Journal of Plantation Crops 24 (Supplement) : 453-457 (1996)

EVALUATION OF *HEVEA* GERMPLASM: VII. ASSOCIATION ANALYSIS IN WILD *HEVEA* GERMPLASM

JAYASHREE MADHAVAN, C.P. REGHU, SAJI T. ABRAHAM, P.J. GEORGE and S.N. POTTY
Rubber Research Institute of India, Kottayam - 686 009, Kerala.

ABSTRACT

Simple correlations and path coefficients were worked out from a sample of fifty six genotypes drawn from the wild germplasm introduced into India. Observations were taken on seven year old plants for nine traits: yield, single leaf area, specific leaf weight, bark thickness, girth, number of latex vessels, density of latex vessels per row, diameter of latex vessels, and average of distance between latex vessel rows. The results showed that yield was positively correlated with bark thickness, girth, number of latex vessels, and negatively with single leaf area. There was no significant correlation with specific leaf weight, or distance between vessel rows. Single leaf area was also negatively correlated with specific leaf weight. The highest positive correlation was between girth and bark thickness. Number of latex vessels decreased with increase in average distance between vessel rows. The direct effect of number of latex vessels on yield accounted for the total correlation between them. Girth also had a high positive direct effect, while single leaf area and specific leaf weight had negative direct effects on yield.

INTRODUCTION

Yield in *Hevea* is a complex character and is affected by a number of other associated morphological, anatomical and physiological traits. The 1981 IRRDB Brazil expedition resulted in a very large collection of *Hevea* germplasm, that can perforce be evaluated only in batches, owing to limitations of resources. Hence a knowledge of the associations between yield and other traits, is essential for making a preliminary selection of genotypes that should be given priority for evaluation so that potential high yielders can be identified as early as possible. With this objective in view, the *inter se* associations of yield and eight other morphological and anatomical parameters likely to influence yield, were studied through correlation and path analysis, in a sample of wild *Hevea* germplasm introduced in India.

MATERIALS AND METHODS

Fifty six genotypes belonging to the 1981 Brazilian germplasm collection introduced in India and maintained in nurseries at the Central Experiment Station of the RRII, were chosen at random for the study. Observations were taken on 3 plants per genotype at the age of 7 years. For anatomical studies, bark samples were taken at 45 cm. height from the bud union and fixed in Formalin - Acetic - Alcohol (FAA). Sledge microtome sections of bark were taken in the transverse, radial and tangential longitudinal planes having 40-60mm thickness and stained with Sudan III for microscopic observations. Standard microtechniques were adopted for recording the bark anatomical characters. The following observations were recorded:

(1) Yield: Total of 5 test tappings at a height of 45 cm, expressed in g $tree^{-1}$ (2) Single Leaf Area: Leaf samples were collected from the middle of 2 outer most mature whorls and the area (cm^2) was recorded using LI-3000 leaf area meter. (Li-Cor_1-USA). (3) Specific leaf weight (SLW): The ratio of the weight of the oven dried leaves, to their area and expressed as mg/cm^2. (4) Bark thickness: The thickness of sampled

bark, expressed in mm, was recorded soon after sampling, (5) Girth: Taken at a height of 45 cm from bud union and expressed in cm. (6) Number of latex vessel rings: The total number of latex vessel rings (NLVR). (7) Density of latex vessels: The number of latex vessels per ring per mm circumference of the plant. (8) Diameter of latex vessels (m) and (9) Average distance between latex vessel rings from cambium outward (hereafter referred to as average distance) : expressed in mm.

Simple correlations were worked out according to Panse and Sukhatme (1967) and parth co-efficients as per Singh and Choudhary (1985).

RESULTS AND DISCUSSION

The simple linear correlation matrix is presented in Table I. Yield was found to be positively correlated with bark thickness, girth and NLVR. These results are in accordance with the results obtained by many workers, (Narayanan *et. al.*, (1973), Ho (1976), Hamazah and Gomez (1982), Paiva (1982), Ribeiro (1984), and Licy and Premakumari (1988)). Olapade (1988) reported a negative correlation between girth and yield, which he stated was most probably a spurious one - i.e., the negative correlation was probably due to an association with other characters. Yield was found to have no correlation with average distance, which is in conformity with the findings of Lavorenti *et. al.* (1990) in 31/2 year old trees. NLVR, followed by girth and bark thickness, showed the highest correlation with yield.

Girth and bark thickness showed the highest correlation ($r = 0.6527^{**}$) among all the traits, in this study. High correlation between girth and bark thickness have been reported in mature and immature trees by Momoh and Alika (1987), Narayanan *et. al.* (1973), Ho (1976), Hamazah and Gomez (1982) and Licy and Premakumari (1988), though Nazeer *et. al.* (1992) observed no significant correlation.

