Evaluation of Rubber Clones (Hevea brasiliensis Mull. Arg), derived from the first Hand Pollination Programme an the Rubber Research Institute of Nigeria[1])

By O. U. Onokpise[2])

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Abstract

Latex yield and girth were reported for rubber clones and families of the first hand-pollination programme at the Rubber Research Institute of Nigeria. Mean latex yield and girth of the first year were higher than those of the second year, for clones and families. Analysis of the two characters indicated considerable variation among the families and among the clones *per se*. Intercharacter correlations were non-significant in both years, whereas the between year correlations were highly significant for each of the two characters.

Although there is a close relationship among the clones, the significant mean squares would suggest that improvement for the two characters studied can be made through selection. However, the non-significant relationship, between latex yield and girth would suggest that girth at opening may not be a major factor to consider when opening trees for tapping. It is also postulated that yield data from the early years of tapping could be useful in predicting yields in later years of *Hevea* clones.

Key words: Hevea brasiliensis, clones, latex yield, girth.

Zusammenfassung

Im Rubber Research Institute in Nigeria wurden bei *Hevea brasiliensis* Klone und Nachkommenschaft aus Kreuzungen auf Latexernte und Baumumfang untersucht. Sowohl für die Klone als auch für die Familien waren die mittlere Latexernte und der Baumumfang des ersten Jahres höher als die des zweiten Jahres. Eine Analyse der beiden Merkmale zeigte eine beträchtliche Variation zwischen Familien und besonders zwischen Klonen. Die Korrelation zwischen den Merkmalen war in beiden Jahren nicht signifikant, während die Korrelation für jedes der beiden Merkmale zwischen den beiden Jahren hoch signifikant war. Obwohl eine enge Beziehung zwischen den Klonen besteht, sind die signifikanten mittleren Quadrate ein Zeichen dafür, daß für die zwei untersuchten Merkmale durch Selektion eine Verbesserung erreicht werden kann. Die nicht signifikante Beziehung zwischen Latexernte und Baumumfang belegt, daß dieser nicht als Hauptfaktor zum Anzapfen der Bäume angesehen werden kann. Es wurde ebenfalls festgestellt, daß bei *Hevea brasiliensis* die Erntedaten jüngerer Bäume bei *Hevea* Klonen zur Vorhersage von Erntemengen späterer Jahre nützlich sein können.

Introduction

Rubber production in Nigeria dates back to 1894 when wild rubber trees *(Funtumia elastica)* found in the rain forests were exploited and the rubber exported for foreign exchange. *Hevea brasiliensis* was brought into Nigeria in 1895 from part of the Wickham collections that were sent to the Far East (Tappan, 1969). Nigeria is presently the world's seventh largest natural rubber producer. Most of the production has come, and still comes, from small holders' farms and a few estates located in Bendel, Imo, Cross Rivers, Ondo and Rivers States. Eighty five percent of the nation's production comes from Bendel State. These farmers have an average of three hectares of unselected seedling rubber trees producing an estimated latex yield of 200—300 kg per hectare per annum. Today, natural rubber is the fourth major agricultural export crop in the country, and the estimated annual contribution of natural rubber to the country's economy will be 80 million dollars by 1985. This would suggest an intensification of research into all aspects of natural rubber production in the country, aimed at increasing latex yields and also improving latex quality. There has however, been little research on natural rubber in Nigeria as compared with that done in countries in South-East Asia.

It was only in 1961, with funds from the United States Agency for International Development (USAID) and the Western Nigerian government, that a Research Station was established at Iyanomo, Benin City, for conducting research into all aspects of rubber production including rubber breeding. This later became a Federal Rubber Research Institute in 1972. Early breeding work was done by Aappan (USAID adviser), who initiated a hand pollination programme in 1965. Seedlings and clones derived from this programme are presently under evaluation.

The utilization of variance components in the comparison of family performances in *Hevea* breeding has received attention of *Hevea* breeders only in the last 10—12 years. Simmonds (1969), and Gilbert *et al.*, (1973), suggested that variation among individual family latex yields from the Phase II breeding programme of the Rubber Research Institute of Malaysia (RRIM) could be accounted for by additive genetic variance. The significance of general and specific combining abilities (GCA and SCA) in the selection of families for utilization in future *Hevea* breeding programmes has also been reported (Tan, 1978). While earlier workers had favoured the use of girth as a major factor in determining the time when trees should be opened for tapping (Sharp, 1951; Ross, 1965), more recent information indicates that girth may not be very important (Tan, 1977, Tan, 1978). These workers have, however, not provided direct information on the clones *per se*, derived from the families which they have so far evaluated. Because only clonal materials (budwoods and budded stumps) are distributed to farmers and estate owners, an evaluation which takes into account the clones *per se* is very important.

