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BREEDING OF *HEVEA BRASILIENSIS* MUELL. ARG. IN TRIPURA : PERFORMANCE OF A FEW STRESS TOLERANT CLONES IN THE EARLY PHASE

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Tripura offers a potential non-traditional environment for *Hevea* with an extreme minimum temperature of 3.8°C, and with a near zero precipitation during winter. *Hevea* thus encounters an exceptional stress situation in Tripura almost similar to the rubber areas of South China. A breeding experiment was conducted with six clones (RRII 208, RRIM 600 and PR 107, SCATC 88-13, SCATC 93-114 and Haiken 1) of which three are Chinese. The analysis of stability variance involving data on girth increment indicated Haiken 1 to be the most stable clone followed by the other clones in the descending order : PR 107, SCATC 93-114, SCATC 88-13, RRIM 600 and RRII 208. Haiken 1 and RRII 208 were prominent through their increased contribution towards girth increment during winter. The attainment of optimum tappability was achieved in almost all clones consistently except in PR 107. However, PR 107 showed a great deal of resistance towards wind stress. A survey of *Oidium* incidence showed all clones to be susceptible. However, the severity of incidence varied among clones. The initial yielding pattern (g/tree/tap) showed Haiken 1 and RRII 208 to be superior followed by RRIM 600.

INTRODUCTION

The traditional rubber growing tract offers ideal environmental conditions with a mean annual temperature of 28°C ± 2°C, and a well spread rainfall of 2000-4000 mm extending from 100-150 days a year (Pushparajah, 1983). Tripura of North East India (more than 20°N) offers a nontraditional environment for *Hevea*, where mean annual temperature is 30.5°C with a mean annual variation of 10.5°C, The lowest minimum temperature recorded during winter is 3.8°C with a near zero precipitation. When sharp fall in ambient temperature below 18°C is experienced, dry rubber yield in *Hevea* is seen to decrease and the cells divide just to meet the tissue differentiation (Zongdao and Xueqin, 1983). This contention amply argues that the best suited clone for Tripura should have cold tolerance as an attribute besides above average yield potential under normal environmental conditions.

A superior clone is expected to exhibit higher yield and other secondary attributes and should be stable in a range of environments. The clones studied have been exposed to a unique nontraditional environment and hence, the analysis of phenotypic stability along with other attributes would be worthwhile.

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MATERIALS AND METHODS

The clone evaluation garden involving twelve clones including three Chinese ones (RRII 105, RRII 118, RRII 208, RRIM 600, PB 5/51, PB 86, PR 107, GT 1, SCATC 88/13, SCATC 93/114 and Haiken 1) was established during 1987 at the Regional Research Station of the Rubber Research Institute of India at Agartala, India (Location 91°15'E; 23°53'N; 30 MSL). Girth data from all the clones were collected at quarterly intervals (February, May, August, November). Since a severe tropical storm hit the area on 21st April 1994, with wind speed exceeding 100 kmph, many clones became devoid of minimal stand (less than 30). Hence, data from six clones including the three Chinese clones (RRII 208, RRIM 600, PR 107, SCATC 88-13, SCATC 93-114 and Haiken 1) could only be gathered further (Table 1). Data on the performance of the other clones which formed part of another clone trial had already appeared elsewhere (Vinod *et al.*, 1996).

Table 1. Parentage of clones

Clones	Parentage	Attribute
RRII 208	Mil 3/2 x AVROS 255	Disease tolerant
RRIM 600	Tjir 1 x PB 86	High yielder
PR 107	Primary clone	Wind tolerant
SCATC 88-13	RRIM 600 x Pil B - 84	Cold tolerant
SCATC 93-114	TR 31-45 x HK 3-11	Cold tolerant
HAIKEN 1	Primary clone	Cold tolerant

Dry rubber yield was recorded from these clones at weekly intervals to closely monitor the pattern of yielding during winter. Girth increment during 1992-94 and 1994-96 were considered for an analysis of variance. The data were further subjected to an analysis of Shukla's stability variance in order to spell out the best stable clone (Shukla, 1972; Becker and Leon, 1988) and were computed using the following equation.

