A Study of Reliability of Yield and Vigour Indices for Early Selection of *Hevea* Genotypes

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ABSTRACT

The main objective of this study was to study the reliability of yield and girth indices for early selection of *Hevea* genotypes. Two hundred and forty eight *Hevea* seedlings derived from the hand pollination programme in 1976 were micro tapped and 29 promising seedlings were selected for further evaluation. These were cloned and planted in a clone trial along with RRIC 121, RRIC 100, RRIC 102 as control clones. Randomized complete block design with 4 blocks, each having a plot of four trees for each clone was used. In this paper, results of correlations between micro tapping yield of seedlings and test tapping yield of clones, and correlations between test tapping yield and the girth of clones are discussed. Correlations were not significant between micro tapping yield collected from 29 selected seedlings and yearly test tapping yield collected from clones produced from the selected seedlings. This indicated that micro tapping yield is not a reliable index for early selection of *Hevea* genotypes. Possibility of using repeated girth measurements, as an index for predicting commercial yield in later years is discussed using correlation, between these two characters , over first five years of tapping. According to Duncan's multiple range test on yield data HP 52 and RRIC 121 were found to be significantly different from other clones and these two clones were not significantly different from each other. This indicated that clone HP 52 was as good as RRIC 121.

KEY WORDS: *Hevea brasiliencis*, Hand Pollination, Micro Tapping Method, Reliability, Early Selection.

INTRODUCTION

The rubber tree (*Hevea brasiliensis)* was first introduced to Sri Lanka in 1876, when 1919 seedlings of the Wickham Collection were planted in Peradeniya and Henerathgoda Botanic gardens. The seeds and seedlings derived from these trees of Wickham origin were distributed to other South East Asian countries and formed the foundation stock for the development of the rubber plantation in Asia (Attanayake, 2001).

In 1950, the rubber sector's contribution to Sri Lanka's GDP was about 8 percent. However, this share has decreased to 0.5 percent in 2003 (Anon, 2003). The total extent of cultivated rubber is around 101000 ha (Anon, 2003) and the total production of rubber in 2003 was 92 million kg and the total exports in the same year was 35 million kg (Anon, 2003).

The domestic consumption of rubber in the industrial sector increased by 4.4% to 57 million kg and accounted for 62 percent natural rubber output in 2003 (Anon, 2003). The amount of rubber imported to the country in 2003 increased by 85 percent to 9 million kg (Anon, 2003). The quantity of rubber exported as intermediate products declined by 4 percent to 35 million kg due to high domestic demand. This clearly indicates that rubber has become an important industrial raw material for local industries and will continue to do so in future. The national average yield of rubber increased by 2.6 percent to 911 kg/ha in 2003 (Anon, 2003). However this yield is still below the potential yield of 1500-2000 kg/ha, estimated by the Rubber Research Institute of Sri Lanka. The low yield levels are mainly attributed to non application of recommended level of fertilizer, poor usage of high yielding clones and the scarcity of the skilled labour *etc.* To overcome the poor production and productivity, use of improved clones in new planting and replanting is very important. Therefore, selection of genetically superior clones plays a vital role not only in determining the future rubber productivity but also in minimizing the uneconomic immature period involved in this type of long term investment. In the breeding programme of RRISL, each year a large number of seeds is derived from the hand pollination (HP) programme. Considering the land, labour, and capital required, it is impossible to clone all the seedlings and test them in clone trials. Thus, promising genotypes must be identified early in order to reduce the breeding population. Such a selection early in breeding programme will also help to reduce long term breeding process of rubber which has long economic life span (Jayasekara and Hettiarachchi, 1983). Therefore, rubber breeders have made attempts to develop techniques of early selection to identify superior genotypes among hand pollinated seedlings when they are very young.

Aim of this study was to determine the reliability of such early selection indices, micro tapping yield (Waidyarathna and Fernando, 1972), and girth measurements to predict the yield potential of clones at early stages.

MATERIALS AND METHODS

a) Materials

Experimental material consisted of 248 seedlings derived from artificial hand pollination programme in 1976 (Table 1) and 29 clones produced by 29 selected seedling from this seedling population. Selection of these seedlings was based on high yielding potential as determined by micro tapping yield.

Table 1. Crosses made and number of seedling obtained in each cross.

Crosses made	Seedling Obtained
RRIC103*PB86	6
RRIC 103* RRIC52	3
RRIC100*PB86	22
RRIC100*RRIC52	28
RRIC100*RRIC101	57
RRIC101*RRIC52	10
RRIC101*RRIC88	---
RRIC101*PB86	56
RRIC101*82	2
RRIC101*RRIC100	4
RRIC101*RRIC101	---
RRIC100*82	5
RRIC100*RRIC100	---
RRIC100*RRIC103	---
PB86*RRIC101	10
PB86*RRIC88	---
PB86*RRIC103	3
PB86*82	3
PB86*PB86	---
PB86*RRIC100	---
82*RRIC101	21
11*PB86	13
82*82	3
82*RRIC100	2
1035*PB86	2
TOTAL	**248**

b) Methods

This study was carried out at two sites. Seedling evaluation was done at the Rubber Research Institute (RRI) sub station at Matugama. and the evaluation of clones was done at Tempo division of Neuchatel Estate which is a commercial estate managed by a company. In 1976 HP programme, 8198 pollinations were done and the 248 seedlings were derived. They were raised in a poly bag nursery with close spacing. Normal management practices recommended by RRISL for poly bag nurseries were adopted in maintaining the nursery. Early evaluation of young seedlings was done by using the micro tapping technique proposed by Waidyarathna and Fernando (1972).