The objective of the present paper is to report on the latex yield and girth of clones derived from the first hand

[1]) Contribution from the Rubber Research Institute of Nigeria, Iyanomo, Benin City

[2]) Research Officer, RRIN

Present address: Dept. of Forestry, Iowa State University, Ames, Iowa, 50011, USA.

pollination programme at the Rubber Research Institute of Nigeria (RRIN) and to provide additional information on *Hevea* breeding.

Materials and Methods

In 1965, established clones of Malaysian origin were hand pollinated. The method of hand pollination at RRIN has been described previously (ONOKPISE, 1977). In brief, all male flowers and opened female flowers of an inflorescence to be pollinated are removed leaving only healthy female flowers. The perianth lobes are gently forced apart and the whole staminal column of a mature male flower is inserted into the female flower and allowed to rest on the stigma. The staminal column is kept in position with a plug of cotton wool smeared with a drop of latex. This also prevents unwanted pollination by rogue pollen. To reach the very high branches, specially constructed ladders or scaffolds are used.

The seeds produced by hand pollination were then planted in a nursery at the experimental station in Iyanomo. Clones were obtained from 18 months old seedlings by taking budwood from each seedling and budgrafting them to rootstocks that had been previously established. The clones were transplanted to the field in 1967. The field layout was a row-plot design with clones randomly allocated to single plots, regardless of the family source. Each clone was represented by nine trees spaced 5.40 m apart (TAPPAN, 1969b). Thirty of these clones were opened for tapping in November 1975, eight years after transplanting. The method adopted in obtaining latex yield data involved coagulating the latex from each day's tapping and storing the resultant "biscuits" on a wire fixed to each tree. At the end of the month the "biscuits" were collected from each tree and weighed. "Biscuits" from each clone were pooled and a composite sub-sample of coagulated latex was air dried for 21 days to determine the dry rubber content. (d.r.c.). The d.r.c. expressed in percentage and multiplied by the wet field weight gave the required yield figures. The average yield per tree per tapping for a year (grams/tree/tapping) was obtained by dividing the total production of the coagulate by the number of recordings for the particular year. Tapping was done using the half-spiral alternate daily (S/2 d/2) system. Girth of mature trees were taken at opening (1975/76) and again in the second year (1976/77) using the method described by TAN *et al* (1975). Analysis of variance was performed on the data for each year separately and correlations between latex yield and girth at opening and in the second year, as well as correlations between both years for yield and girth were calculated on the basis of clonal means.

Table 1. — Mean latex yields for 30 rubber clones *(Hevea brasiliensis)* eight years old in 1975, at Iyanomo, Nigeria.

Family ♀ x ♂	Clone	Latex Yield (g/t/t+) Year 1 1975/76	Year 2 1976/77
RRIM 501 x HAR 1	76	55.8 (55.7)	55.4 (46.3)
	75	56.2	36.9
RRIM 501 x RRIM 628	114	55.5 (53.2)	38.9 (35.7)
	118	50.9	32.5
RRIM 628 x RRIM 501	106	52.3	46.8
	105	51.5	35.3
	104	46.0	44.0
	11	53.9 (47.4)	30.6 (34.5)
	98	42.3	30.2
	8	43.2	28.6
	97	42.9	26.0
RRIM 600 x TJIR 1	1	46.4 (44.2)	42.7 (34.7)
	3	42.0	26.6
RRIM 600 x PR 107	47	53.3	50.8
	86	48.1	45.6
	83	42.8	42.8
	42	41.7	44.5
	43	44.2	36.7
	54	44.2	36.4
	82	48.6 (41.6)	35.5 (34.5)
	51	48.7	33.7
	58	40.6	24.6
	52	31.5	30.7
	85	28.9	29.2
	87	35.8	20.3
	55	32.9	22.0
RRIM 628 x HAR 1	28	42.7	32.3
	29	41.6	31.0
	21	36.4 (37.8)	21.5 (27.0)
	27	30.6	23.0
Overall mean		44.36	34.5
Standard error		6.69	4.32

Values in brackets are family means.

+g/t/t = grams per tree per tapping.

Table 2. — Mean girths for 30 rubber clones *(Hevea brasiliensis)* eight years old in 1975 at Iyanomo, Nigeria.

