

STUDIES ON THE METHODS OF BRINGING CLONAL TEA INTO BEARING IN THE HIGH COUNTRY OF SRI LANKA

2—FURTHER OBSERVATIONS ON THE EFFECTS OF CUTTING AND BENDING ON BRANCHING AND THE GROWTH OF YOUNG PLANTS

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Experiments were carried out at St Coombs (1400 m amsl) to compare the effects of methods of bringing young tea plants into bearing by bending and cutting with free-growing plants on growth and branching. Free-growing plants produced the maximum growth in terms of total dry matter. Bending reduced growth slightly compared with free-growing plants, but cutting at 10 cm and 20 cm resulted in a greater reduction in growth, because of the removal of green shoots and leaves. Cutting plants at 10 cm after three months resulted in a large number of deaths compared with plants allowed to grow freely, plants which were bent, and plants which were cut at 20 cm. Bending of branches resulted in a better spread of plants than by cutting or by allowing the plants to grow freely. The best combination of growth and low branching was obtained with bending.

The effect of three methods of bending the main shoot (shoot orientation) on growth of lateral shoots and the growth of the plants were also studied. The main shoot was bent (a) 30° above horizontal, (b) horizontally, and (c) 30° below horizontal. The growth of lateral shoots in the proximal region of the stem were unaffected by the method of shoot orientation, but that of the distal region showed differences. The number of lateral shoots and the mean total lateral growth of the distal region of the stem was highest in the plants bents 30° above horizontal followed by bending horizontally and 30° below horizontal. The extension growth of the terminal bud also showed similar trends. The leaf, stem and total dry weight of plants were greater in the plants that were bent 30° above the horizontal than in plants that were bent 30° below the horizontal.

Although young plants, when allowed to grow freely, produce maximum growth, it is suggested that by bending plants better spread and branching may be obtained and this method would also cause less reduction in growth compared with cutting. By bending branches to a position slightly above the horizontal, even growth of laterals may be obtained with disturbances to the plants being minimized.

Clonal tea plants are normally planted out in the field when they are 9 to 12 months old in the nursery and they are brought into plucking in 18 to 24 months after planting. During this period various treatments are given to the plants to form a bush of low-spreading habit. The main methods used in bush formation are:

- 1—bending or pegging down of main branches to promote lateral growth followed by subsequent pruning
- 2—various techniques of pruning young plants to promote lateral branching.

In terms of early growth, bending has been found to be superior to different methods of cutting (Manipura 1971).

The formation of the permanent frame of the bush is largely influenced by the initial methods of pruning or bending in young plants. One or two low cuts in the early stages of growth may promote the development of low-spreading branches while delayed pruning at higher levels may result in a poor spreading frame. All pruning treatments involve the removal of green shoots and leaves and cutting, therefore, would retard growth to varying degrees depending on the severity of the cuts and the interval between such cuts. Bending or pegging down the branches would cause the least disturbance to the plant, while it allows the formation of a low-spreading frame without unduly retarding the growth of young plants (Brandram-Jones, Currie, Maxwell and O'Shea 1965).

By pegging down the upright branches the axillary buds on them are stimulated to develop into vertical branches. Many variations in the bending of branches may be seen in field practice. Branches are sometimes bent to slope downwards where in extreme cases the terminal bud of the shoots may touch the ground. It has been suggested that pegged branches should slope upwards at about 20° to the horizontal to obtain best results (Green 1970). No experiments have been reported however, on the effects of different methods of bending on growth and branching in young plants.

Detailed investigations on the growth response of young plants to methods of cutting and bending are required to determine suitable techniques to bring young tea plants into bearing. Much of the earlier work has attempted to determine the total growth and yield in subsequent years (Brandram-Jones *et al.* 1965; Visser 1969; Green 1970). The experiments reported in this paper were aimed at obtaining information on the effects of cutting and bending on shoot growth, branching and growth of young plants. In the present investigation, the effects of different methods of bending on the growth of young plants were also studied.

