.

(2) Agronomist Centro Nacional de Pesquisa da Seringueira (CNPSe)-EMBRAPA, Caixa Postal, 319, CEP 69.000—Manaus - AM - Brazil.

(3) RRI of Sri Lanka.



**FIGURE 1 - Localization of Vila de Joanes where *Hevea camargoana* species were collected in Marajó island, Pará State**

For breeding work the advantage of the ever-flowering habit of *H. camargoana* is of special importance.

In the Brazilian National Center for Rubber located at Manaus, controlled pollination with *H. camargoana* has been carried out since 1978 for the following purpose.

- (a) To obtain a small to medium size tree with favourable characteristics of yield, vigour and disease resistance.
- (b) Propagation of selected individual progenies.
- (c) To test the genetic characteristics of selected trees.

This report summarizes and gives some preliminary information on the selection of interspecific crosses from the hybrid population. Selections were done after measuring yield, bark thickness, total number of latex vessel rings and growth.

#### METHODS

The technique used to make controlled pollination at the National Research Centre for Rubber follows that described by Dijkman (1951).

Waidyanatha and Fernando (1972) and Mendes (1971) have described methods for selecting high yielding seedlings from a population. Several steps are necessary for judging *a priori* the genetic qualities of the selected seedlings.

- (a) Yield; as a preliminary test by micro-tapping.
- (b) Growth; by measurement of height and diameter.
- (c) Resistance to disease; by visual assessment.

The interspecific pollination between *H. camargoana* and *H. brasiliensis* hybrids was carried out in 1978 in two experimental areas. Altogether nine different families with a total of 65 legitimate seedlings were obtained. The number of seedlings per family varied from one (IAN 873  $\times$  *H. camargoana*) to 14 (PFB 5  $\times$  *H. camargoana*). The *H. camargoana* plants used for breeding work originated from seeds obtained from selected wild plants, growing near to Salvaterra city in Marago Island (Fig. 1).

The parental clones used in combination with *H. camargoana* were:

- PFB 5 — a primary clone of *H. brasiliensis* selected in Belterra.
- IAN 873 — the progeny of a cross between PB 86 and FA 1717 which were primary clones of Malaysia and Brazil respectively (Both *H. brasiliensis*).
- FX 4098 — the progeny of a cross between PB 86 and FB 74, both primary clones from Malaysia and Brazil respectively (Both *H. brasiliensis*).
- FX 3810 — the progeny of a cross between F 4542 (*H. benthamiana*) and AV 363 (*H. brasiliensis*) which were primary clones from Brazil and Sumatra.

All clones were used reciprocally as male and female parent with *H. camargoana*, but some combinations were not successful.

Apart from these controlled pollinations an intraspecific combination of *Hevea brasiliensis* (IAN 873  $\times$  PFB 5) was attempted in order to obtain information on the height, disease incidence and bark characters when compared with *H. camargoana* hybrids. Unfortunately only one seedling was obtained which made comparison impossible (Table 1).

In January 1979 the seed obtained from both breeding areas was sown in the seedbed, germinated and planted out in the nursery at 1.0 x 0.5 x 0.5m spacing (Fig. 2).

Yield, growth vigour, disease incidence and leaf thickness were recorded at one year after planting. Characters of the bark as well as bark thickness, total number of latex vessel rings, average distance between consecutive latex vessel rings, and diameter of latex vessels, were noted (Table 1).

