THE INFLUENCE OF NODE POSITION ON THE DEVELOPMENT OF TEA CUTTINGS

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The development of roots and shoots of cuttings from nodes 3 to 12 inclusive have been compared in three clones differing in growth and yield at 6, 14 and 24 weeks from planting, using uniform vigorous shoots taken from pruned mother bushes.

The effect of node position of cutting on shoot development was significant in the early stages of growth, but did not conform to any definite pattern, and the differences disappeared as the plants grew older. Root development was unaffected by node position. Comparing the development of cuttings from nodes 5 to 8, which are considered suitable according to currently established practice, with 9–12 at 14 and 24 weeks showed that plants obtained from the older nodes compared favourably indicating their suitability. The number of acceptable cuttings can thus be increased twofold resulting in greater economy of cutting material and lower cost of production.

The three clones behaved similarly in respect of node position of cuttings and their development. The vigorous and high yielding clone TRI 2025 established early and showed marked increase in growth of roots and shoots compared with the slower growing clones DT 1 and TRI 777.

Tea is now propagated on a large scale almost exclusively by "single-node" cuttings (consisting of a leaf with the included axillary bud at the node and the internode below it) obtained from aperiodic shoots (Bond 1945) which are produced immediately following pruning. Propagation by seed is resorted to only in special cases. In practice about four to five cuttings are taken from a single aperiodic shoot. The regions from which these cuttings are taken have been designated the green-wood and red-wood regions of the shoot. The apical tender region and the more mature reddish-brown region are usually discarded as being unsuitable (Visser & Kehl 1958; Green 1964; Richards 1967). It was generally believed that the green region of the shoot gave the most suitable cuttings followed by the red region, but for reasons of economy cuttings from both regions are generally included. Secondary and in some cases tertiary aperiodic shoots which develop after removal of the primary shoots for propagation are also used when cutting material is in short supply. In some instances shoots are collected for propagation from bushes which have not been grown specifically for this purpose, such as from mature bushes in plucking following a light prune or skiff, or even from young plants in new clearings. Further, in each of the above mentioned cases the central shoots of the plant show greater vegetative vigour than the peripheral shoots. Therefore, the source of the cuttings and the vegetative vigour of the shoots taken are generally very variable. This may be one of the causes for the variable results and non-uniformity of the plants obtained in nursery beds.

Following pruning of a mature bush, the shoots produced are very vigorous and about 20 to 30 leaves are produced on the central leader shoots before the terminal bud goes dormant. Bushes which have been given a lighter prune or a skiff produce fewer leaves on comparable shoots before the terminal bud goes dormant. Plucking (which can be considered as a light prune) results in shoots which have about two to four leaves before the terminal bud goes dormant. One of the reasons for pruning a bush is to keep the plant in the vegetative phase for an extended period and prevent it from entering the reproductive phase when floral buds instead of vegetative buds tend to develop. Frequent cycles of dormancy generally indicate diminishing vegetative vigour so that in bushes of the same age, vegetative shoots differing in vigour, depending on the type of treatment given, may be obtained. In younger plants decapitation results in vegetative shoots of comparatively low vigour because of the smaller size of the root system. Shoots produced in mature bushes in plucking are less vigorous in spite of a bigger root system because of the numerous buds that have to be supported resulting in competition for the *"root-stimulus" (Kulasegaram 1969a). It will, therefore, be clear that the most vigorous shoots can be obtained only after a proper prune of fairly mature bushes (Green 1964; Richards 1967). The secondary and tertiary shoots following collection of the primaries are comparatively less vigorous. With diminishing vegetative vigour such as is found in free-growing plants and plants growing under unfavourable climatic and nutritional conditions or even in plants affected by pests and diseases, there is a greater tendency towards development of floral buds resulting in unsuitable shoots for propagation (Visser 1959; 1962).

Information in respect of the mother bush as the source of cutting material is limited. This includes types of shoots, number of suitable cuttings that can be taken from the different types of shoots, the length of time the shoots can be allowed to remain on the plant following pruning for suitable shoots to be obtained without loss of vegetative vigour and the associated reproductive phase setting in (Visser and Kehl 1958; Visser 1959; 1962), nutrition of the mother bush, *etc.*

Recently Goodchild (1969) compared the growth of roots and shoots of tea cuttings taken from nodes 3 to 9 (counting from the apex) of leader shoots. He showed that the number of cuttings with roots and the weight of roots were generally unaffected by node origin but shoot growth was more advanced in cuttings from older nodes. The object of this work was to study the influence of node position on the development of cuttings with a view to minimizing at least some of the variations in the growth of cuttings observed in nurseries. This study also served to determine the number of potentially viable cuttings that can be taken from vigorous vegetative shoots.