By using micro tapping yield data, 29 seedlings were selected as potentially high yielding genotypes from the seedling population. Those were vegetatively propagated to produce 29 clones. The selected 29 clones and control clones (RRIC 100, RRIC 102, RRIC 121) were planted in a field experiment to evaluate the new selection.

Randomized complete block design (RCBD) with 4 blocks and each block having a plot of 4 trees for each clone was used in the small scale clone trial with the spacing of 3.5 m within rows and 5.5m between rows.

c) Measurements

When the plants reached tappable girth, actual yield was collected once a month on a normal tapping day. Latex collected in to the cup was coagulated by adding formic acid. The resulted coagulum was dried and dry rubber content was recorded for each tree as grams per tapping per tree (g/t/t).

As a parameter of vigour, plants were measured once a year for the diameter (1-3 year) and girth (after 3 years) and recorded in centimeters. Assuming that the stem of young trees is cylindrical, diameter measurements of small plants below 3 years were converted to girth using the formula for measuring the circumference (Girth = $2 \prod r$).

d) Analysis

All the analyses were performed on individual clone means using Statistical Analysis System (SAS) procedure. Correlation analysis between the micro tapping yield data collected from 29 selected seedlings and test tapping yield collected from clones produced from selected seedlings were performed. In this analysis, data collected from each year were analysed separately. Another correlation analysis was done between the girth measurements collected during 1992 to 1995 and yield of 29 clones produced from selected seedlings. Duncan multiple range test (DMRT) was performed on yield of all 32 clones to group them according to their superiority.

RESULTS AND DISCUSSION

The results of correlation analyses between micro tapping yields (MTY) collected from 29 selected seedlings and the yearly test tapping yield (TTY) data collected from clones produced from selected seedlings are summarized in Table 2.

Table 2. Results of the Correlation Analysis between MTY and TTY

	Correlation Co-efficient	P-value
TTY – 1st year Vs MTY	0.44952	0.0144*
TTY – 2nd year Vs MTY	0.43861	0.0173*
TTY – 3rd year Vs MTY	0.39597	0.0335*
TTY – 4th year Vs MTY	0.23337	0.2231

Significant at 5 %

Correlations between 1st, 2nd, 3rd year TTY and MTY were significant at 5% probability level. The table 2 shows the gradual reduction in the magnitude of the correlation coefficient from 1st year to 3rd year and, by the 4th year correlation between TTY and MTY was not significant. These features of correlations between MTY of seedlings and the TTY of clones produced from selected seedlings indicated that the selection of high yielding seedlings based on micro tapping yield, was not reliable and the reliability decreased as indicated by the reduction in magnitudes of the correlation coefficients over the years.

The results of correlation analyses of girth and yield of clones collected from 1992 to 1995 are shown in Table 3. The results indicated that out of 10 possible correlations, six were significant at 5% probability level. Three important features were observed in the table 3.

Table 3. Correlation between girth and yield of selected clones (from 1992-1995)

Girth Year	Test Tapping Yield 1992	1993	1994	1995
1992	0.16573 (0.3902)	0. 41706 (0.0244)*	0.58699 (0.0006)*	0.69201 (0.0001)*
1993		0.28576 (0.1329)	0.55942 (0.0016)*	0.68771 (0.0001)*
1994			0.24564 (0.1990)	0.34206 (0.0693)
1995				0.53709 (0.0027)*

Significant at 5 %

Parenthesis refers the probability values

First feature was that only one out of four possible correlations between girth and yield collected in the same year (diagonal array of the Table 3) was found to be significant.

The other feature was that correlations between girth and yield data collected in the later years were significant (five out of six such possible correlations were significant).

As the third feature, along the rows of correlation matrix (Table 3) magnitudes of correlation coefficients increased suggesting the reliability of girth as an index to predict the yield potential increased with the year of test tapping. Sethuraj (1992) considered girth as an important yield component directly linked to the latex vessels rings in the trunk of the rubber trees. Thus, a correlation between girth and yield is expected as in this study.

DMRT performed on yield data (Table 4), group the control clone RRIC121 and the new selection (HP 52) together but separated from the rest. Results indicated that these were significantly different from rest of the clones.

Table 4. Results of the Duncan multiple range test (DMRT)

Clone	Mean Yield (g/t/t)
HP52*	52.00
RRIC121*	48.75
HP162	44.81
HP182	44.38
HP8	39.16
RRIC100	38.49

significantly different from other clones

Figure 1 gives the average yield of some of the clones for each year under consideration and mean yield when averaged over all four years. The new selection (HP 52) recorded highest mean yield for 3rd year and 4th year and also had the highest mean yield (52 g/t/t) when averaged over all four years.