TABLE I. PARENTAGE AND SCORING VALUES FOR SEEDLINGS OF THE POPULATION

No. of the tree	Parents			Height (m)	Circumference (cm)	No. of flush leaves	Characters of the bark				Leaf thickness (mm)	Micro tapping mg/t/t	Incidence of <i>M. ulie</i>
							Thickness (mm)	No. Latex Vessel rings	Diam. Vessel	Density Cr			
1	PFB 5	x	H.c.	0.98	1.27	3.74	0.5	1	15.3	57.37	0.26	0.36	1.22
2	PFB 5	x	H.c.	1.34	1.92	2.74	0.8	1	15.3	65.57	0.25	0.80	1.22*
3	PFB 5	x	H.c.	1.39	1.77	2.91	0.8	1	15.3	57.37	0.26	1.11	1.22
4	PFB 5	x	H.c.	1.69	2.92	2.74	1.2	2	16.8	98.36	0.30	2.97	1.22*
5	PFB 5	x	H.c.	2.16	2.21	3.08	1.1	4	15.3	204.91	0.27	1.35	1.87
6	PFB 5	x	H.c.	2.01	2.60	2.91	0.9	1	16.8	65.57	0.29	2.50	1.22*
7	PFB 5	x	H.c.	2.21	2.39	2.91	1.0	3	15.3	163.93	0.32	1.30	1.87
8	PFB 5	x	H.c.	1.38	1.61	2.91	0.7	3	15.3	147.54	0.30	0.90	1.87
9	PFB 5	x	H.c.	1.60	1.90	2.74	1.0	2	16.8	98.36	0.26	2.80	1.22*
10	PFB 5	x	H.c.	2.04	2.68	2.74	1.2	2	16.8	106.55	0.31	3.17	1.58*
11	PFB 5	x	H.c.	2.22	2.41	2.91	1.0	2	15.3	98.36	0.30	0.21	1.22*
12	PFB 5	x	H.c.	1.43	1.87	2.91	0.9	1	15.3	57.37	0.31	0.20	2.11
13	PFB 5	x	H.c.	2.93	2.45	2.91	1.0	3	15.3	172.13	0.34	2.36	1.87
14	PFB 5	x	H.c.	1.42	2.19	2.91	0.8	1	15.3	57.37	0.31	0.84	1.87*
15	IAN 873	x	PFB 5	1.74	2.89	2.91	1.3	2	17.2	106.55	0.28	2.85	1.58
16	H.c.	x	Fx 4098	0.84	1.05	3.08	0.5	1	15.3	57.37	0.29	0.46	1.22
17	H.c.	x	Fx 4098	2.74	2.57	3.24	1.0	2	16.8	106.55	9.35	3.53	1.58
18	H.c.	x	Fx 4098	1.70	1.85	3.08	0.8	1	15.3	57.37	0.26	0.22	1.58*
19	H.c.	x	Fx 4098	2.30	2.65	2.91	1.2	1	16.8	65.57	0.27	1.74	1.22*
20	H.c.	x	Fx 4098	2.72	2.70	2.91	1.0	1	16.8	65.57	0.31	0.16	1.22*
21	H.c.	x	Fx 4098	2.17	2.39	3.24	1.0	1	16.8	65.57	0.31	0.51	1.22*
22	H.c.	x	Fx 4098	2.33	2.47	3.24	0.9	1	15.3	57.37	0.31	0.97	1.87*
23	H.c.	x	Fx 4098	2.50	2.61	2.91	1.0	2	16.8	98.36	0.37	1.35	1.87
24	H.c.	x	Fx 4098	1.00	1.20	3.05	0.6	1	15.3	57.37	0.31	0.42	1.22*
25	H.c.	x	Fx 4098	1.00	1.01	3.08	0.5	1	15.3	65.57	0.29	—	1.22
26	H.c.	x	Fx 4098	0.98	1.21	3.24	0.7	2	15.3	106.55	—	0.35	1.22
27	IAN 873	x	H.c.	2.58	3.45	3.08	1.6	3	17.2	188.52	0.32	4.59	1.58
28	H.c.	x	PFB 5	1.26	1.63	2.91	0.7	1	16.8	65.57	0.31	—	2.12
29	H.c.	x	PFB 5	2.18	2.50	2.91	1.0	3	15.3	163.93	0.33	3.90	1.22
30	H.c.	x	PFB 5	2.21	2.45	3.08	1.0	2	15.3	106.55	0.37	3.05	1.58*