EXPERIMENTAL

Experiment 1

This experiment was designed to compare different methods of cutting and bending on growth and branching in two clones TRI 2025 and DT 1.

The treatments were:

- T₁—*Control*—The plants were allowed to grow freely without any pegging or cutting.
- T₂—*Cut at 10 cm*—The plants were cut 10 cm from ground level three months after planting.
- T₃—*Cut at 20 cm and 30 cm*—The plants were cut at 20 cm, three months after planting and 30 cm, eight months after planting.
- T₄—*Bending branches horizontally*—The branches were bent to a horizontal position at three months and again at eight months from planting.
- T₅—*Bending branches below horizontal*—The branches were bent to a position about 45° below the horizontal at three and eight months from planting.

The ten treatment combinations were replicated three times and there were 15 plants per plot. The plants were about 12 months old in the nursery at the time of planting and the mean heights of plants were 32.2 (\pm 1.44) cm in clone TRI 2025

and 24.4 (± 1.13) cm in clone DT 1. As the experiment was a short-term one to evaluate effects on early growth, plants were spaced 60 cm apart. Fertilizer was applied as a mixture as recommended by Tolhurst (1961). The experiment was laid out in November 1970. Monthly assessments of the number of leaves, and the number of shoots (greater than 1 cm) per plant were made from March through July 1971. As the plants grew bigger counting was difficult and no further assessments of leaf and shoot number were made after July. At the end of one year from planting the number of branches below a height of 30, 20 and 10 cm, and the spread of branches within each row and between rows at 30 cm above the ground were determined. Thereafter the plants were uprooted and the dry weights of leaf, stem and root were determined.

Experiment 2

Three methods of bending the main stem on the growth of lateral shoots, and the growth of leaves, stems and roots were studied.

The three methods of bending were: --

- 1—Bending the main stem at the midpoint keeping the distal portion of the stem in a horizontal position.
- 2—Bending the main stem at the midpoint keeping the distal portion of the stem in a position 30° above the horizontal.
- 3—Bending the main stem at the midpoint keeping the distal portion of the stem in a position 30° below the horizontal.

One-year-old plants of Clone N 2 of uniform height (about 30 cm) were planted out in the field spaced 60 cm apart in September 1971. There were ten plants per treatment. One week after planting the plants were bent as described above by tying the stems onto thick galvanized iron wire which was bent to the required angles. Monthly assessments were made from February 1972 till May 1972 of the number of shoots greater than 1 cm on the proximal (from base of the plant to the midpoint) and the distal (from the midpoint to the position of the terminal bud at planting) regions of the stem, the length of shoots in the proximal and distal regions, and the extension growth of the terminal bud. After the final assessment in May *ie* nine months after planting, the plants were uprooted and the dry weights of leaf, stem and roots were determined separately for each plot. The data from both experiments were analysed statistically by the analysis of variance method.

RESULTS

Experiment 1

The effects of the methods of cutting and bending on the number of leaves and the number of shoots per plant are shown in Figs 1 & 2 respectively. As there were no marked interactions between the methods of bringing into bearing and clones, the results are presented as means of two clones throughout. In determining shoot number, all the axillary branches and shoots greater than 1 cm in length were counted. The number of leaves refer to all fully-opened leaves.