NLVR has been reported to have a high positive correlation with bark thickness (Hamazah and Gomez (1982) and Licy and Premakumari (1988). In the present study too, NLVR had a high positive correlation with bark thickness and girth. Nazeer *et al.* (1992) however, could detect no significant relationship between these three traits. It was also observed in the present study that increase in NLVR was associated with a decrease in average distance between latex vessel rings ($r = -0.4391^{**}$), though there was no significant relationship between average distance and yield. Ho (1976) reported a low but significant positive correlation between yield and average distance.

A feeble, though significant correlation ($r = 0.1864^{**}$) was found between density and diameter of latex vessels, though Premakumari *et al.* (1984) could not detect any relationship between the two. Yield, bark thickness, girth and NLVR were also found to be independent of these two traits. Hamazah and Gomez (1982) reported a negative relationship ($r = -0.34^{**}$) between density of latex vessels was only a minor factor for yield.

Single leaf area was found to be negatively correlated with yield. Nugawela and Aluthhewage (1985) have stated that there is a tendency for clones with smaller leaf size to have high CO_2 assimilatory capacity per unit leaf area. Elmore (1980) suggests that this is due to the photosynthetic apparatus getting diluted when leaf area is large. Hence clones with smaller leaf area but larger number to increase total assimilatory area, could form a canopy with high CO_2 assimilatory capacity. This probably explains the negative correlation between SLA and yield in the present study. SLA was also found to have a negative association with bark thickness, girth and NLVR. Specific leaf weight, however,

Table I. Correlation matrix of 9 traits in wild *Hevea* germplasm

	SLA	SLW	Bark thickness	Girth	NLVR	Density	Diameter	Av. distance
Yield	-0.2438**	0.1246	0.3897**	0.4180**	0.4260**	0.1191	-0.1419	-0.0463
SLA		-0.2281**	-0.3267**	-0.2283**	-0.1745**	-0.0892	-0.0239	0.0399
SLW			0.2799**	0.2368**	0.2995**	-0.0407	0.0929	-0.1772*
Bark thickness				0.6527	0.3514**	0.0427	-0.0814	-0.1140
Girth					0.2706**	-0.0400	-0.1176	-0.0356
NLV						0.1035	-0.0417	-0.4391**
Density							0.1864*	-0.0442
Diameter								-0.0548

Table II. Direct and indirect effects of eight traits on yield

	SLA	SLW	Bark thickness	Girth	NLVR	Density	Diameter	Av. distance	Total Corr. with yield
SLA	-0.110	0.014	-0.025	-0.058	-0.063	-0.009	0.002	0.005	-0.24**
SLW	0.025	-0.060	0.022	0.060	0.111	-0.004	-0.009	-0.023	0.12
Bark thickness	0.036	-0.017	0.080	0.163	0.130	-0.004	-0.008	-0.014	0.39**
Girth	0.025	-0.014	0.052	0.250	0.100	-0.004	0.012	-0.005	0.42**
NLVR	0.019	-0.018	0.028	0.068	0.370	0.010	0.004	-0.057	0.43**
Density	0.010	0.002	0.003	-0.010	0.037	0.100	-0.019	-0.005	0.12
Diameter	0.002	-0.005	-0.006	-0.030	-0.015	0.019	-0.100	-0.007	-0.14
Distance	-0.004	0.011	-0.009	-0.010	-0.163	-0.004	-0.005	0.130	-0.05

was positively correlated with these three traits, though there was no correlation at all with yield. This type of contrasting relationship of bark thickness, girth and NLVR with SLA and SLW is probably due to the inverse relationship observed between SLA and SLW themselves.

The direct and indirect effects of the eight parameters on yield obtained in the present study, are given in Table II. NLVR was found to have the highest direct effect on yield, followed by girth. The total effect of NLVR on yield was mainly through its direct effect, though its indirect effect through girth, helped boost the correlation coefficient. Similarly, though the direct effect of girth on yield was fairly large, the total effect of girth on yield was substantially increased by its indirect effects via, NLVR and bark thickness.

Ho (1976) reported that the high positive correlation that was obtained between bark thickness and yield disappeared when other traits, specifically girth, were controlled. Narayanan *et al.* (1973) also observed that bark thickness affected yield, but is linked to girth in its effect on yield. The results of the present study confirm these findings. Although the correlation between girth and yield was high, its direct effect was negligible. The high correlation appeared to be mainly due to the large indirect effects of bark thickness through NLVR and girth, with which it had a high positive correlation, and which in turn were highly and positively correlated with yield. All other traits had low to negligible direct effect on yield.

Though the direct effect of average distance on yield was positive, the larger counteracting influence of its negative association with NLVR resulted in a net negative, though still nonsignificant, correlation between average distance and yield. Though the direct effect of SLA on yield was smaller in magnitude than that of average distance, the correlation between the former became significant due to the combined indirect effects, in the same direction, through NLVR, girth and bark thickness. The effect of SLW on yield, though not significant, was mainly through NLVR.