MATERIALS AND METHODS

Comparable leader shoots were collected from mature mother bushes of clones TRI 777, DT 1 and TRI 2025, six months following pruning. Cuttings were taken from nodes 3 to 12 (counting from the apex), giving a total of 10 cuttings per shoot. Although more nodes could have been included in the faster growing clone TRI 2025, the number was restricted to 12 for want of uniformity between clones. The cuttings were planted in polythene sleeves containing suitable soil, one cutting being inserted per sleeve. The 10 treatments (nodes 3 to 12) were arranged in a randomized, block design and replicated four times. Each replicate had 30 cuttings per treatment, and at each assessment 10 cuttings were selected at random per treatment. The same design and methods of assessment were used for the three clones.

Three assessments were made at six, 14 and 24 weeks from planting. The number of cuttings dead, callused or rooted, the number with top growth and the weights of tops and roots were recorded separately. The analyses of some of the results were carried out on transformed data.

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*"Root-stimulus" is used in the sense to cover water and nutrient supply, both inorganic and organic, as well as root-synthesised growth factors.

RESULTS

The results of the first assessment done six weeks after planting, when callusing and sometimes rooting are known to occur in most clones, are summarized in Tables 1 and 2. Node position significantly affected the number of cuttings callused/dead at six weeks. A large number of cuttings were dead from node 3 which is to be expected under normal nursery conditions. The variation in the number of cuttings callused/dead from nodes 4 to 12 was irregular. It is to be expected that where a greater number of cuttings have callused and rooted there will be correspondingly fewer cuttings dead. Node position did not affect the number of cuttings with roots. This may be due to the fact that only a few cuttings had roots at six weeks and this was largely seen in the quick-rooting clone TRI 2025. Node position significantly affected the number of cuttings with top growth and also their fresh weight. Again the effect of node position was irregular.

The means of the variates from nodes 5 to 8 inclusive are given alongside in the Tables for comparison, as they normally comprise the acceptable range in a shoot.

Clonal differences in respect of the above variates which are all very highly significant ($P < 0.001$) are given in Table 2. It will be noted that the vigorous clone TRI 2025 had shown a greater number of cuttings callusing and rooting with correspondingly fewer dead cuttings. This clone also had more cuttings with top growth, the fresh weights of which were significantly greater than those of TRI 777 and DT 1.

The second assessment was carried out 14 weeks after the cuttings were planted by which time majority of cuttings of most clones would have rooted. Node position significantly affected the number of cuttings surviving, *ie* number of cuttings callused + rooted and correspondingly the number dead and the number with top growth. Except for node position 3, the variation again appeared to be irregular. The mean dry weight per plant and that of the tops were significantly affected by node position but that of the roots were unaffected. Again except for node position 3, the differences in the variates appeared to be at random and there was no indication that cuttings from nodes 9 to 12 were inferior to those from nodes 5 to 8 in development (Table 3).

Clonal differences as expected were highly significant showing that the dry weight increment per plant (roots + tops) of clone TRI 2025 was significantly greater in comparison to DT 1 and TRI 777, the slower growing clones. Differences in the other variates also indicated the overall superiority of TRI 2025 as a vigorous clone compared with DT 1 and TRI 777 (Table 4).

The third assessment was done 24 weeks after planting when the cuttings were fully established and growing vigorously. In terms of the more important growth attributes of increase in height and dry matter accumulation, the effect of node position did not appear to have much importance as the mean dry weight of the whole plant (roots + tops) and mean height were not affected by node position. It appeared that earlier differences became non-existent with time. The only significant difference in dry weight observed was in respect of top growth, but it is doubtful whether much importance can be attached to this in view of the fact that both the root weight and total plant weight were unaffected. The performance of cuttings from nodes 9 to 12 compared favourably with those from nodes 5 to 8 (Table 5).

Clonal differences in respect of the variates listed in Table 6 were all highly significant ($P < 0.001$) as in earlier assessments. Differences in height and increases in dry weight components of the plant clearly indicated that the increased vigour of the high yielding clone TRI 2025 is evident at the nursery stage (Kulasegaram 1969b).