31	H.c.	x	PFB 5	2.40	2.53	2.91	1.0	1	16.8	73.77	0.28	0.26	1.22*
32	H.c.	x	PFB 5	2.14	2.19	2.91	1.0	1	16.8	73.77	0.33	2.57	1.22
33	H.c.	x	PFB 5	2.56	2.50	2.91	1.0	1	15.3	65.57	0.33	9.80	1.22
34	H.c.	x	PFB 5	2.31	2.00	2.91	1.1	2	16.8	106.55	0.29	0.40	1.58
35	H.c.	x	IAN 873	1.35	1.50	2.91	0.7	1	16.8	73.77	0.24	—	1.58*
36	H.c.	x	IAN 873	2.65	2.51	3.08	0.9	1	16.8	73.77	0.24	1.95	1.58
37	H.c.	x	IAN 773	3.50	3.21	3.39	1.0	1	17.2	73.77	0.32	1.68	1.22
38	H.c.	x	IAN 873	3.85	3.32	3.39	1.0	1	17.2	73.77	0.32	3.85	1.58
39	H.c.	x	IAN 873	3.34	3.17	3.24	1.2	2	16.8	131.14	0.30	5.63	1.58*
40	H.c.	x	IAN 873	3.05	2.98	3.39	1.0	1	17.2	65.57	0.31	1.72	1.58
41	H.c.	x	IAN 873	1.91	2.48	3.24	1.0	1	17.2	73.77	0.26	1.56	1.58*
42	H.c.	x	IAN 873	2.74	2.63	3.39	1.0	1	17.2	73.77	0.28	3.23	1.58*
43	H.c.	x	IAN 873	2.76	2.60	3.24	0.9	1	16.8	65.57	0.37	1.47	1.87*
44	H.c.	x	IAN 873	2.53	2.72	3.08	1.0	1	17.2	73.77	0.32	1.94	1.87*
45	H.c.	x	IAN 873	2.70	2.99	3.24	1.2	2	17.2	131.14	0.31	1.83	1.58*
46	H.c.	x	IAN 873	2.37	2.62	3.08	0.9	1	16.8	65.57	0.34	1.39	1.58
47	H.c.	x	IAN 873	2.33	2.30	2.91	0.9	1	16.8	73.77	0.25	0.62	1.22
48	H.c.	x	IAN 873	2.58	2.49	2.91	0.9	1	16.8	65.57	0.33	1.97	1.58
49	Fx 3810	x	H.c.	2.97	2.51	3.24	0.8	1	16.8	73.77	0.26	0.43	1.87*
50	H.c.	x	Fx 4098	2.50	3.11	3.24	1.2	3	17.2	188.52	0.33	10.68	1.22*
51	H.c.	x	Fx 4098	3.20	3.19	3.24	1.2	4	17.2	254.09	0.33	9.57	1.22*
52	H.c.	x	Fx 4098	3.05	3.02	3.08	1.1	5	16.8	295.08	0.38	8.16	1.58*
53	H.c.	x	Fx 4098	2.08	2.49	3.08	1.0	3	16.8	263.93	0.31	2.49	1.58
54	H.c.	x	Fx 4098	2.57	2.94	3.24	1.0	2	16.8	122.95	0.30	4.31	1.22
55	H.c.	x	Fx 4098	3.05	3.16	3.24	1.1	3	17.2	177.13	0.37	12.80	1.58*
56	H.c.	x	Fx 4098	2.55	2.53	3.24	0.9	1	16.8	73.77	0.31	2.18	1.22*
57	H.c.	x	Fx 4098	2.70	2.58	3.08	1.1	2	17.2	106.55	0.35	4.62	1.22*
58	H.c.	x	Fx 4098	2.95	2.99	3.39	1.1	2	17.2	114.75	0.34	1.19	1.58
59	H.c.	x	Fx 4098	2.67	3.31	3.08	1.1	2	17.2	114.75	0.31	5.63	1.22
60	H.c.	x	Fx 4098	3.21	2.90	3.39	0.9	1	16.8	73.77	0.32	6.86	1.58
61	H.c.	x	Fx 4098	2.84	2.83	3.24	0.8	1	16.8	65.57	0.34	1.29	1.58
62	H.c.	x	Fx 4098	1.15	1.72	3.24	0.5	1	15.3	57.37	0.31	0.34	1.22
63	H.c.	x	Fx 4098	0.67	0.98	3.08	0.4	1	15.3	57.37	0.33	0.10	1.22
64	H.c.	x	Fx 4098	1.19	1.20	3.24	1.0	2	17.2	114.75	0.31	0.00	1.22
65	PFB 5	x	H.c.	1.22	1.48	3.08	1.0	1	17.2	73.77	—	0.24	1.58