The present study showed that in wild germplasm, NLVR followed by girth had the highest correlation with, and direct effect on, yield. Since the direct effect of NLVR on yield accounted for most of the correlation between them, NLVR appears to be the best indicator of yield. Also, since the association between NLVR and girth and that between girth and yield was also high, girth can be used effectively in conjunction with NLVR in identifying the likely high yielders. Bark thickness *per se* was found to be a poor selection parameter, inspite of its high correlation with yield, since path analysis showed negligible direct effects and high indirect effects through NLVR and girth. Hence genotypes showing high NLVR and girth should be given priority for evaluation. A high residue ($r = 0.82$) due to unaccounted for factors, was obtained in this study. Other factors, such as physiological and biochemical are likely to have played a role, and inclusion of such factors in future studies might prove worthwhile.

ACKNOWLEGDEMENT

The authors are grateful to the Director, RRII, for granting permission and to the Dy. Director (ES) for providing local facilities, for carrying out the study. The authors also gratefully acknowledge the help rendered by Shri. Subbrayalu, Dy. Director (S&P) and his staff in the statistical analysis, and Smt. K. P. Leelamma, Asst. Technical Officer for the anatomical work.

REFERENCES

ELMORE, C.D. (1980). The paradox of no correlations between leaf photosyntheic rates and crop yields, in predicting

photosynthesis for Ecosystem models. vol. 2J. D. HESKTH, J.W. JONES, Ed., CRC Press, Inc., pp 156-164.

HAMAZAH, S. and GOMEZ, J.B. 1982. Some structural factors affecting productivity of *H. brasiliensis* III. Correlation studies between structural factors and plugging. 1. *J. of the Rubber Res. Institute of Malaysia* **30** (3) : 148-160.

HO, C.Y. 1976. Clonal characters determining yield of *Hevea braziliensis. Proceedings of the International Rubber Conference*, Kuala Lumpur, 1975, **2** : 27-44.

LAVORENTI, C., GONCALVES, P. DES., CARDOSO, M., BOAVENTURA, M.M and MARTIN, A.L.M. 1990. Relacco Entre Diferentes Caracteres De Plantas Jovens De Seringueira. Bragantia, Campinas **49** (1) : 93-103.

LICY, J. and PREMAKUMARI, D. 1988. Association of characters in hand pollinated programmes of *H. brasiliensis. Indian J. Natural Rubber Res.* **1** (1) : 18-21.

MOMOH, W.E. and ALIKA, J.E. 1987. Preliminary assessment of the growth performance of some selected NIG 800 clones of rubber *(Hevea brasiliensis). J. Plantn. Crops.* **15** (2) : 101-107.

NARAYANAN, R., GOMEZ, J.B. and CHEN, K.T. 1973. Some structural factors affecting the productivity of *H. brasiliensis* II. Correlation studies between structural factors and yield. *Journal of the Rubber Research Institute of Malaysia* **23** (4) : 285-297.

NAZEER, M.A., MARATTUKALAM, J.G., CHANDRASEKHAR, T.R., MYDIN, K.K., PREMAKUMARI, D. and PANIKKAR, A.O.N. 1992. Early growth performance of some *Hevea* clones in Konkan region of Western India. *Indian J. Natural Rubber Res.* **5** (1&2) : 223-228.

NUGAWELA, A and ALUTHHEWAGE, R.K. 1985. Gas exchange parameters for early selection of *Hevea brasiliensis* Muell. Arg. *J. Rubber Res. Institute of Sri Lanka* **64** : 13-20.

OLAPADE, E.O. 1988. Secondary characters and their association with latex yield in Hevea brasiliensis. (Muell Arg.). *J. Rubber Res. Institute of Sri Lanka*. **68** : 11-16.

PAIVA, J.R. 1982. Use of path coefficients in *Hevea brasiliensis* breeding, *Pesqui, Agropecu, Bras.* **17** (3) : 433-440.

PANSE, V.G. and SUKHATME, P.V. 1967. Statistical methods for agricultural workes, ICAR, New Delhi.

PREMAKUMARI D., SASIKUMAR, B., PANIKKAR, A.O.N. and MARATTUKALAM, J.G. 1984. Variability and association of certain bark anatomical traits in *Hevea brasiliensis* Muell. Arg. *Proceedings of the VIth Symposium on Plantation Crops* held at Kottayam, India, 16-20 Dec. 1984 pp 49-54.

RIBEIRO S.L. 1984. Correlation among 9 characters of rubber tree clones at Porto Velho conditions, Rondonia State, *Pesqui Agropecu. Bras.* **19** (10) : 1235-1246.

SINGH, R.K. and CHOUDHURI, B.D. 1985. Biometrical methods in Quantitative Genetic Analysis. Kalyani Publishers, New Delhi.