S.L.J. Tea Sci. **60** (2), 76-86, 1991. *Printed in Sri Lanka.*

NURSERY PLANT ATTRIBUTES AS CRITERIA FOR SELECTION OF NEW TEA CLONES

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An attempt was made to correlate various plant attributes of ten tea clones in the nursery stage with their proven yields in order to identify attributes that could be employed directly or in combination as selection criteria for future selection programmes; these clones had initially been identified as high and low yielders.

Plants of high yielding clones grew better in the nursery, resulting in greater plant dry weight. Differences in growth attributes were more marked in 8 and 12-month-old plants than in 4-month-old plants. Strong positive linear correlations were obtained between plant height, number of side shoots, leaf area, girth of stem and dry weights of stem and of plant of 8 and 12-month-old plants with proven yields indicating that selection of promising clones could be done at the nursery stage in plants that are 8 and 12 months of age. Linear regression equations of attributes that showed a high correlation with the proven yields gave predictability values of 85% at 8 months.

INTRODUCTION

Clonal selection is a widely adopted method of plant improvement in tea because of the great heterogeneity in the existing seedling populations. Selection in mature seedling fields is carried out by visual observation of morphological characters. Various criteria have been used in selection.

Wellensiek (1940) obtained negligible correlations when he compared the yields of clones with those of their mature seedling parents. Similarly, Green (1965) also obtained negligible correlations when he compared yields of clones with yields, areas of plucking surface and yields per unit area of bush surface of their mature seedling parents. Selection in fields of immature seedlings and in nurseries have long been accepted as alternatives to the selection of mature seedling bushes (Green, 1971). If this were effective it would be most useful.

Harada, Watanabe and Mitusui (1961) showed that shoot length of rooted tea cuttings had a good relationship to yield in subsequent field tests and that seedlings with low shoot weight were low yielders. Kulasegaram (1969) studied several plant characters in the nursery at three different stages from planting with their respective mean first cycle yields and obtained positive correlations. Green (1971) found that plant height, girth at collar, root weight and branching angle of young seedlings in the nursery are correlated with the sizes and yields of the same plants when mature. After examining seven characters of young tea seedlings Amma (1973) found it difficult to estimate the yield at maturity from any one character during the nursery period. Sakai and Nakayama (1973) suggested that early growth of cuttings would reflect the yield of a clone at maturity because the light conditions of a bed of cuttings is similar to that of a mature tea garden.

After assessing the yield of 31 clones and one seedling population over a period of seven years, Sebastiampillai and Solomon (1976) found highly significant positive correlation between the yield in the immature stages (four years at St. Coombs and two years at Kottawa) and that of the first seven years.

The objective of this study is to correlate various attributes of nursery plants of clones identified as high and low yielders (on their proven yields) so as to identify attributes that could be employed directly or in combination as early selection criteria as well as to estimate the potential yield of new selections.

MATERIALS AND METHODS

This study was carried out at the Tea Research Institute, St. Coombs Estate, Talawakele (1372 m amsl) in the Up Country Wet Zone. Of the ten clones used, clones TRI 2023, TRI 2025, TRI 2026, Drayton 1 (DT 1) and Talankande 48 (TK 48) which gave a yield of 2500 kg ha^{-1} an^{-1} and above were considered high yielding while clones Craig 4 (CR 4), Endane 31 (EN 31), Poronuwa 26 (PO 26), Passara 22 (PA 22) and Thotulagalla 5/35 (T 5/35) which yielded less than 2500 kg ha^{-1} an^{-1} were considered low yielding for the purpose of this study; this differentiation was based on clonal proving trials (Pethiyagoda, 1968). The mean yield was recorded during the first pruning cycle lasting for a period of three years.