TABLE 1 — *Effect of node position on the development of tea cuttings*

1st assessment done after 6 weeks from planting

(Analyses of numbers of the variates done on $y = \sqrt{n+1}$ transformed values)

	Node position										LSD ($P < 0.05$)	Mean of nodes 5–8
	3	4	5	6	7	8	9	10	11	12		
No. of cuttings dead	2.13	1.13	1.47	1.10	1.17	1.28	1.31	1.33	1.31	1.36	0.24	1.26
No. of cuttings not callused	1.54	1.51	1.59	1.42	1.35	1.46	1.43	1.34	1.26	1.36	NS	1.46
No. of cuttings callused only	2.30	2.95	2.71	3.04	3.07	2.95	2.95	2.98	3.01	2.94	0.27	2.94
No. of cuttings rooted	1.00	1.00	1.00	1.07	1.03	1.03	1.00	1.03	1.07	1.00	NS	1.03
No. of cuttings with top growth	2.51	3.25	2.99	3.23	3.16	3.17	3.03	3.08	3.06	3.08	0.17	3.14
Mean fresh weight (g) of tops	0.04	0.05	0.09	0.15	0.18	0.14	0.19	0.13	0.17	0.10	0.04	0.14

TABLE 2 — *Clonal differences in the development of tea cuttings*

1st assessment done after 6 weeks from planting

(Analyses of numbers of the variates done on $y = \sqrt{n+1}$ transformed values)

	Clones			
	TRI 777	DT 1	TRI 2025	LSD ($P < 0.05$)
No. of cuttings dead	1.56	1.31	1.21	0.14
No. of cuttings not callused	1.89	1.37	1.02	0.16
No. of cuttings callused only	2.49	3.01	3.17	0.15
No. of cuttings rooted	1.01	1.00	1.06	0.04
No. of cuttings with top growth	2.91	3.11	3.15	0.09
Mean fresh weight (g) of tops	0.08	0.11	0.18	0.02

TABLE 3 — *Effect of node position on the development of tea cuttings*

2nd assessment done after 14 weeks from planting

(Analyses of numbers of the variates done on $y = \sqrt{n+1}$ transformed values)

	Node position 3	4	5	6	7	8	9	10	11	12	LSD ($P < 0.05$)	Mean of nodes 5–8
No. of cuttings dead	2.40	1.62	1.83	1.53	1.40	1.68	1.56	1.66	1.64	1.61	0.28	1.61
No. of cuttings surviving, *ie* callused + rooted	2.48	3.02	2.84	3.08	3.15	2.97	2.97	2.99	2.99	3.03	0.19	3.01
No. of cuttings with top growth	1.90	2.54	2.24	2.48	2.64	2.28	2.40	2.29	2.46	2.27	0.31	2.41
Mean dry weight (g) (*a*) Plant	0.06	0.13	0.17	0.17	0.16	0.17	0.17	0.14	0.11	0.12	0.05	0.17
(*b*) Tops	0.03	0.07	0.09	0.11	0.10	0.10	0.10	0.08	0.06	0.06	0.03	0.10
(*c*) Roots	0.03	0.06	0.08	0.06	0.06	0.07	0.07	0.06	0.05	0.06	NS	0.07

TABLE 4 — *Clonal differences in the development of tea cuttings*

2nd assessment done after 14 weeks from planting

(Analyses of numbers of the variates done on $y = \sqrt{n + 1}$ transformed values)

	Clones			
	TRI 777	DT 1	TRI 2025	LSD ($P < 0.05$)
No. of cuttings dead	2.04	1.76	1.28	0.15
No. of cuttings surviving, *ie* callused + rooted	2.73	2.94	3.18	0.11
No. of cuttings with top growth	1.61	2.61	2.83	0.17
Mean dry weight (g) (*a*) Plant	0.03	0.09	0.26	0.03
(*b*) Tops	0.02	0.05	0.14	0.01
(*c*) Roots	0.01	0.04	0.12	0.02

TABLE 5 — *Effect of node position on the development of tea cuttings*

3rd assessment done after 24 weeks from planting

(Analyses of numbers of the variates done on $y = \sqrt{n+1}$ transformed values)

	Node position										LSD	Mean of nodes
	3	4	5	6	7	8	9	10	11	12	($P < 0.05$)	5–8
No. of plants surviving (rooted)	2.29	2.58	2.62	2.69	2.72	2.74	2.79	2.82	2.84	2.85	0.28	2.69
No. of plants with top growth	2.16	2.59	2.56	2.67	2.64	2.61	2.50	2.33	2.69	2.53	0.27	2.62
No. of leaves retained	1.96	2.13	2.24	2.23	2.26	2.17	2.36	2.02	2.24	2.28	0.22	2.23
Mean height (cm)	6.99	7.29	8.73	9.14	10.33	8.19	9.16	6.22	7.59	9.09	NS	9.10
Mean dry weight (g) (*a*) Plant	0.50	0.55	0.65	0.70	0.69	0.61	0.66	0.50	0.54	0.53	NS	0.66
(*b*) Tops	0.21	0.23	0.32	0.34	0.34	0.29	0.36	0.23	0.27	0.29	0.10	0.32
(*c*) Roots	0.29	0.32	0.33	0.36	0.35	0.32	0.30	0.27	0.27	0.24	NS	0.34

