

## THE EFFECT OF SEVERITY OF PRUNING ON GROWTH AND YIELD OF HIGH-COUNTRY SEED TEA (*CAMELLIA SINENSIS L.*)

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The effects of different pruning heights (20, 30, 40 and 50 cm) and of branch numbers (3, 4, 5, 6 and retaining all branches) on growth and yield of old seed tea, in the high-country, were studied in two trials.

In general, in both trials, when the height and branch numbers were greatly reduced at pruning, the total number and fresh weight of tipped shoots were less. More shoots originated at the collar but less on the pruned frame after two and five years of weekly harvests except that in the latter period more branches were seen to originate at the collar in bushes pruned at 40 cm than in those pruned lower or higher. Surface area of bushes determined after two years of harvests showed no differences in both trials. In general, there were no differences in the yields among the height treatments but they were reduced only during the first year when fewer branches were retained. Analyses of carbohydrates in roots showed a greater reduction followed by a slower rate of build-up of their levels after pruning in bushes pruned lower.

The implications of severity of pruning of old seed tea affected by wood-rot and die-back are discussed. It is suggested that while maintaining a pruning height of about 40 cm throughout the field, bush renovation could be effected by pruning lower and/or removing branches, if necessary, phased over two or three cycles.

### INTRODUCTION

Of the total tea extent in Sri Lanka, only about 15% has been planted with high yielding clones while the balance area is still in seed tea. About two-thirds of this tea is 70 years old or more. There is as yet no reliable means of ascertaining the economic productive life span of the tea plant, but it is increasingly becoming evident that there is a decline in yield in most of these ageing tea fields (Kulasegaram, 1980). Several factors may have contributed to this decline, chief among which are the initially low stand of tea; lack of a sustained programme of infilling; planting of tea up and down the hill resulting in erosion of valuable top soil over the years; changes in fertilizer and shade practices; several cycles of pruning have resulted in the exposure of the shaded frame and soil to the sun resulting in scorch of frame and deterioration of soil with each successive prune; low horizontal bending adopted previously, etc. The obvious step to prevent decline of crop is to infill vacancies and to adopt a systematic programme of renovating these debilitated bushes by judicious pruning along with a planned programme of replanting.

Weakening of bushes could result from the accumulation of scorch and wood-rot. Bush renovation could be achieved by eliminating most of the ageing and non-productive branches in order to invigorate the bush to produce new vigorous vegetative shoots. Pruning, particularly in the absence of shade trees, exposes the bark of the frame, which was shaded for 3-5 years, to the sun which is easily scorched. Thus, over several cycles of pruning to which the seed tea has been subjected to, such scorched areas can accumulate on the frame reducing

the number of emerging buds and eventually leading to wood-rot, weakening of the bush and a decline of crop. Hard pruning had at one time or another been suggested as a means of overcoming bush senility and to rejuvenate the plant (Kandiah and Wimaladharna, 1980). This can be achieved either by reducing the height of prune or the branch numbers or by a combination of both, depending on the state and condition of the bush. Selective rejuvenation pruning coupled with other follow-up agricultural practices have substantially increased the yields of seed tea under South Indian conditions (Venkata Ram, 1976).

This study reports the results of two experiments on the effect of reducing the height or branch numbers at pruning on recovery, growth and yield of seed tea.

## MATERIALS AND METHODS

Both trials of this study were conducted on 40 to 45-year-old mature seed tea in Field No. 6, St. Coombs Estate, Talawakele. The treatments were applied in June/July 1975 and the shoots were 'tipped' in late January 1976 and brought into plucking in mid-March 1976. In each trial, at tipping, five randomly selected bushes were tipped and their shoot numbers and weights recorded. Weekly harvests were maintained for 96 plucks and again from the 201st to the 208th pluck when the trials were terminated. The lay out was of a randomized block design with treatments replicated five times with 200 bushes in each treatment. Carbohydrate reserves (starch + polysaccharides) in the bushes were determined at 3, 4, 5 and 21 months from prune by the method of Priestley (1962) with some modifications (Kandiah, 1971). Root samples were analysed in both trials from the treated bushes as well as from unpruned bushes surrounding the experimental plots. Measurements were made of the surface area of bushes at 96 weeks while the number of branches at the collar and on the pruned frames were determined at 96 and 250 weeks, from first harvest.

### Pruning height trial

The treatments were pruning at: (1) 20 cm; (2) 30 cm (3) 40 cm and (4) 50 cm above ground level.

### Initial branch number trial

The plants were pruned at 40 cm leaving behind the following number of branches: (1) 3; (2) 4; (3) 5; (4) 6 and (5) all branches (control).

## RESULTS

### Pruning height trial

The height of prune did not affect the number of 'tipping' shoots while the fresh weight of shoots was greatest when the plants were pruned at 50 cm (Table 1).