Stability variance

$$\sigma^2_i = \frac{t}{(s-1)(t-1)} \frac{Wi - MS(GE)}{(t-2)}$$

where $Wi = \sum_j (Y_{ij} - \overline{Y}_i - \overline{Y}_{.j} + \overline{Y}_{..})^2$

and MS (GE) = interaction mean square. When the stability variance is least, the genotype is considered to be the most stable/adaptable.

The other related attributes like attainment of tappability (50 cm girth), contribution towards girth increment during winter (November-February) and non-winter periods (March-October) and wind fastness were judged. For wind fastness, a clonewise score of trees affected after the storm during April 1994 has been taken as a basis.

Oidium incidence was measured following a visual score of number of 'spots' available over the leaves, number of leaves affected per branch and number of branches affected per tree (Tan *et al.*, 1992). As per the method followed, three visual scores were made viz., +++, ++ and + which represents 75%, 50% and 25% of the branches infected per tree.

Apart from these, data on dry rubber yield for the initial period (1995-96) is also presented to illustrate the yielding pattern of clones. While dry rubber yield was monitored at weekly intervals during winter months to have a closer scrutiny, that on monthly basis was recorded during rest of the period.

RESULTS AND DISCUSSION

Stability analysis

The data on girth increment was subjected to analysis of variance which showed differences in girth increment between years, significant only at 5% level. This is indicative of the fact that the reaction of clones towards subsequent years is the same and the adaptability shown to the environment is stable. The details of stability analysis are given in Table 2. The clone Haiken 1 expressed the lowest stability variance indicating its high adaptability. Haiken 1 was followed by the other clones in the descending order : PR 107, SCATC 93-114, SCATC 88-13, RRIM 600 and RRII 208. The individual F values were nonsignificant rationalising that there is no variation in stability of clones among themselves.

Table 2. Stability of clones

Clones	Wi	Stability variance*	F-value**
RRII 208	6.6066	8.9366	0.762
RRIM 600	5.9685	7.9795	0.680
PR 107	0.8256	0.2651	0.022
SCATC 88-13	3.3930	4.1162	0.351
SCATC 93-114	1.8721	1.8349	0.156
Haiken 1	0.8001	0.2269	0.019

* Shukla (1972) ** All F - values non-significant

The better performance of Chinese clones was expected since rubber growing areas of both Tripura and China are under the same latitude range. It is worth mentioning that though many of these areas fall under the same latitude range, the elevation varies from 3.9 to 552.7 m offering a spectrum of climatic conditions. However, the Zhanjiang perfecture of Hainan island where the elevation is 25.3 m offers a climatic condition similar to that in Tripura (Table 3). The climatic features of both Taranagar and Zhanjiang are considered representative samples of Tripura and China. The primary clones Haiken 1 and PR 107 and the third most adaptable clone SCATC 93-114 are found to be prominent clones in China also (Zongdao and Xueqin, 1983; Huasun and Shaofu, 1990).

Table 3. Geo-climatic features of rubber areas of Tripura and China

Attributes	Tripura (Taranagar)	China* (Zhanjiang perfecture)
Temperature		
Annual mean	30.5	23.1
Annual range	10.5	13.4
Coldest month mean	17.5	15.5
Extreme minimum	3.8	2.8
Annual precipitation	1818.0	1543.0
No. of days with precipitation	129	139.0
Relative humidity (%)	—	82.0
Annual mean wind velocity (m/s)	4.6	3.2
Maximum wind speed (m/s)	35.0	34.0
Sunshine hours	—	1934.0
Total solar radiation (KC/cm/year)	—	118.0
Latitude	23° 53'N	21° 13'N
Longitude	91° 15'E	110° 24' E
Elevation (m)	30	25.3
Rubber areas		
Latitude	22° 56'- 24° 32'N	18° 9' - 24°N
Longitude	19° 10'- 92° 21'E	97°31' - 121°E