Cuttings from the ten clones used in this study were grown in soil filled polythene bags of 23 x 10 cm (9 x 4 inch) diameter (12.7 cm or 5 inch layflat) and arranged in randomized blocks with treatments (different clones) replicated thrice; there were ten plants per treatment per replicate. The growth of these cuttings were assessed thrice at 4 monthly intervals from planting. The characters measured were height, number of side shoots, total leaf area and stem girth. Girth of the stem was determined by measuring the circumference of the new shoot using a piece of twine and reading its length. The length of the longest root was measured and dry weights of leaves, stem and roots of individual plants determined. The plants were grown under standard nursery conditions.

The data was subjected to analysis of variance and the means correlated with the dry weight yields of the first two cycles of the bushes from which the cuttings were obtained. A forward stepwise regression procedure was adopted in obtaining linear regression equations of yield with the attributes contributing significantly to yields. The coefficient of variation (R^2) obtained for the equations fitted will indicate the per cent of total variation in yield that could be accounted for by the attribute/s in the model.

RESULTS AND DISCUSSION

Plant height

At 4 months there were no significant differences between plant heights of high and low yielding clones (Fig. 1). However at the age of 8 months all high yielding clones were significantly taller than the low yielders and gave high correlation with the yield (Table 1). A similar pattern was maintained at 12 months but the differences were less marked showing that the plant height at 8 months was a better indicator of yield than those at 4 months or 12 months. This is probably because at the 4th month the plants have not shown sufficient growth while at the 12th month limitations of space would have resulted in competition leading to poor correlations.

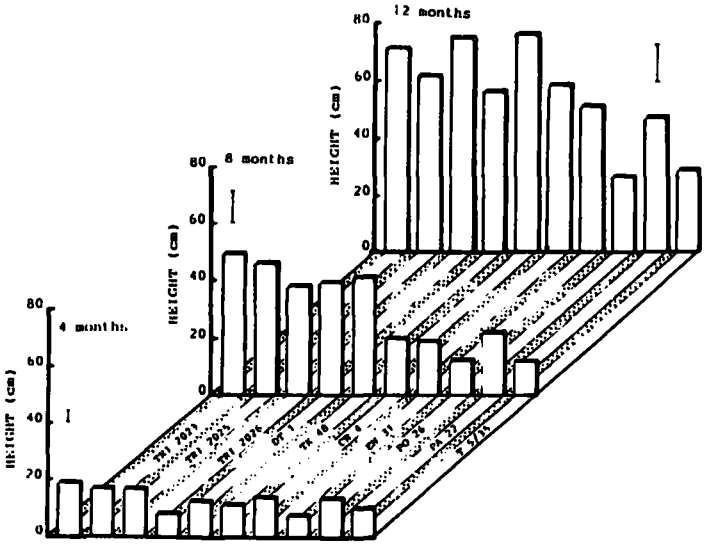

Fig. 1–Height of nursery plants of high and low yielding clones at 4, 8 and 12 months. Vertical bars indicate LSD (P = 0.05). (Each figure is the mean of 30 plants).

Leaf number

Unlike the plant height, the number of leaves produced did not vary between high and low yielders even at the eighth month (Table 2) and the correlation was also fairly low (Table 1).

TABLE 1 – *Correlation coefficients between attributes of nursery plants and their yields**

Attributes	*4th month*	*8th month*	*12th month*
Height of plant (Length of shoot)	0.49	0.92	0.66
No. of leaves produced	0.63	0.63	0.36
No. of side shoots	–	0.85	0.83
Leaf area	0.70	0.92	0.83
Leaf area index	0.70	0.92	–
Girth	–	0.92	0.84
Dry weight of shoot	0.56	0.92	0.85
Dry weight of plant	0.56	0.89	0.86
Shoot/root ratio	-0.005	0.69	0.18

* Kilogram of made tea/ha/an, from the clonal proving trial at St. Coombs, Talawakele.

Branching

In this study, side shoot production had not commenced at the age of 4 months but at 8 and 12 months the high yielding clones had more side shoots than the low yielders (Fig. 2) and the correlation between this attribute and the yield was also high at the 8th and 12th months (Table 1).