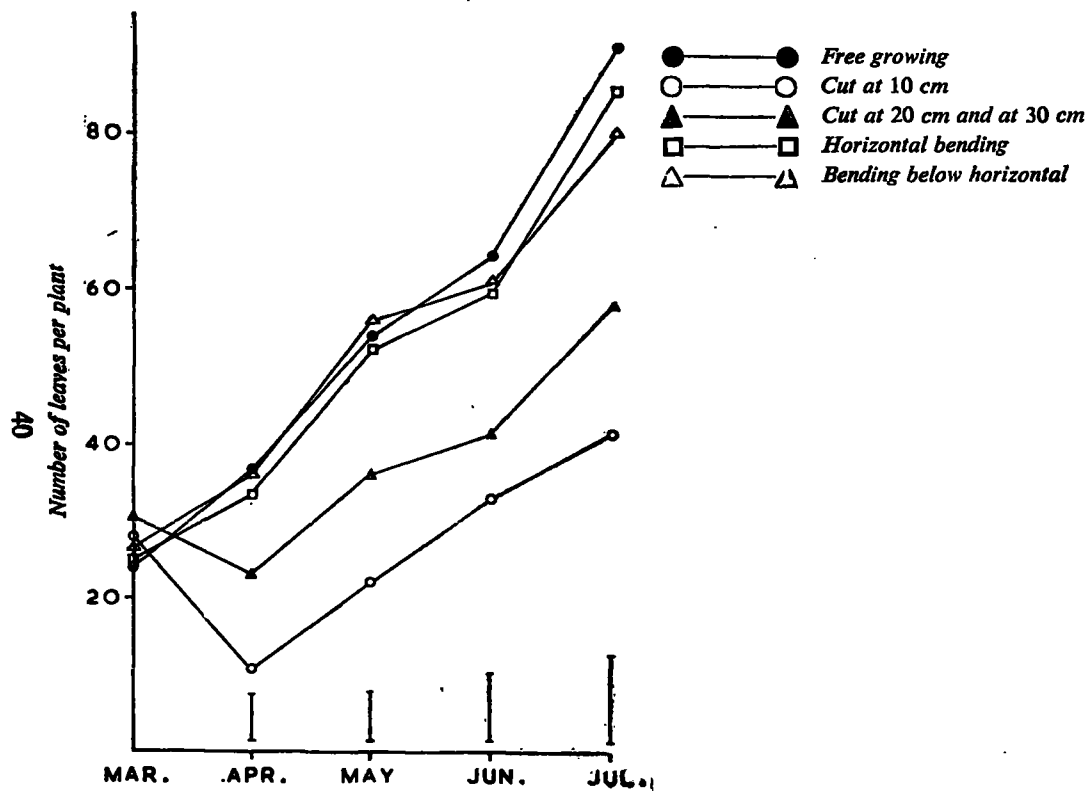


FIG. 1—Effect of cutting and bending on the number of leaves per plant
Vertical lines indicate LSD at $P=0.05$

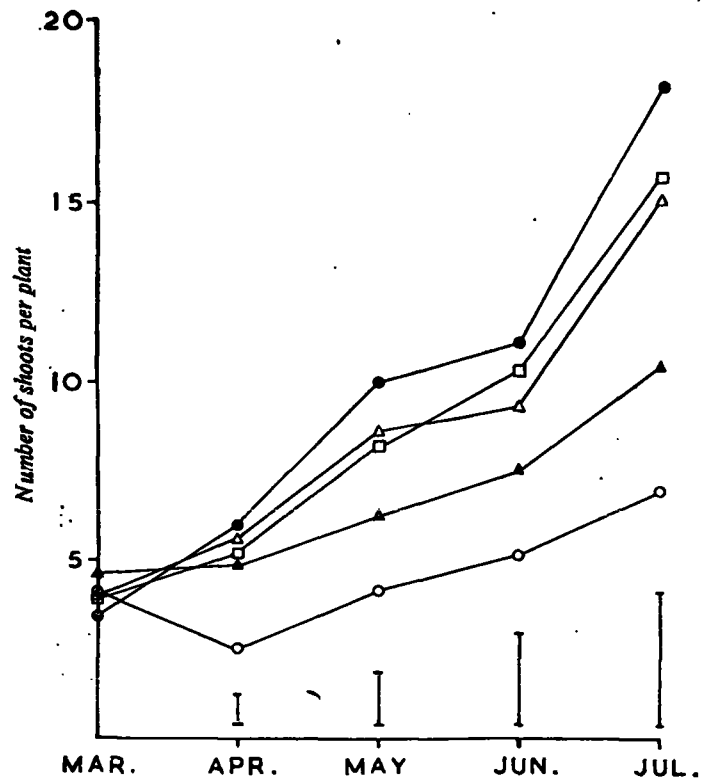


FIG. 2—Effect of cutting and bending on the number of shoots per plant—Vertical lines indicate LSD at $P<0.05$

