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Growth Characters as Criteria for Selection of New Tea Clones (*Camellia sinensis* (L.) O. Kuntze)

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ABSTRACT: This study was carried out to identify selection criteria for developing high yielding clones in a shorter period since the present methods of selection are time consuming.

Various attributes of the tea plant recovering from pruning as well as in plucking were correlated with their proven yields to identify promising attributes as well as to obtain an estimate of the yield potential of new selections. The results showed that the depth of canopy of bushes in plucking as well as the length of internode of tipping shoots were reliable indicators of high yield potential.

INTRODUCTION

The out-breeding nature of tea causes seed populations to be heterogeneous. Hence the development of improved strains of seed tea is extremely difficult.

Selection of a potential clone is a long and laborious process. Present visual selection depends on the assumption that the vigour manifested in mother bushes will be reflected by their clonal derivatives. However, the work done so far has produced inconsistent results (Green, 1965; 1971).

Current methods of selection involve visual assessment for vigour followed by yield determinations of individual bushes and of their rooting performance and further field evaluation of the progenies before release to the industry involving periods ranging up to 17 years.

The main objective of the present study was to correlate various attributes of the tea plant in its different growing phases with their proven yields obtained from the first two pruning cycles (7 years) in order to identify promising attributes that could be employed as selection criteria for future selection programmes as well as to obtain an estimate of the yield potential of new selections, by substituting those values of attributes that have shown high predictability values, in the appropriate models. It was hoped to develop a rapid means of selection that would overcome some of the drawbacks of the previous methods.

MATERIALS AND METHODS

This study was conducted on mature clonal tea at the Tea Research Institute, St. Coombs, Talawakelle in the up country wet zone (1372 m amsl). Of the ten clones used in this study, five clones – TRI 2023, TRI 2025, TRI 2026, DT 1 and TK 48 which gave a yield of 2500 kg/ha/an and above, in clonal proving trials were considered high-yielding and other five clones – CR 4, EN 31, PO 26, PA 22 and T 5/35 which gave a yield of less than 2500 kg/ha/an were considered low yielders. The bushes were 5 months after pruning when the studies commenced.

The attributes studied on bushes recovering from pruning were length of internode and the leaf angle of the 4th leaf while on bushes in plucking they included the bush width, depth of canopy, leaf area, leaf area index, number of flush per unit area and per 100 g and per cent contribution by components to flush weight.

The means of the various attributes were correlated with the dry weight proven yields of the respective clones. Forward step wise regression procedure was adopted in obtaining linear regression models of yield with the attributes contributing significantly to yields. The coefficient of determination (R^2) obtained for the models 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

Bushes recovering from pruning

All high yielding clones showed longer internodes compared to the low yielding clones but the attribute leaf angle ("leaf pose") failed to discriminate between high and low yielders (Table 1) and showed a very low correlation coefficient (r = 0.32). Since the length of internode gave a high correlation (r = 0.94) it was fitted into a linear model in order to estimate the yield potential. The fitted model is given by:

$$Y = -3091.7 + 1515.5 X_1 \quad (1)$$

$$(t = 7.87^{***})$$

(X_1 = length of internode)

However, the contribution made by the length of internode in explaining the variation in yield was 88% as indicated by the R^2 value.

The shoots arising on pruned frames of a tea bush are referred to as tipping shoots. The length of internodes of tipping shoots of high yielders were in general, longer than those of low yielders (Table 1). These shoots, being fewer, make more use of the root factor (Kulasegaram, 1969) and hence produce longer internodes, which however is a clonal character. The correlation between the length of internode and the proven yield was high (r = 0.94), indicating the significant contribution made by the length of internode to the variation in yield. The predictability value was 88% as obtained from model 1.

Bushes in plucking

In general, the high yielding clones had greater bush width, deeper canopy, higher total leaf area and leaf area index (Table 1). Number of flush per unit area, in general, was more in high yielding clones. The per cent contribution to flush weight by the internodes of clone TRI 2025 was greater than that of all low yielding clones (Table 2). The correlation coefficients of bush width, depth of canopy, leaf area, leaf area index, number of flush per unit area and per cent contribution to flush weight by internodes with the yield were 0.86, 0.88, 0.77, 0.58, 0.68 and 0.61 respectively.

Since the bush width between rows and the depth of canopy showed a high correlation to proven yield they were fitted into linear models in order to predict the yield.

Table 1. Attributes measured on tipping shoots and on mature bushes in plucking.

Clone	Attributes of tipping shoots		Attributes of bushes in plucking			
	Mean internode length (cm)	Leaf angle (degrees) 4th leaf	Bush width between rows (cm)	Depth of canopy (cm)	Total leaf area (m^2)	Leaf area index
TRI 2023	4.50	141.80	99.26	18.29	3.56	5.85
TRI 2025	4.07	77.50	101.68	19.23	4.33	7.02
TRI 2026	3.68	87.60	99.24	14.81	4.04	6.18
DT 1	3.82	63.00	111.84	18.80	3.33	5.19
TK 48	3.93	71.90	97.21	15.42	2.20	3.79
CR 4	3.01	63.40	80.34	12.37	1.98	4.45
EN 31	2.99	62.20	78.49	11.25	1.87	4.19
PO 26	3.25	104.70	93.98	11.94	3.04	5.54
PA 22	3.35	84.60	89.74	11.61	2.18	4.29
T 5/35	3.19	92.10	82.78	10.92	2.23	4.62
LSD (P=0.05)	0.35	7.60	10.34	2.49	1.14	1.75

Table 2. Flush characters and proven yields of mature bushes in plucking.