*Zongdao and Xueqin (1983)

Girth increment

The per cent contribution towards girth increment attains greater prominence because of cold stress experienced in Tripura. The seasonal contribution during winter (November-February) would demonstrate the competence of a clone to survive and perform during the stress period. Our results show that the highest contribution towards girth increment during winter was observed in RRII 208 followed by Haiken 1 and SCATC 93-114 (Fig. 1). RRII 208 was bred under South Indian conditions (Kerala) selected for higher yield and tolerance towards diseases. It would be worthwhile to critically evaluate the performances of Haiken 1 and

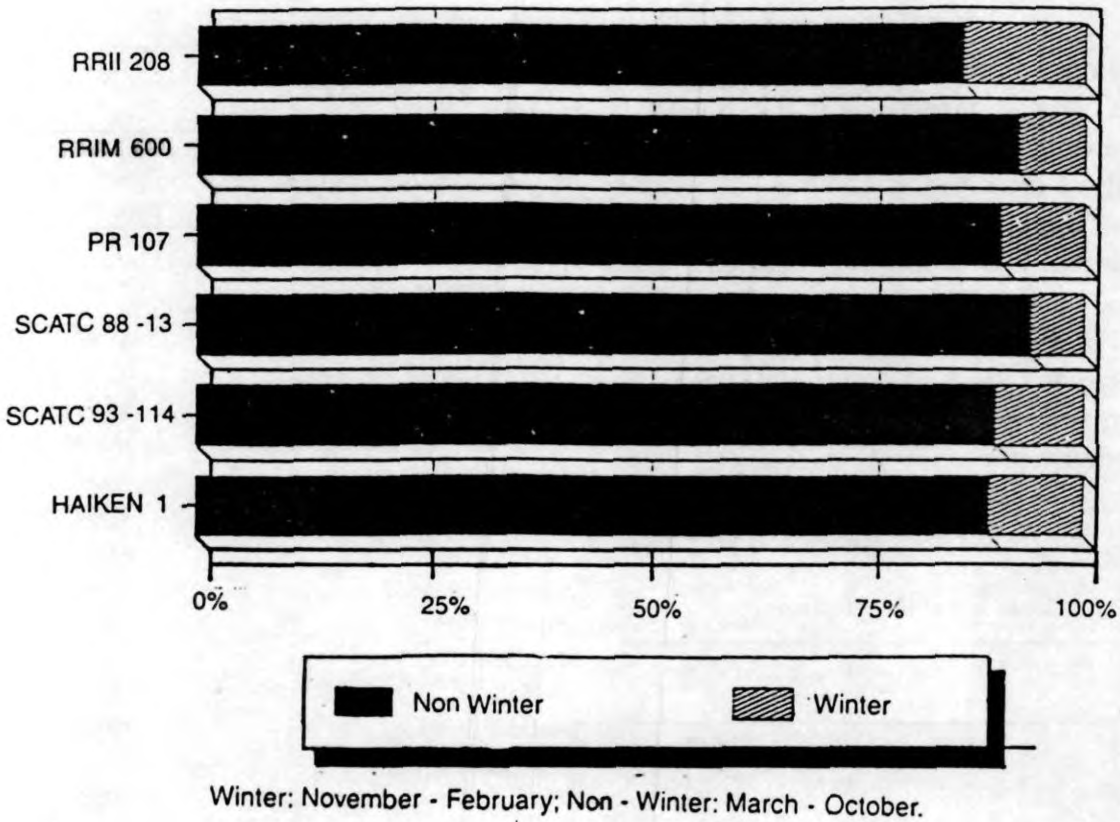

Fig. 1. Contributions to girth (%)