TABLE 2 – *Number of leaves and leaf area index of nursery plants at different stages*

Clone	*Mean No. of leaves/plant*			*Leaf area index*	
	4 months	*8 months*	*12 months*	*4 months*	*8 months*
TRI 2023	14.63	19.73	27.77	2.04	7.89
TRI 2025	12.53	22.60	29.53	1.85	7.06
TRI 2026	11.50	19.33	28.63	1.88	5.83
DT 1	10.70	21.77	27.67	0.90	3.90
TK 48	12.13	19.13	30.83	1.21	4.86
CR 4	11.83	20.80	30.40	1.05	1.92
EN 31	10.77	16.97	28.53	0.98	1.32
PO 26	11.13	15.07	24.00	0.96	1.22
PA 22	10.60	16.87	25.77	1.13	2.16
T 5/35	9.53	13.30	23.40	1.12	1.19
LSD (P=0.05)	NS	2.96	2.78	0.36	1.46

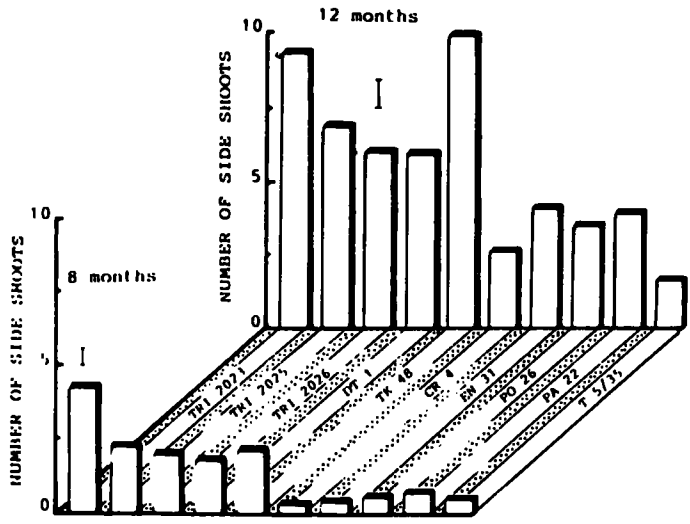

Fig. 2 – Mean number of side shoots of nursery plants of high and low yielding clones at 8 and 12 months. Vertical bars indicate LSD (P = 0.05). (Each figure is the mean of 30 plants).

Leaf area

The total leaf area of the TRI 20.– series of clones was greater than that of all other clones at the age of 4 months but at the 8th month the leaf area of all high yielders (including clones DT 1 and TK 48) was greater than that of the low yielders (Fig. 3). This is because the clones DT 1 and TK 48 showed poor growth in the early stages in the nursery but become vigorous with time. The same trend was maintained at the 12th month as well except for clone DT 1 which shows a levelling off. The correlation between the leaf area and yield was high at all three assessments (Table 1).

The leaf area index (LAI) which is the total leaf area per unit land area (Table 2) and the correlation between the LAI and yield (Table 1) followed the same trend as that of leaf area but the LAI was not calculated at the 12th month. This is because it was felt that the determination of LAI at the 12th month would have resulted in unrealistic values as by this time there would have been a greater leaf canopy while the plant bag size remains constant.

Stem girth

The high yielding clones had significantly larger girths of stem than the low yielding clones (Fig. 4). At the age of 12 months clone DT 1 showed signs of levelling off. The correlation between this attribute and yield was high (Table 1).