Clone	Number of flush per 100 g	Number of flush per unit area	Per cent contribution by components to flush weight *			Proven yield (Kg/ha/an)
			Buds	Leaves	Internodes	
TRI 2023	134.67	22.87	6.73	61.85	27.78	3218.03
TRI 2025	135.00	25.90	4.95	60.20	32.67	3344.38
TRI 2026	149.00	21.33	4.62	68.30	23.72	2857.95
DT 1	191.67	28.80	5.28	64.16	28.01	2806.19
TK 48	199.67	27.90	5.09	67.70	24.47	2981.53
CR 4	231.33	13.37	5.11	71.87	20.19	1454.70
EN 31	194.00	21.00	6.79	64.87	26.05	1119.54
PO 26	152.67	23.67	5.96	64.22	26.44	1855.43
PA 22	169.00	19.67	6.17	68.90	22.51	2154.06
T 5/35	176.67	11.90	4.89	74.38	15.57	1532.34
LSD(P=0.05)	18.73	6.17	0.90	3.51	2.79	537.63

* The total doesn't add to 100 due to loss of moisture during separation of components.

The models are:

$$Y = -3794 + 65.556 X_2 \quad (t = 4.77^{**}) \tag{2}$$

(X_2 = bush width between rows)

$$Y = -788.59 + 215.8 X_3 \quad (t = 5.39^{***}) \tag{3}$$

(X_3 = depth of canopy)

The R values for the models with bush width and depth of canopy were 74% and 78% respectively.

It was found that when the length of internode of tipping shoots and the bush width between rows of bushes in plucking were combined. They could explain 93% of the total variation in yield. The model representing both these attributes is as follows:

$$Y = -3986.2 + 1102.4 X_1 + 25.393 X_2 \quad (t = 4.39^{**}) \; (t = 2.14) \tag{4}$$

(X_1 = length of internode)

(X_2 = bush width between rows)

The canopy structure is influenced by the type of plucking that is practiced. In Sri Lanka, the method of plucking adopted (single leaf plucking), permits the retention of a leaf on the bush at each harvest resulting in the build-up of the depth of canopy. These maintenance leaves play a vital role in the continuous generation of new shoots by manufacturing carbohydrates and supplying them to the tissues which import photosynthates or the sinks.

The characters of the canopy that influence yield are bush width, depth of canopy, total leaf area, leaf area index, size and density of flush, *etc*.

The differences in bush width between high and low yielders were marked (Table 1) and this attribute showed a good correlation with yield (r = 0.86).

The present study showed that the high yielding clones had deeper canopy than the low yielders (Table 1) and had strong positive association (r = 0.88) with yield. Work in Kenya also showed that high yielding clones had deeper canopy (Anonymous, 1986). The F ratio was significant when the proven yield was regressed on depth of canopy indicating the significant contribution made by depth of canopy towards yield. The high correlation obtained led to a predictability value of 78% as obtained from model 3.

The leaf area but not the leaf area index showed a high correlation to proven yield (r = 0.77).

The harvested flush of low yielders showed more shoots per 100 g with greater leaf weight (Table 2). Thus the superior yields of the high yielders is due to the contribution made by the internodes and hence it is important to select bushes whose flush have longer internodes.

In general, the high yielding clones had a greater shoot density (Table 2) and showed a positive association with proven yield (r =0.68). Pool (1982) found that of the components of yield, shoot density was most strongly associated with yield (dry weight) which corroborated his previous work (1981) that shoot density was the major factor influencing yields. These observations indicated that high yielding genotypes will comprise bushes combining large numbers of shoots per unit area with high rates of shoot extension.

At the Tea Research Institute, Talawakelle conventional selection of high yielding tea generally takes about 8 – 10 years prior to a further period of experimental evaluation of about 10 years before a clone could be recommended to the industry. A purposeful programme of selection necessarily aims at choosing clones with a yield which is high and which varies as little as possible.

The results of this study shows that the length of internode of tipping shoots, depth of canopy and bush width between rows of bushes in plucking could be considered as simple and reliable criteria for selection of high yielding mother bushes. While the actual measurements of these attributes are necessary to provide a sound scientific basis for discriminating a potential high yielding bush from those of low yielding ones such discrimination may usually be obtained in practice by visual assessment of most of the important mature bush attributes as has been established in this study. This provides a rapid and easy way to select bushes as the practical selectionist has to only bear these proven characters in mind while commencing selection work in a tea field. Using this method we could recommend clones in about a third of the time presently needed. Another advantage is that no space is needed for clonal proving trials and hence does away with after care measures and to this extent cuts down on expenses.

The steps involved in the selection employing the results of this study are – visual selection of mature bushes using the attributes identified, evaluation of the nursery vigour and rooting percentage of the selections and evaluation of drought tolerance, pests and disease resistance, quality *etc.* in glass house or by tissue culture techniques once this technology is perfected. The whole exercise would thus take about 5 years before clones could be made available to the industry for large scale multiplication.

When a bush is selected it has to be pruned and allowed to grow to obtain cuttings for a rooting test. During this period the length of internode could be measured (or observed) and the bushes with relatively longer internodes could be selected.

Once a bush has been identified as a potential high yielder an estimate of the potential yield (kg/ha/an) could be obtained by measuring simple attributes which have been identified in this study as selection criteria and by substituting these values in the relevant models worked out in this study.

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