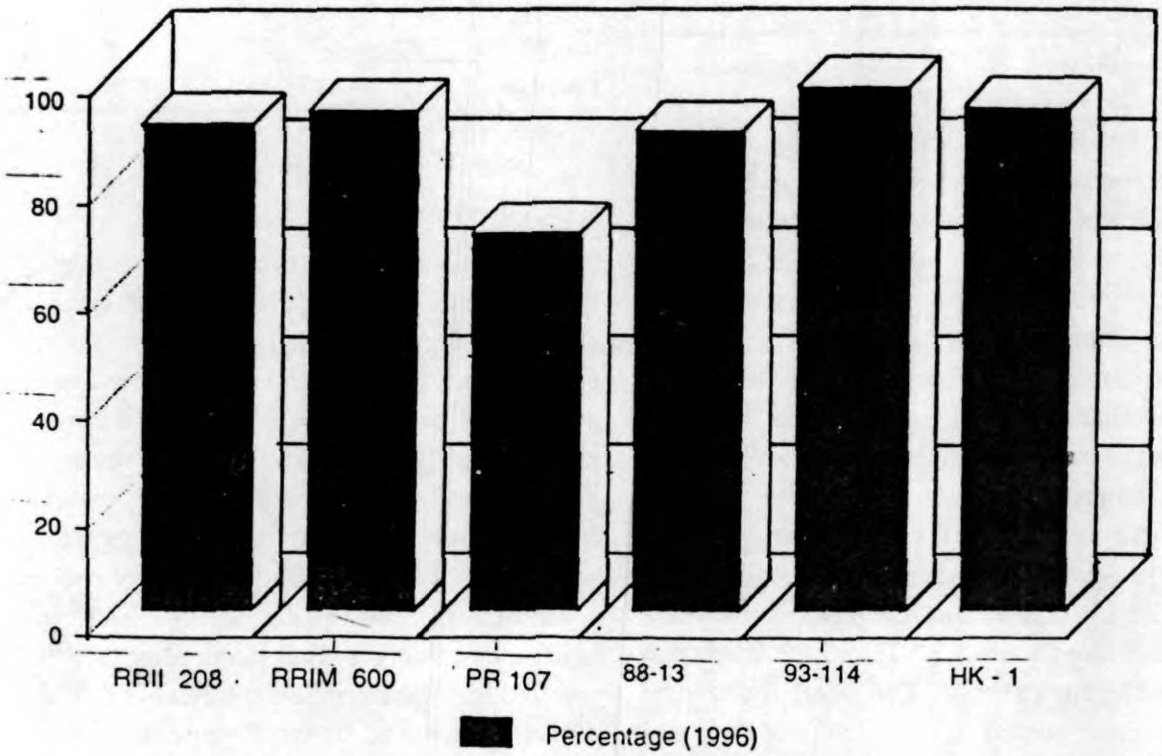

Fig. 2. Tappability

SCATC 93-114 in China and Tripura. It is argued that Haiken 1 can endure low temperature of 0°C for a short span while SCATC 93-114 and PR 107 can withstand even lower temperature of -1°C (Zongdao and Xueqin, 1983; Huasun and Shaofu, 1990). These observations agree with the present results obtained in these clones. If cellular electrolyte exudation can be regarded as a measure for cold resistance SCATC 93-114 has been counted as the cold tolerant clone (Ruiyan and Zhenfei, 1986). The same investigation rationalized RRIM 600 to be the least cold endurant clone substantiating our results on girth increment during winter period. However, the Chinese bred SCATC 88-13 showed minimal contribution towards girth increment during winter.

Tappability

The percent of tappability attained during 1996 showed the following descending order : SCATC 93-114, Haiken 1, RRIM 600, RRII 208, SCATC 88-13 and PR 107 (Fig. 2). The supremacy of Haiken 1 and SCATC 93-114 has been thus further substantiated by their improved tappability. PR 107, on the other hand, recorded the least percent of tappability (69.6%). A comparison of attainment of girth towards tappability and contribution during different seasons rationalize that environment within the year has no specific effect on girth increment and tappability. The effect of one year in toto, however, influences clonal performance towards tappability.