TABLE 6 — *Clonal differences in the developments of tea cuttings*

3rd assessment done after 24 weeks from planting

(Analyses of numbers of the variates done on $y = \sqrt{n+1}$ transformed values)

			Clones		
		TRI 777	DT 1	TRI 2025	LSD ($P < 0.05$)
No. of plants surviving (rooted)		2.21	2.77	3.11	0.15
No. of plants with top growth		1.90	2.74	2.95	0.15
No. of leaves retained		1.69	2.55	2.33	0.39
Mean height (cm)		6.55	6.69	11.58	2.34
Mean dry weight (g)	(*a*) Plant	0.21	0.50	1.06	0.10
	(*b*) Tops	0.08	0.23	0.55	0.05
	(*c*) Roots	0.13	0.27	0.51	0.05

DISCUSSION

It has been suggested that for satisfactory results cuttings should normally be taken from vigorous leader shoots which develop immediately after pruning of mother bushes (Visser and Kehl 1958; Green 1964; Richards 1967). Cuttings taken from shoots older than 12 months have shown a marked tendency to develop flower buds. Further such cuttings are considered to root poorly and do not develop into good plants. There seems to be no clear indication of whether green-wood or red-wood cuttings are more suitable. Although the former was generally preferred, under certain conditions red-wood cuttings appeared to root better (Visser 1962). This is because maturity as indicated by colour and succulence is largely subject to climatic influences. The node position and hence node age would appear to be a more reliable guide, provided the shoots are of comparable vigour. There is evidence from this study that the node position has a significant effect upon shoot growth of cuttings taken from vigorous shoots. Differences in the number of cuttings with top growth and in their corresponding weights were evident six weeks after planting and continued to exist at 14 and 24 weeks from planting. However, these differences did not show any definite pattern in regard to node position, except for node 3 which showed significantly less shoot growth than the other nodes. It is interesting to note that the development of cuttings from nodes 9 to 12 compared favourably with those of nodes 5 to 8. There was no evidence that growth was more advanced in the older nodes as was observed by Goodchild (1969).

The number of cuttings with roots was unaffected by node origin at six weeks from planting but significant differences were seen in the number surviving (*ie* callused and rooted) at 14 and 24 weeks from planting. There were no significant differences in the dry weight of the roots at 14 and 24 weeks in relation to node position and the early differences noted in the dry weight of the plants at 14 weeks were not significant at 24 weeks from planting. The height of the plants at 24 weeks was also not affected by node position. The number of leaves retained by the plants was significantly affected by node position at 24 weeks, but there was no clear indication that more leaves were retained by plants from the older nodes.

Comparing the performances of the three clones, it was evident that the more vigorous and high yielding clone TRI 2025 had a better start in respect of the number of cuttings callusing and rooting and the number with top growth. These differences which were all very highly significant ($P<0.001$), were maintained throughout the 24 weeks during which observations were carried out (Tables 2, 4 and 6). Similar differences in height and dry weight components of the plants were also recorded. There was no indication that the development of cuttings from different nodes varied with the clones.

It appears that some of the variation in shoot growth observed in plants in the early stages of growth in clonal nurseries may be due to differences associated with node position of the cuttings (hence their age) in the shoots, prior to their severance from the mother bush. This study has shown that these differences disappear as the plants grow older, when the effect of node position becomes less important. Variations in growth seen after six months of planting of cuttings are probably due to differences in the vigour of the shoots from which cuttings are taken and perhaps to other nursery practices. It is thus likely that some of the variations can be minimized by the selection of uniform vigorous shoots for propagation. This study indicates that for practical purposes cuttings from node 3 may have to be excluded, but cuttings could be taken from nodes 4 to 12. This would furnish twice the number of cuttings that are now taken from mother shoots.

CONCLUSIONS

1. Shoot growth of cuttings in the early stages of growth appeared to be affected by node position in the mother shoot. The variation in shoot growth due to different node positions did not conform to any pattern and disappeared as the plants grew older since no differences were observed in respect of plant weight and height at 24 weeks from planting. Root development was unaffected by node position of cutting.

2. Cuttings from nodes 4 to 12 appeared to be suitable for practical purposes. The plants produced from the older nodes 9 to 12 compared favourably with those obtained from nodes 5 to 8. Cuttings from nodes 5 to 8 are accepted as suitable in current practice. Thus the inclusion of cuttings from nodes 4 to 12 would furnish double the number of cuttings resulting in economy of cutting material and lower cost of production.

3. Three clones with widely different growth characteristics behaved in a similar manner in regard to development of cuttings from nodes 3 to 12. The vigorous and high yielding clone TRI 2025 showed an early and better start and root and shoot development was markedly superior to DT 1 and TRI 777.

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