\* Susceptible to *Thanatephorus cucumeris*.

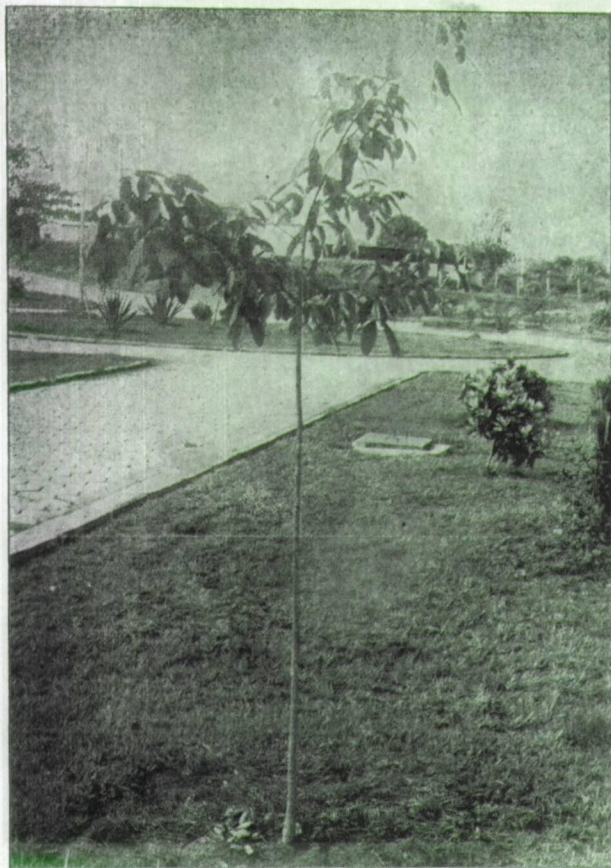


Fig. 1. 4-year old plant of *H. Camargoana* at the CNPSe, Manaus (foreground). Note freedom from SALB.



Fig. 2. *H. Camargoana* hybrids in nursery with SALB susceptible plants on each side providing inoculum.



Fig. 3. Severe *M. ulei* attack on a susceptible plant.

The parameters were measured as follows:

- \* Growth vigour was expressed by the diameter and height of the seedlings. The former was measured at 5 cm from the ground.
- \* Yield was estimated by use of a micro-tapping test (Waidyanatha and Fernando, 1972).
- \* Bark thickness was measured from samples taken at 5 cm from the ground.
- \* Total number of latex vessel rings was determined by examining the radial longitudinal sections of the same bark samples.
- \* Latex vessel diameter was observed in the transverse section of the bark samples.
- \* Density of latex vessels was determined per 5 sq. mm of the laticiferous tissue of the bark.
- \* Thickness of the mature leaf was determined as the average of 10 leaves per plant using a micrometer.

As a source of inoculation, seedlings originating from uncontrolled pollination considered highly susceptible to *M. ulei*, were planted among the seedlings obtained by controlled pollination. Classification and elimination of susceptible clones were started as soon as the first leaf flushes were in the susceptible stage. A simple system by eye estimate, which included four classifications as follows, was adopted:

Highly Resistant (1) — Plants exhibiting only a few non-sporulating lesions.

Resistant (2) — Plants exhibiting few disease lesions with sporulation.

Moderately Resistant (3) — Plants exhibiting more and larger lesions than those of the resistant class, often on the borderline of susceptibility.

Susceptible (4) — Plants exhibiting many lesions on stem petioles and leaves (Fig. 3).

In addition, attack by the fungus *Thanatephorus cucumeris* was recorded.

Estimates of correlation between yield and other characters of the individual progeny data were computed. Progeny data were also subjected to Duncan's Test. Differences at the 0.05 level were considered significant.

Data of vessel rings and disease incidence were transformed by the formula  $\sqrt{x + 0.5}$  according to Steel and Torrie (1960).

#### RESULTS AND DISCUSSION

Parentage, circumference, height, number of leaf flushes, leaf thickness, yield (micro-tapping), incidence of South American Leaf Blight (SALB) and characters of bark are shown in Table 1.

The overall mean for the characteristics studied, their range, standard deviation, coefficient of variation and number of progenies per mean are listed in Table 2.

TABLE 2. OVERALL MEANS, STANDARD-DEVIATION, COEFFICIENT OF VARIATION, AND NUMBER OF TREES FOR CHARACTERISTICS OF THE 1 YEAR-OLD CONTROLLED POLLINATED PROGENY TEST

Character	Units	Mean	Range	Standard deviation	Coefficient of variation(%)	No. of seedlings
Yield (micro-tapping)	mg	2.43	0.10 — 12.80	2.75	113.17	61
Total height	m	2.20	0.67 — 3.85	0.73	33.18	65
Circumference	cm	2.39	0.98 — 3.45	0.62	25.94	65
No. of leaf flushes		3.08	2.74 — 3.39	0.18	5.84	65
Bark thickness	mm	0.95	0.40 — 1.60	0.21	22.10	65
Total no. of latex vessel rings		1.44	1.22 — 2.34	0.29	20.14	65
Diam. latex vessels	μ	16.57	15.30 — 26.80	1.51	9.11	65
Density of latex vessels per 5sq mm	per	100.73	57.37 — 295.08	53.55	53.16	65
Leaf thickness	mm	0.30	0.24 — 0.38	0.03	10.00	63