The data presented in Fig 1 shows that cutting plants at 10 cm and 20 cm reduced the leaf number per plant compared with free growing plants and those that were bent. Cutting plants at 10 cm resulted in a greater reduction in the leaf number than due to cutting at 20 cm. These differences were evident throughout the period of assessment. Similar trends were also shown in the number of shoots per plant Fig 2. The two methods of bending did not significantly reduce the number of leaves or sheets per plant compared with these of the free-growing plants during the early stages of growth.

The mean spread of branches between rows and in the row, and the number of shoots below 10, 20 and 30 cm at 12 months from planting are shown in Table 1.

The spread of branches 30 cm above ground level between rows and in the row were greater with the two methods of bending than with the two methods of cutting or in free growing plants. The spread of branches with horizontal bending was slightly greater than with bending below the horizontal. Cutting at 10 cm resulted in a lower spread than cutting at 20 cm.

The number of shoots below 10 cm was greater in the plants that were cut at 10 cm than in the other treatments, while the number of shoots below 20 cm were greater with the two methods of bending compared with all the other treatments. The shoot number below 30 cm was greatest with horizontal-bending followed by bending below the horizontal and cutting at 20 cm. Plants cut at 10 cm and free-growing plants gave the lowest number of shoots.

The dry weights of leaves, stems and roots, the total dry weights of plants and the percentage vacancies for different treatments are presented in Table 2.

Cutting plants 10 cm above the ground resulted in a large number of deaths (74.5%) compared with all other methods where deaths were less than 5%. The dry weights of leaves and stems per plant were significantly greater in the free-growing plants or plants that were bent, than in plants treated with the two methods of cutting. The dry weight of roots was highest in the free-growing plants followed by that in the bent plants and finally in the plants which were cut. The total dry weight of plants also showed similar trends.

Experiment 2

Table 3 shows the mean extension growth of the terminal shoot from February to May 1972. The greatest extension growth was in plants trained 30° above the horizontal followed by plants trained horizontally. The plants trained 30° below the horizontal produced the least extension growth. It was observed that in plants trained in various positions there was a tendency for the terminal shoot to revert to a vertical position. Apart from the initial training treatments, no attempts were made to keep the shoot in that position subsequently.

TABLE 1 — *Effect of cutting and bending on the spread of branches and the number of shoots*

<i>Treatments</i>	Spread between rows (cm)	Spread in the row (cm)	No branches below 10 cm	No branches below 20 cm	No branches below 30 cm
Free growing	14.3	13.7	2.75	7.80	14.93
Cut only at 10 cm	12.9	11.4	5.11	9.33	15.85
Cut at 20 cm & at 30 cm	16.1	15.1	2.71	10.03	21.15
Horizontal bending	27.4	19.7	3.25	15.05	32.31
Bending below horizontal	20.7	17.7	3.18	13.80	26.60
LSD ($P = 0.05$)	2.7	2.5	0.69	2.71	3.46

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TABLE 2 — *Effect of cutting and bending on dry weight components of plants and percentage vacancies*

<i>Treatments</i>	Leaf dry wt/ plant (g)	Stem dry wt/ plant (g)	Root dry wt/ plant (g)	Total dry wt/ plant (g)	Percent vacancies $\sqrt{n+1}$	
Free growing	48.0	42.6	21.6	112.3	1.59	(1.52)*
Cut only at 10 cm	27.9	19.7	8.7	56.4	8.69	(74.51)*
Cut at 20 cm & at 30 cm	18.0	21.2	9.1	48.5	2.30	(4.29)*
Horizontal bending	42.6	41.0	15.0	98.7	2.35	(4.52)*
Bending below horizontal	36.6	34.9	13.8	85.4	1.88	(2.52)*
LSD ($P = 0.05$)	16.0	13.3	4.3	28.5	1.41	—