Figure 2 compares pre and post tapping girth of HP 52 with the two control clones, RRIC 121 and RRIC 100. It showed that growth of HP 52 was as good as the best control clone (RRIC 121) and better than RRIC 100.

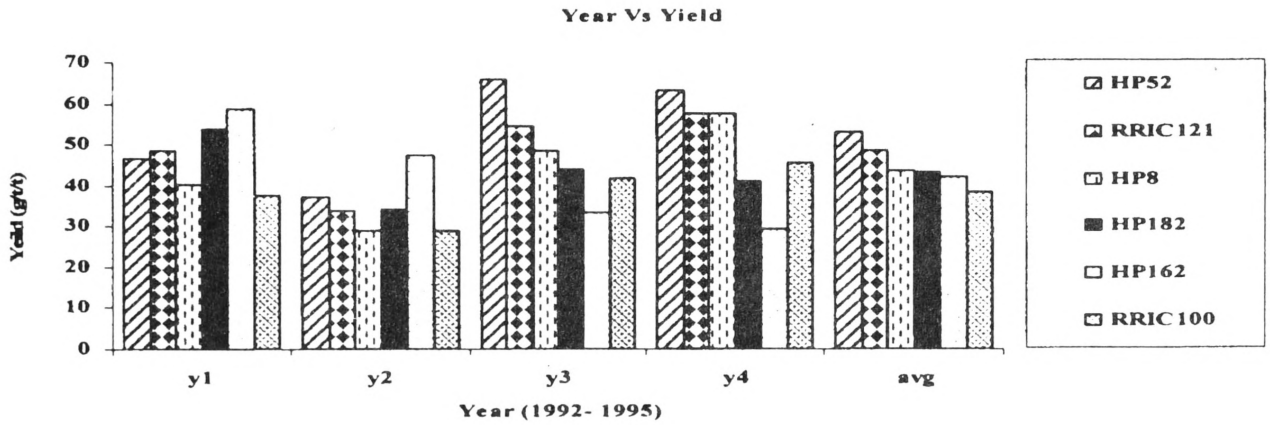

Figure 1. Yield of HP52, RRIC121, RRIC 100, and few promising selections

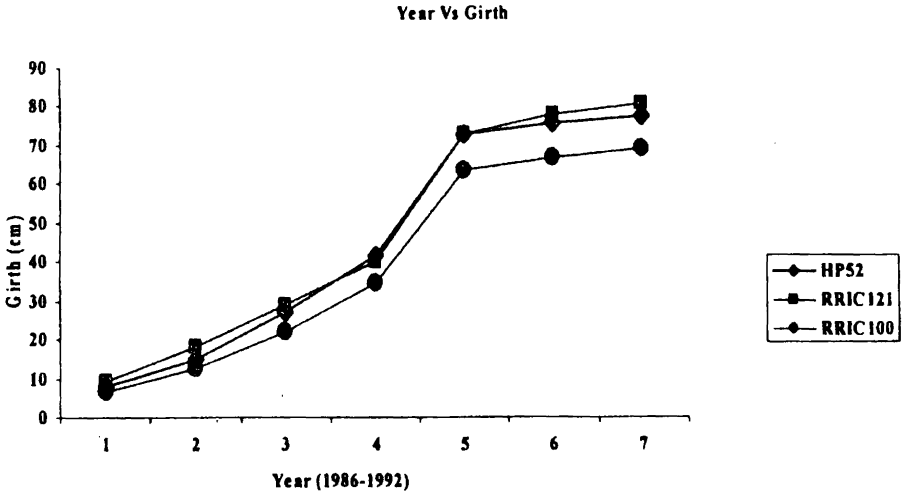

Figure 2. Growth of HP52, RRIC 121 and RRIC 100

CONCLUSIONS

Absence of correlation between MTY of seedlings and the TTY collected from clones produced from selected seedlings proved that micro tapping method is not a reliable yield index that could be used to select potentially high yielding genotypes from the seedling populations produced by hand pollination programme. Weakening correlations between micro tapping yield and test tapping yield as clones become older make micro tapping an unreliable index to base the early selection especially for a crop like rubber, which has a long economic life span of about 24 years.

Girth and test tapping yield data considered in this study are for a short period when compared to the long economic life span. Therefore, further studies are necessary to determine whether the trends observed among correlation between girth and yield data continue to exist in later years of the economic life span of rubber.

Further, the significant correlation between girth and yield as observed in this study could just be a chance effect. This can only be checked by testing whether such correlations are consistent over different clonal populations.

In this study, out of 29 genotypes selected on the basis of MTY only one clone (HP52) as good as the best control clones (RRIC121) was identified. Thus, the success rate can be considered as 1:29 which is very low. Hand pollination is expensive, laborious, and time consuming. Success rate of hand pollination in Sri-Lanka is 1%- 2%. Hence it is important to exploit this valuable genetic variability present in seedlings populations generated by hand pollination programme by employing more reliable selection indices.

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