Among the progenies, there is a wide range of variability for some characters. Yield appeared to be the most variable character (C.V. = 113.17%). Tan and Subramaniam (1975), working with seedlings of intraspecific crosses of *H. brasiliensis* found 91 % of variation in their population. The moderately variable characters were density of latex vessels per 5 sq. mm (C. V. = 53.16%), height (C.V. = 33.18%) and circumference (25.94%). Number of leaf flushes (5.84%) and diameter of latex vessels (9.11%) were the least variable characters.

Narayan *et al* (1974) showed that latex yields in adult trees of *Hevea* is consistently correlated with bark thickness, total number of latex vessel rings, girth increment and plugging index.

Selection of progenies in plant breeding programmes is based on an understanding of correlations between yield and various yield determining factors. Selection can be affected through study of simple characters which are related to yields.

Table 3 shows the linear correlation between yield and several structural characters of the progeny. Yield was found to be significantly correlated to total height (0.5215), circumference (0.6015), bark thickness (0.4882), total number of latex vessel rings (0.4990), density of latex vessels per 5mm per ring and leaf thickness (0.3487). Therefore the selection was only concentrated on yield, bark thickness, total number of latex vessel rings, circumference and incidence of (SALB).

TABLE 3. LINEAR CORRELATION COEFFICIENTS BETWEEN YIELD AND VARIOUS STRUCTURAL CHARACTERS

Character	Symbol	P	TH	Cc	LF	BT	NVR	DLV	DLR	LT
Yield (MTP)	P	1.000	0.5214***	0.6015***	0.1921	0.4882***	0.4990***	0.0879	0.5569***	0.3487***
Total height	TH		1.0000	0.8629***	0.4084***	0.6021***	0.2234*	0.3188***	0.3004**	0.3962***
Circumference	Cc			1.0000	0.2210*	0.7735***	0.3071**	0.3199***	0.3620***	0.4277**
Total number of leaf flushes	BLF				1.0000	0.0273	0.0606	0.0638	0.0756	0.0480
Bark thickness	T					1.0000	0.3876***	0.3289***	0.4955**	0.1838
Total number of latex vessel rings	NVR						1.0000	0.0613	0.9442***	0.2074**
Diameter latex vessels	DLV							1.0000	0.0231	0.0158
Density of latex vessels per 5 sq mm	DLR								1.0000	0.2052*
Leaf thickness	LT									1.0000

\* Significance at 5% level

\*\* Significance at 1% level

\*\*\* Significance at 0.1% level

Brookson (1959), showed that there was positive correlation between the yields of individual mature seedlings and the clones derived from them in small-scale trials. According to Tan and Subramanian (1975), a similar situation may also exist for the seedling material in the nursery phase. The next selection with grafted material should show us in what extent the seedling characters are expressed in the budgraft.

The Duncan's test analysis assisted in the selection from families. Only 11% of the progeny were selected (Table 4). Plant numbers 55, 50, 51 and 52 showed a higher yield. In addition to higher yield some selections show better growth, bark thickness and total number of latex vessel rings. Plant number 05 showed the highest degree of susceptibility on the scale of incidence of disease. On the other hand plant numbers 33, 50 and 51 showed a lesser incidence of SALB. Townsend (1961) observed that higher yieldings clones show more susceptibility to *M. ulei*. The combination of *H. camargoana* × FX 4098 appears to promise progeny with both yield and resistance to *M. ulei*.

TABLE 4. SELECTED PROGENIES BASED IN DUNCAN'S TEST IN RELATION TO YIELD BY MICRO-TAPPING CIRCUMFERENCE, BARK THICKNESS, TOTAL NUMBER OF LATEX VESSEL RINGS AND INCIDENCE OF *M. SALB* AT 0.05 LEVEL OF SIGNIFICANCE