Family ♀ x ♂	Clone	Girth (cm) Year 1 1975/76	Year 2 1976/77
RRIM 600 x TJIR I	1	79.0 (74.7)	79.5 (77.4)
	3	70.3	75.3
RRIM 501 x RRIM 628	114	71.0 (69.7)	73.8 (73.2)
	118	68.3	72.5
RRIM 628 x RRIM 501	98	65.3	75.3
	106	68.0	70.5
	11	68.5	68.5
	97	66.8 (65.8)	66.8 (68.0)
	8	64.0	66.0
	104	63.8	64.8
	105	63.3	63.8
RRIM 600 x PR 107	55	71.8	75.7
	86	68.8	73.0
	42	68.3	71.0
	82	68.5	70.3
	87	68.3	69.8
	85	68.5	68.5
	52	67.5 (65.6)	68.3 (67.4)
	54	65.3	66.3
	83	64.0	64.5
	43	62.3	64.3
	47	62.3	63.3
	51	60.1	62.0
	58	56.8	58.5
RRIM 628 x HAR 1	29	70.3	69.8
	27	61.0	68.5
	28	63.8 (62.8)	63.8 (65.4)
	21	56.5	58.8
RRIM 501 x HAR 1	76	63.8 (61.9)	65.8 (63.2)
	75	60.0	60.50
Overall Mean		65.91	67.98
Standard error		6.91	8.37

Values in brackets are family means.

Table 3. — Analysis of variance for Latex yield of rubber clones and families.

Source	df	Year 1 Mean Square	F.	Year 2 Mean Square	F.
Family	5	1376.11	3.41**	1309.12	7.79**
Clones-in-family	24	634.98	1.57*	971.45	5.78**
Error	240	403.39		168.11	
Coefficient of Variability (CV)		45.28%		37.75%	

* ** Significant at 0.05 and 0.01 probability levels.

Table 4. — Analyses of Variance for girth of rubber clones and families

Source	df	Year 1 Mean Square	F	Year 2 Mean Square	F
Family	5	13230.87	30.77**	3027.91	4.80**
Clones-in-family	24	622.86	1.45*	807.18	1.27NS
Error	240	430.02		630.80	
Coefficient of Variability (CV)		31.46%		36.95%	

* ** Significant at 0.05 and 0.01 probability levels.
NS — Non-significant

Results

The mean latex yields in grams per tree per tapping (g/t/t) for clones and families were higher in the first year than in the second year *(Tables 1* and *2)*. Only two of the 30 clones showed increased latex yield in the second year over the first year. However such increases were non significant. Mean girth (cm) showed positive but non-significant increases in the second year of tapping *(Tables 1* and *2)*. For some clones, there was virtually no girth increment after one year of tapping.

There was considerable variation among families and clones for latex yields in both years *(Table 3)*. Significant mean squares were also obtained for girth among families in both years *(Table 4)*, but only first year girth was significant among clones *(Table 4)*.

Latex yield was not significantly correlated with girth in either year *(Table 5)*. Correlations between first year and second year latex yields were however, significant and similarly, girth in the first year was significantly correlated with girth in the second year *(Table 5)*.

Table 5. — Correlation coefficients relating mean latex yield and mean girth in 30 rubber clones *(Hevea brasiliensis)* at Iyanomo, Nigeria.

	1st Year Girth	2nd Year Yield	1st Year Yield
2nd Year Girth	0.91**	.04NS	-.09NS
1st Year Girth		.01NS	-.01NS
2nd Year Yield			.50**

1. Significance levels:
NS = Non-significant
** = Significant at 0.01 probability level.

Discussion

The reduced latex yield in the second year of tapping may be attributable to a number of factors. The unusually dry weather experienced in 1977, may have put the clones under stress with a consequent reduction in yield. These clones were opened for tapping eight years after transplanting to the experimental fields. The mean girth at opening was 65.9 cm which was 15.9 cm more than the minimum 50 cm girth recommended for opening (HADRIDAS and PUSHPARAJAH, 1978). This, coupled with the fact that the clones were two to three years past usual opening age of five to six years (SHARP. 1951) may have resulted in an initial gush of latex at opening.

Initial tapping of the trees could also impare plant vigour and hence reduce growth and yield in the second year of tapping, as was the case in this experiment. Whether the yield will be restored and further increase obtained remains to be seen when yields of the third and subsequent years are analysed.