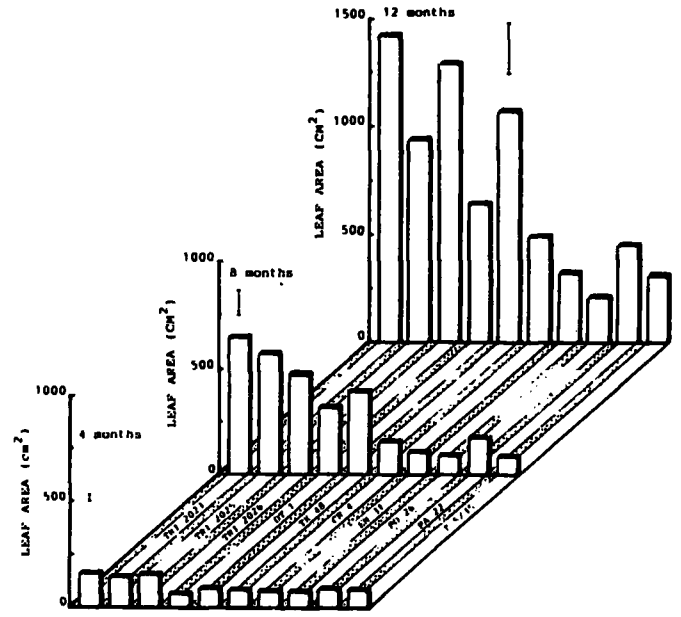

Fig. 3–Total leaf area of nursery plants of high and low yielding clones at 4, 8 and 12 months. Vertical bars indicate LSD (P = 0.05). (Each figure is the mean of 30 plants).

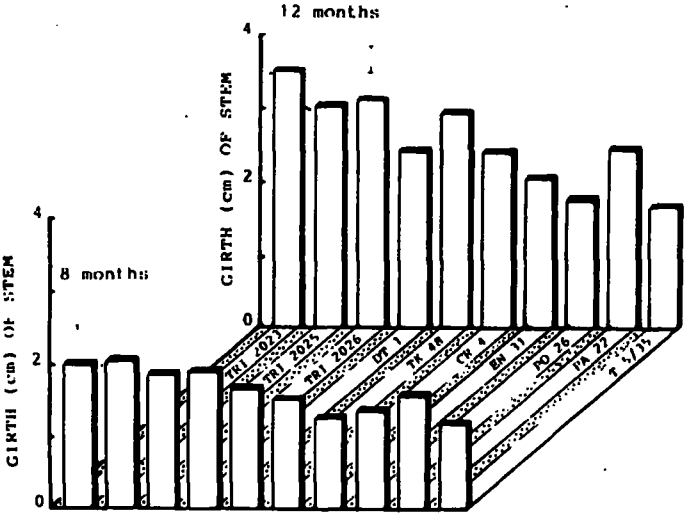

Fig. 4–Girth at base of stem of nursery plants of high and low yielding clones at 8 and 12 months. Vertical bars indicate LSD (P = 0.05). (Each figure is the mean of 30 plants)

Dry weights

The high yielding clones had greater dry weight of leaves at both 8 and 12 months. DT 1 showed the lowest growth among the high yielding clones (Table 3). With minor exceptions the dry weight of stem of high yielding clones was greater than that of low yielding clones (Table 3). At all three assessments the dry weight of shoots (above ground portion) of the high yielding clones was greater than that of the low yielders, being more marked as the plants grew older (Fig. 5). The correlation between the weight of new shoot and the yield was high at 8 and 12 months (Table 1). All high yielding clones showed greater dry weight of roots particularly at the more mature stage of 12 months (Table 3). When the dry weight of the whole plant was considered (Fig. 6) the predictability of the yield was higher for this measurement done at the age of 8 months. This confirms a feature noted almost throughout this study that among the times at which the measurements were made, 8 months is probably the most reliable for reflecting the yield potential of the mature bush.