*Percent vacancies re-transformed

TABLE 3 — *Effect of shoot orientation on the extension growth of terminal shoot*

<i>Treatment</i>	Mean extension growth per plant (cm)			
	February	March	April	May
Bending horizontally	16.1	18.0	20.2	22.3
Bending 30° above horizontal	20.1	23.5	26.7	29.5
Bending 30° below horizontal	10.5	12.1	14.0	15.8
LSD ($P = 0.05$)	5.7	5.9	6.1	5.9

The shoot number per plant in the proximal region and distal regions of the main stem for the three methods of bending are shown in Table 4.

TABLE 4 — *Effect of shoot orientation on the number of lateral shoots per plant*

<i>Treatment</i>	Shoot number/ plant (distal region)			
	February	March	April	May
Bending horizontally	4.5	5.8	7.2	9.6
Bending 30° above horizontal	4.2	6.6	8.8	10.5
Bending 30° below horizontal	3.7	4.7	5.4	6.9
LSD ($P = 0.05$)	NS	NS	2.3	2.8

Generally more shoots were produced in the distal region than in the proximal region of the stem. The number of shoots in the proximal region were not affected by the three methods of bending but the shoot number in the distal region was significantly lower in the plants that were bent 30° below the horizontal, than in plants which were bent 30° above the horizontal in the months of April and May. The shoot number in the distal region of stem in the plants bent horizontally were not significantly lower than that in the plants bent 30° above the horizontal.

TABLE 5 — *Effect of shoot orientation on mean total lateral growth per plant*

Bending horizontally	34.1	38.6	43.5	66.7
Bending 30° above horizontal	34.5	50.2	67.4	93.2
Bending 30° below horizontal	22.8	30.4	36.8	47.4
LSD ($P = 0.05$)	NS	14.4	14.3	23.6

The mean total lateral growth of the proximal region was not affected by the method of bending but that of the distal region was significantly lower in the plants that were bent 30° below the horizontal, than in plants that were bent 30° above the horizontal (Table 5). The lateral growth of plants bent horizontally were slightly but not significantly lower compared with plants bent 30° above the horizontal. It was also observed that the shoots produced in the proximal region were generally longer and more vigorous than the shoots produced in the distal region of the main shoot for all three methods of shoot orientation.

The effect of the method of bending on the dry weight components of plants are presented in Table 6.

TABLE 6 — *Effect of method of bending on dry weight component of plants*

<i>Treatment</i>	Leaf dry wt per plant (g)	Stem dry wt per plant (g)	Root dry wt per plant (g)	Total dry wt per plant (g)
Bending horizontally	8.01	8.96	3.96	20.94
Bending 30° above horizontal	9.76	9.69	3.56	23.02
Bending 30° below horizontal	7.00	6.90	3.32	17.23
LSD ($P = 0.05$)	2.06	1.78	NS	4.30

Bending of the main shoot 30° below the horizontal resulted in a smaller dry weight of leaf, stem and total plant compared with those bent 30° above the horizontal. The root dry weight per plant was not significantly affected by the method of bending.

DISCUSSION

Results obtained in Experiment 1 showed that the maximum total dry weight was produced by plants that were allowed to grow freely, followed by the two methods of bending and then two methods of cutting. Similar trends were also shown for root dry weight of plants. The two methods of bending resulted in a small reduction in leaf and stem dry weight of plants compared with free-growing plants but cutting at 10 cm and 20 cm resulted in a marked reduction of these components compared with free-growing plants. These results indicate that free-growing plants generally produce the maximum growth while bending of branches and cutting may reduce

growth. The reduction in growth due to bending, however, was relatively small compared with that due to cutting. Cutting plants at 10 cm, three months after planting resulted in larger number of deaths compared with all other methods. It was observed that by cutting plants at 10 cm there were only three or four leaves remaining in the plant. It would appear that such drastic treatment of plants in the early stages of growth may result in very poor recovery probably due to inadequate reserves in the roots. These results are in agreement with those reported by Visser (1969).