Although mean squares for latex yields were significant for both families and clones, the family mean-squares were significantly higher than those of the clones. The lower mean-squares for clones would be expected because of the close relationship among these clones. The significant mean squares observed for families and clones for latex yield suggests that sufficient variability remains in the families for future breeding programmes to prosper. How much of this variation is due to genetic components is discussed in a second paper (ONOKPISE *et al.*, in press). However the close relationship among clones, would suggest that new sources of materials are needed with which to conduct provenance and progeny tests, from which selected trees of the best families would be retained to make new crosses, as is presently done in many forest tree breeding programmes. This approach will be important not only because it will help to supplement existing breeding pro--grammes but will also broaden the genetic base of available materials and reduce the risk of excessive inbreeding.

The lack of correlation between latex yield and girth for clones in either year would indicate that the two characters are controlled by different genes or, even if they were controlled by the same genes, that these genes act differently in influencing yield and girth. If so, girth at opening should not be used as a deciding factor on when to open trees for tapping. Earlier workers favoured the use of girth as the criterion for opening trees. To reach the required girth of 50 cm, rubber farmers have to wait five to seven years before receiving any return from their investments. This study, and other recent information (Ho, 1975; TAN, 1977; HADRIDAS and PUSHPARAJAH, 1978), all indicate that girth at opening may not be as important as other characters for deciding when to begin tapping. The significant correlation between first year and second year yield indicates that those clones which were the best yielders in the first year were also the best yielders in the second year. This result agrees with earlier reports (GILBERT *et al.*, 1973; and Annual Report of the Rubber Research Institute of Nigeria, 1976/77). If annual yields during the first four years show similar correlations, it may be possible to predict future yields

from measurement of latex yield over two or three years. (TAN, 1978), and thus save the time and resources that are presently spent in testing clones for 15 to 25 years before recommendations are made.

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Provenance and Clonal Variation in Growth, Branching and Phenology in Picea sitchensis and Pinus contorta

By CH. M. CAHALAN[1])

Institute of Terrestrial Ecology, Bush Estate,
Penicuik, Midlothian, EH 26 OQB, Scotland

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Summary

Four clones from each of five provenances of *Picea sitchensis* and *Pinus contorta* were grown from cuttings taken from 15 and 14 year-old trees, planted at a lowland and an upland site in Scotland and measured annually for five years. Fifth year data are presented here. Provenances, covering much of the species' natural ranges, accounted for 25—72% of the variation in fifth year heights and diameters, and clones within provenances for 9—31%. Significant and visually striking differences between clones within provenances occurred in branching characteristics in both species, and in dates of bud burst and bud set in *P. sitchensis*, the largest *P. sitchensis* clones being those with the longest seasonal periods of elongation. Significant ortet-ramet correlations were found in *P. contorta*, but clonal differences were not associated with differences in rooting speed in either species.

Repeatabilities of clone means for height and diameter were 0.84 and 0.76 for *P. sitchensis* at the lowland site, predicting genetic gains of 38% and 30% over the mean from selecting the best 5% of clones within provenances. Corresponding repeatabilities for *P. contorta* were 0.54 and 0.58, predicting gains of 10% and 14%. Genetic gains from selection at the upland site were expected to be somewhat lower.

Key words: Picea sitchensis, Pinus contorta, clones, provenances, variation.

Zusammenfassung

Vier Klone von je fünf Provenienzen von *Picea sitchensis* und *Pinus contorta*, die als Stecklinge von 14- und 15jährigen Bäumen stammen, wurden im schottischen Hoch- und Tiefland an jeweils einem Standort ausgepflanzt und jährlich über den Zeitraum von fünf Jahren gemessen. Die Ergebnisse aus dem fünften Jahr werden in dieser Arbeit veröffentlicht.

Den Provenienzen, die nahezu das gesamte natürliche Verbreitungsgebiet der Art abdecken, war in bezug auf ihre Fünfjahreshöhen- und -durchmesser eine Variation von 25—72% zuzuordnen, den Klonen innerhalb der Provenienzen eine von 9—31%. Signifikante und sichtbare Klonunterschiede innerhalb der Provenienzen traten bei den Zweigmerkmalen beider Arten, sowie im Zeitpunkt von Austriebsbeginn und Vegetationsabschluß bei *Picea sitchensis* zutage. Bei *Picea sitchensis* waren die Klone mit der längsten Vegetationsspeziode am größten. Signifikante Mutterbaum-Stecklings-Korrelationen wurden bei *Pinus contorta* gefunden, aber die Klonunterschiede stan-

[1]) Present address: School of Plant Biology, Memorial Buildings, University College of North Wales, Bangor, LL57 2UW, Gwynedd, U. K.