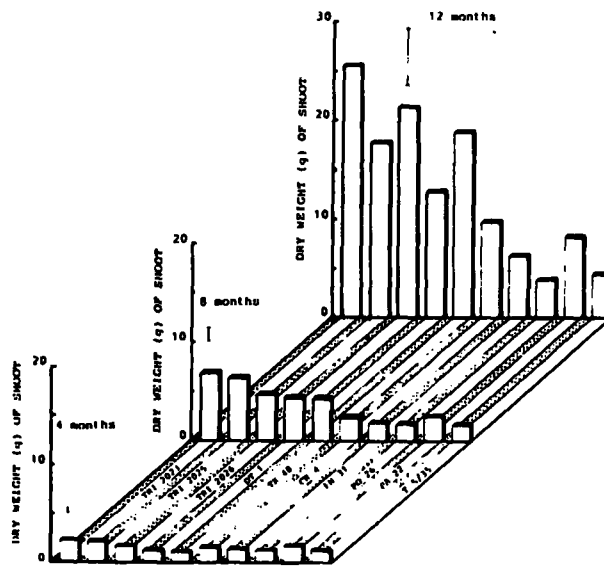

Fig. 5–Dry weight of shoot of nursery plants of high and low yielding clones at 4, 8 and12 months. Vertical bars indicate LSD (P = 0.05). (Each figure is the mean of 30 plants).

TABLE 3 – *Dry weights (g) of leaves, stem and roots per plant and shoot/root ratios of nursery plants at different stages*

Clone	*Leaves*			*Stem*			*Roots*			*shoot/root ratio*		
	4 months	*8 months*	*12 months*	*4 months*	*8 months*	*12 months*	*4 months*	*8 months*	*12 months*	*4 months*	*8 months*	*12 months*
TRI 2023	1.32	4.15	11.48	0.79	2.64	13.95	0.92	2.06	8.80	2.37	3.32	2.92
TRI 2025	1.33	3.74	8.31	0.93	2.52	9.23	0.70	1.27	5.94	3.22	4.95	2.97
TRI 2026	1.04	2.79	9.16	0.59	1.78	12.11	0.51	0.76	5.14	3.40	6.00	4.30
DT 1	0.70	2.28	5.39	0.54	2.00	7.18	0.56	1.02	4.70	2.20	4.20	2.69
TK 48	0.79	2.61	8.23	0.43	1.57	10.52	0.33	0.62	6.33	3.66	6.82	2.96
CR 4	0.93	1.36	4.27	0.57	0.94	5.35	0.51	0.78	3.08	2.93	2.95	3.18
EN 31	0.81	0.92	3.04	0.52	0.78	3.20	0.45	0.58	2.18	2.95	2.87	2.86
PO 26	0.81	0.91	2.23	0.50	0.74	1.70	0.36	0.49	2.11	3.67	3.37	2.53
PA 22	1.00	1.45	3.82	0.63	1.01	4.27	0.64	0.80	2.19	2.57	3.06	3.77
T 5/35	0.93	0.93	2.53	0.39	0.64	1.93	0.48	0.69	1.56	2.78	2.29	2.77
LSD (P=0.05)	0.26	0.74	2.91	0.17	0.70	3.13	0.19	0.30	1.77	0.54	0.95	NS

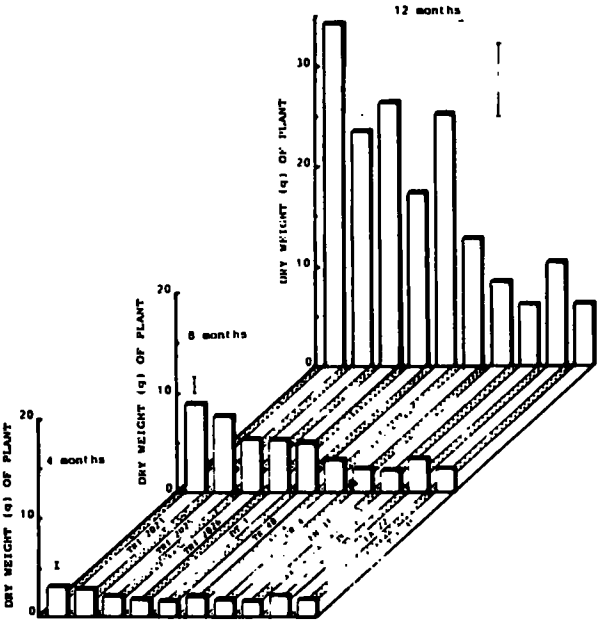

Fig. 6—Dry weight of nursery plants of high and low yielding clones at 4, 8 and 12 months. Vertical bars indicate LSD (P = 0.05). (Each figure is the mean of 30 plants).