It was evident in Experiment 1 that cutting resulted in a marked reduction in the number of shoots and leaves compared with free-growing plants and plants that were bent (Figures 2 & 3). Such removal of green shoots and leaves by cutting would result in a reduction in growth of young plants through a reduction in the photosynthetic area. In the final assessment a reduction in growth was observed in bent plants compared with free-growing plants. This seems to indicate that re-orientation of branches from their normal positions would also result in reduction of growth though to a lesser extent than with cutting.

Although it is clear that maximum growth takes place in free-growing plants, the necessity for cutting or bending of young plants arises because it assists in the formation of branches lower down on the main stem. The better spread of branches 30 cm above the ground with the two methods of bending, compared with cut or free-growing plants was clearly evident. The spread of branches seem to be slightly better with horizontal bending than with bending below the horizontal. The better spread of branches obtained by cutting at 20 cm than by cutting at 10 cm is probably due to the very poor growth of plants in the latter method. These results confirm the earlier findings that bending leads to better spread of plants (Manipura 1971).

Few studies have been carried out to determine the mode of branching in relation to methods of bringing into bearing. Green (1970) determined the mode of branching in stumped plants in relation to different heights of cutting and he observed that the best combination of low branching and maximum number of branches appear to have been obtained by cutting at 10 cm (4 in). In the present investigation the number of shoots below 10, 20 and 30 cm were determined for different methods of bringing into bearing. The shoot number so determined in young plants could be expected to indicate the pattern of branch formation. Cutting plants at 10 cm resulted in a greater number of shoots forming below 10 cm, than in other treatments, and this is in agreement with earlier findings that the low cut may promote low branching (Green 1970). The poor growth of plants and the large number of casualties observed for this treatment, however, shows that such drastic treatments are detrimental to the growth of young plants. In older plants with sufficient root reserves, with a low cut, better recovery could be expected though in such cases much of the early growth may be wasted (Tubbs 1936). The number of shoots below 20 cm were greater with the two methods of bending than in the other treatments and the number of shoots below 30 cm were highest with horizontal bending, followed by bending below the horizontal and cutting at 20 cm and cutting at 10 cm, while the free-growing plants gave the lowest number of shoots. The best combination of better growth and branching in this experiment was obtained with bending plants in a horizontal position.

The results of Experiment 2 showed that training the main stem of plants to a position 30° above the horizontal gave greater extension growth of the terminal shoot than by training the main stem horizontally or 30° below horizontal. The growth of laterals in the proximal region of the main stem were not affected by the method of bending but the growth of laterals in the distal region showed differences. The number of lateral shoots in the distal region of the main shoot were significantly lower in plants bent 30° below the horizontal compared with plants bent 30° above the horizontal. Similarly, the mean total later growth per plant in the distal region appear to be reduced by bending horizontally, or at 30° below the horizontal compared with plants bent 30° above the horizontal. The leaf, stem and total dry weight of plants were also reduced by bending plants 30° below the horizontal compared with bending plants 30° above the horizontal. These results seem to indicate that the method of bending has an effect on the growth of plants. Previous workers have reported that arching or bending branches may result in reduced growth of plants (Wareing & Nasr 1961). Although the maximum growth in young tea plants may be obtained when they are free growing and undisturbed, in order to promote lateral branching it is necessary to either prune or bend the main shoots. The reduction in growth due to bending is less than that due to cutting. The method of bending of branches may also have an effect on the growth of laterals. By bending the branches to a position slightly above the horizontal more even growth of lateral shoots may be obtained, thereby causing minimal disturbance to the plants. This method would cause less damage to bark and stems, and would also reduce damage caused by high insolation under field conditions than when the branches are bent to a position below the horizontal or into a loop.

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