Oidium incidence

As per the visual scores made, all clones were found to be susceptible to *Oidium*, however, severity varied between clones. Among the clones observed, RRII 208 showed the highest incidence of *Oidium* (43.8%) followed by SCATC 88-13 (40.6%), PR 107 (33.3%), RRIM 600 (28.1%), SCATC 93-114 (25.0%) and Haiken 1 (25.0%). The Chinese clones having the lowest score, indicate some amount of resistance towards *Oidium* infection probably due to their late refoliation. PR 107, is observed to have a repeated infection, thus making the refoliation repetitive. It has already been established that PR 107 and RRIM 600 are highly susceptible to Oidium (Tan *et al.*, 1992). Resistance to *Oidium* has to come from primary centre of origin (Clement Demange *et al.*, 1995).

Wind fastness

An estimate of wind damage (branch snap, trunk snap and uprooting) conducted immediately after the storm of April 1994 showed PR 107, Haiken 1 and SCATC 93-114 with least damage (Table 4). A very strict scientific measurement of wind damage could not be conducted in this study. PR 107 is an established wind fast clone. In China, where wind over Beaufort force 8 blows, Haiken 1 and PR 107 are found to be wind tolerant (Zongdao and Xueqin, 1983).

Table 4. Wind damage assessment

Clones	Branch snap	Trunk snap	Uprooted
RRII 208	10 (27.78)	11 (30.56)	5 (13.89)
RRIM 600	8 (21.62)	3 (8.11)	7 (18.92)
PR 107	6 (21.43)	3 (10.71)	2 (7.14)
SCATC 88-13	19 (46.34)	6 (14.63)	1 (2.44)
SCATC 93-114	11 (23.91)	4 (8.7)	7 (15.22)
HAIKEN 1	13 (34.21)	5 (13.16)	5 (13.16)

Figures in parentheses are percentages

Early yield

The trial plants were brought under tapping during 1995. The initial yielding pattern for six months (winter and summer three months each) showed RRII 208 and Haiken 1 having 20.61% and 20.17% higher yield than RRIM 600.

REFERENCES

BECKER, H.C. and LEON, J. 1988. Stability analysis in plant breeding. *Plant Breeding*, **101** : 1-23.

CLEMENT DEMANGE, A., NICOLAS, D., LEGNATE, H., RIVANO, F., GUEN, V.Le., GNAGNE, M.

AND CHAPUSET, T. 1955. Rubber breeding strategies. *Plantations, Recherche Developpment*, **2** : 5-19.

HUASUN, P. and SHAOFU, Y. 1990. A presentation of the situation of selection and breeding of rubber varieties in Yunnan province. *IRRDB Symposium* 1990, Kunming, China, pp. 34-46.

PUSHPARAJAH, E. 1983. Problems and potentials for establishing *Hevea* under difficult environmental conditions. *Planter*, **59** : 242-251.

RUIYAN, H. and ZHENFEI, C. 1986. Preliminary studies on cold resistance of rubber trees determined by electric conductometer. *IRRDB Symposium*, 1986, Hainan, China, pp. 98-105.

SHUKLA, G.K. 1972. Some statistical aspects of partitioning genotype-environmental components of variability. *Heredity*, **29**: 237-245.

TAN, H. 1995. Genotype x environment interaction studies in rubber (*Hevea*) clones. *Journal of Natural Rubber Research*, **10** : 63-76.

TAN, A.M., LOO, T.P., VADIVEL, G., BACHIK, M.R. and YOON, K.F. 1992. Survey of major leaf diseases of rubber in Peninsular Malaysia - 1992. *Planters' Bulletin*, **211** : 51-62.

VINOD, K.K., RAJESWARI, M.J., PRIYADARSHAN, P.M., POTHEN, J., KRISHNAKUMAR, A.K., SETHURAJ, M.R. and POTTY, S.N. 1996. Early performance of some clones of *Hevea brasiliensis* Muell. Arg. in Tripura. *Indian Journal of Natural Rubber Research*, 9(2) 123-129.

ZONGDAO, H. and XUEQIN, Z. 1983. Rubber cultivation in China. *Proceedings of RRIM Planters' Conference*, 1983, Kuala Lumpur, Malaysia, pp. 31-42.