Number of the progeny	Parentage	Micro-tapping Y/t/(mg)	Circumference (mm)	Bark thickness (mm)	No. of vessel rings	Incidence of SALB
38	<i>H. camargoana</i> × IAN 873	3.85	3.32	1.00	1.22	1.58
51	<i>H. camargoana</i> × Fx 4098	9.57	3.19	1.20	2.12	1.22
55	<i>H. camargoana</i> × Fx 4098	12.80	3.16	1.10	1.87	1.58
50	<i>H. camargoana</i> × Fx 4098	10.68	3.11	1.20	1.87	1.22
52	<i>H. camargoana</i> × Fx 4098	8.16	3.02	1.10	2.34	1.58
33	<i>H. camargoana</i> × P.F.B. 5	9.80	2.50	1.00	1.22	1.22
05	<i>H. camargoana</i> × P.F.B. 5	1.35	2.21	1.10	2.12	1.87

#### CONCLUSIONS

Yield by micro-tapping was shown to be correlated with total height, circumference, bark thickness, total number of latex vessel rings, density of latex vessels per 5 sq. mm, and leaf thickness. The significant correlation shown for leaf thickness and density of latex vessels invites more study of these characters.

The hybrid progenies resulting from the crossing with *H. camargoana* showed hybrid vigour when compared with native seedlings under the same environmental conditions. However, it is too early to rule out the appearance of dwarf conditions, later from these selections.

Plant numbers 38, 51, 55, 50, 52, 33 and 5 based on yield (micro tapping), bark thickness, circumference and total number of latex vessels per ring were selected. Correlations of these characters with yield and Duncan's test at 0.05 level of significance supported this selection.

Preliminary tests showed that plant numbers 33, 50 and 52 had higher yield lower incidence of SALB. In view of the selections from the family *H. camargoana* × FX 4098 showing favourable yield and resistance to disease it is advisable to repeat this programme and also subject selections to a genotype/environment test.

#### ACKNOWLEDGEMENT

The authors are grateful to Mr. Alfonso C. C. Valois and Miss M. Amazonild Neves, Head of the Scientific Division and Researcher of the National Center Research of Rubber tree, (CNPSe) respectively for their valuable comments and suggestions. Acknowledgements are also due to Messrs. Antonio Pessoa Rebello and Raimundo S. Freires for their laboratory and field work respectively. Dr. O. S. Peries and Prof. Y. D. A. Senanayake are also thanked for their assistance in preparing the manuscript.

#### REFERENCES

- BALDWIN JR., 1947. *Hevea*: A first interpretation, *J. Heredit* 30: 54—64.
- BROOKSON, C. W., 1959. Seedlings and clones of *Hevea brasiliensis*. *Proc. Inst. World Congr. Agric. Rome*, 699p.
- DIJKMAN, M. J., 1951. *Hevea*. Thirty years of Research in the Far East. *University of Miami, Florida*, 329.
- GONCALVES, P. DE S. 1979. A rubber tree collecting expedition at Ouro Preto, Federal Territory of Rondonia Brazil (Report) Manus, CNPSe, 53 p.
- MENDES, L. O. T. 1971. Poliploidizacao da seringueira: um novo teste para determinacao do capacidade de producao de seringueira jovens. *Polimeros*, 1: 22—3.
- NARAYANAN, R., HO, C. Y. AND CHEN, K. T. 1974. Clonal nursery studies in *Hevea* III. Correlation between yield, structural characters, latex constituents and plugging index. *J. Rubb. Res. Inst. Malaysia*. 24: 1.
- PAIVA, J. R., 1977. Coleta de material sexuado e assexuado de *H. camargoana*. (*unpublished report*). Manus CNPSe, 3 p.
- SIEBERT, R. J., 1974. A study of *Hevea* (with its economic aspects) in the Republic of Peru *Ann. Mo. Bot. Gdn.* 34; 261—350.
- STEEL, R. G. D. AND TORRIE, J. H. 1960. Principles and Procedures of Statistics; with Special Reference to the Biological Sciences. *New York, Mc Graw-Hill*, 481 p.
- TAN, H. AND SUBRAMANTAN, S., 1975. A five-parent diallel cross analysis for certain characters of young *Hevea* seedlings. *Proc. Intern. Rub. Conf. Kuala Lumpur*, 1975. p. 13—26.
- TOWNSEND, (Jr) C. H. 1961. Development of superior *Hevea* clones in Brazil. Rio de Janeiro. *Dept. Nac. Prod. Veg.*, 18 pp.
- WAIKYANATHA, U. P. de S. AND FERNANDO, D. M.; 1972. Studies on a technique of micro-tapping for the stimulation of yields in nursery seedlings of *Hevea brasiliensis*. *Q. Jl. Rubb. Res. Inst. Ceylon*. 49; 6—12.