In general, the plants of high yielding clones grew better, had a greater leaf area index and higher shoot/root ratios. This was particularly apparent at 8 months after planting of cuttings. The mean correlation coefficient for shoot/root ratio at the 8th month and the yield of the bushes was 0.66 (Table 1). Othieno (1979) obtained strong positive linear relationships between the shoot/root ratios of four and five-year old clonal plants and their cumulative yields. He further noted that those clones which showed higher shoot/root ratios when they were four and five-year-old also showed higher ratios in the one-year-old nursery stage.

In this study several strong positive correlations were established between the various growth attributes of nursery plants at the 8th and 12th month and their observed yields (Table 1). Kulasegaram (1969) also made similar observations in his attempt to correlate nursery plant characters of 15 different clones of differing yield capacities and concluded that nursery plants of 8 1/2 and 12 months age gave a better indication of their subsequent performance in the field than plants at an earlier stage in the nursery.

Those attributes that showed high correlations with yield were fitted into an equation that expressed the relationships most precisely. High predictability values (85%) were obtained for equations that used plant height, girth of stem and dry weight of shoot measured at the 8th month and the respective equations are:

	Predictability value (R^2)
$Y = 61.51 + 52.696\ x_1$ ($t = 6.68^{***}$)	85%
(where x_1 = height of plant in cm)	
$Y = -1587.7 + 2394.7\ x_2$ ($t = 6.84^{***}$)	85%
(where x_2 = girth of stem in cm)	
$Y = 953.54 + 385.59\ x_3$ ($t = 6.70^{***}$)	85%
(where x_3 = dry weight of shoot in g)	

The R^2 value for the expressions using the data at 12 months ranged from 68 to 74% and are therefore not presented here.

These results indicate that selection of promising clones could be done on young plants of about 8 months of age and that the yield potential of prospective high yielders could be estimated at the nursery stage itself by measuring the height and girth of 8-month-old nursery plants as well as by determining the dry weight of their shoots and by substituting these values in the appropriate equations.

It would have been prudent if these findings could have been confirmed for many other tea clones including those in the high, medium and low yielding categories at different agroclimatic regions.

The poor correlations obtained at the 4th month (Table 1) could be due to the fact that there are clonal differences in the rooting pattern and not all clones would have formed the full complement of roots by about the fourth month by which time there would also be differential expression leading to poor growth. However high correlations were seen at the 8th month probably because by this time even the poor rooters would have formed the full complement of roots as the early rooters leading to improved growth. It is to be noted that high correlations were obtained between yields and attributes of nursery plants at the 12th month stage as well. However, overall, it is to be noted that higher correlations were obtained at the 8th month. This could be due to the favorable growth obtained at this stage whereas at the 12th month limitations of space would have led to competition. These results point to the fact that the selection of promising clones could be done on young plants. Harada *et al.* (1961) reported a correlation between the weight of new shoots of young plants and the yield of mature bushes and concluded that those with low shoot weight in the young stage were low yielders indicating that potential high yielders could be identified in the nursery stage.

In order to attach greater reliability on attributes that could be used as selection criteria it is clear from the results of this study that only such attributes as height, girth and dry weight of shoot of 8-month-old nursery plants should be employed for this purpose. Yield predictions of selections could be obtained by measuring these attributes and substituting them in the respective equations.

However, it must be pointed out that even though early selection may seem possible in the nursery stage without laborious clonal evaluation trials, initial selection of seedling bushes using conventional selection methods has to be done.

ACKNOWLEDGEMENTS

We are grateful to Messrs T. Thevadasan and M. Sivendiran for statistical advice and analyses and to Dr A. Kathiravetpillai for his suggestions in the writing of and for critically reading the manuscript. Grateful thanks are due to Mr V. Abeyawardene, Biometrician, for useful suggestions and for interpreting the statistical aspects of this study. The help of Mrs D. Pallemulla and Mr S. W. Gunadasa in the assessments is appreciated.

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