TABLE 1 — *Effect of pruning heights on growth and yield of mature seed tea*

Pruning height (cm)	Tipping shoots*		No. of branches**			Surface area** (cm <sup>2</sup> ) of bush	Yield (kg)	
	Number	Fr. Wt. (kg)	At collar	On pruned shoots	Total		Weeks from first pluck	
							4	16
20	55.28	32.42	5.22	31.26	36.48	8652	17.44	91.85
30	66.56	37.98	4.45	30.19	34.64	8938	18.30	95.58
40	67.48	49.23	2.57	36.58	39.15	9195	16.37	100.69
50	77.56	91.81	1.72	42.19	43.91	8801	12.00	114.76
L.S.D. (P=0.05)	NS	11.67	1.52	6.06	5.17	NS	4.38	15.08

\*Mean of 5 bushes

\*\*Mean of 100 bushes at 96 weeks from 1st pluck

At 96 weeks, bushes pruned low had more branches arising at the collar but fewer on pruned shoots (Table 1, Fig. 1A). At 250 weeks more branches arose from the collar in bushes pruned at 40 cm compared to those pruned lower or higher while there was no difference in the number of branches on pruned frames or in their total numbers on the collar and the frame in any of the treatments (Table 2, Fig. 1B). There was no difference in the surface area of the bushes in any of the treatments at the end of 96 weeks. While the total yield was less in bushes pruned at 50 cm at the end of the 4th week these bushes gave a greater yield at the end of 16 weeks (Table 1). Except for differences in yield seen at these two periods no differences were noted at any other time for the duration of this trial when records were maintained (Table 3).

TABLE 2 — *Effect of pruning heights on shoot production at the end of the pruning cycle (6 years)*

Pruning height (cm)	No. of branches*		
	At collar	On pruned shoots	Total
20	13.36	15.58	28.94
30	14.74	13.86	28.60
40	17.34	13.42	30.76
50	14.78	14.32	29.10
L.S.D. (P=0.05)	2.49	NS	NS

\*Mean of 50 bushes at 250 weeks from 1st pluck

TABLE 3 — *Effect of pruning heights and of initial branch numbers on yields (201-208 weeks)*

Pruning height (cm)	Yield (kg)	Branch number	Yield (kg)
20	14.29	Control	14.93
30	14.35	3	15.31
40	14.17	4	14.71
50	13.03	5	16.87
		6	15.85
L.S.D. (P=0.05)	NS		NS

TABLE 4 — *Effect of pruning heights on per cent carbohydrates (starch + polysaccharides) in roots of mature seed tea*

Pruning height (cm)	Months from prune			
	3	4	5	21
20	30	41	21	39
30	38	46	27	52
40	51	50	38	57
50	32	45	40	45
Unpruned	59	54	39	38

There was a reduction in carbohydrate levels after pruning in all the treatments (Table 4). The rate of build-up of reserves was slower in bushes pruned low compared to those pruned higher. The levels in the unpruned but plucked bushes were initially high but declined from the fifth month.

#### Initial branch number trial

The number of 'tipping' shoots on bushes with fewer initial branches (3 or 4) was less than those with more branches (Table 5). The weight of 'tipping' shoots was less in all treatments compared to the control.

At 96 weeks there was no difference in the number of branches arising from the collar in any of the treatments (Table 5). The number of branches on the pruned frame was less when fewer initial branches were left at pruning. At 250 weeks, in treatments where fewer initial branches were left, more branches arose at the collar but less on the pruned frame (Table 6, Fig. 1C). There was no difference in the total number of branches produced in any of the treatments. The surface area of the bushes did not differ in any of the treatments at the end of 96 weeks of harvests (Table 5).

TABLE 5 — *Effect of initial branch number on growth of mature seed tea*

Initial branch number	Tipping shoots*		No. of branches**			Surface area** (cm <sup>2</sup> ) of bush
	Number	Fr. Wt. (kg)	At collar	On pruned shoots	Total	
3	28.40	13.09	11.93	15.91	27.84	8593
4	30.44	17.67	11.35	19.38	30.73	8577
5	48.08	26.53	9.43	23.26	32.69	8300
6	45.48	26.12	8.46	24.85	33.31	8547
Control (8 branches)	55.00	43.19	5.47	29.71	35.18	8858
L.S.D. (P=0.05)	10.77	10.22	NS	8.09	NS	NS

\*Mean of 5 bushes

\*\*Mean of 100 bushes at 96 weeks from 1st pluck

TABLE 6— *Effect of initial branch number on shoot production at the end of the pruning cycle (6 years)*

<i>Initial branch number</i>	<i>No. of branches *</i>		
	<i>At collar</i>	<i>On pruned shoots</i>	<i>Total</i>
3	19.64	9.26	28.90
4	20.12	10.54	30.66
5	15.32	12.08	27.40
6	17.06	12.32	29.38
Control (8 branches)	15.52	12.64	28.16
L.S.D. ( $P=0.05$ )	2.91	2.05	NS

\*Mean of 50 bushes at 250 weeks from 1st pluck

Bushes in which no branches were removed had a greater cumulative yield compared to bushes having 3, 4 or 5 initial branches at 12 weeks, compared to all other treatments at 24 weeks, compared to 3 or 4 branches at 36 weeks and compared to 4 branches at 48 weeks (Fig. 2). No differences in yield were noted thereafter (Table 3).

No consistent differences were noted in the levels of carbohydrates between any of the treatments. The results of this analysis are not presented.

## DISCUSSION

The tea bush, as grown in Sri Lanka, is unique when compared with other crops being a small evergreen bush that grows throughout the year without definite resting seasons and is pruned by various methods to maintain the bush in a shape and size conformable to economic demands from which its young shoots are persistently removed. Pruning of tea is done under the widely varying climatic conditions associated with different parts of the island, at different times of the year and in many different ways.

In the pruning height trial, reducing the height of prune from 50 to 20 cm generally reduced the number and weight of tipped shoots (Table 1). This is due to the longer time taken by the bushes pruned low to recover. It has been shown that bushes pruned at about 20 cm took a longer time to recover than those pruned at about 40 cm (Kathiravetpillai and Kulasegaram, 1980). It is to be noted that in these studies 'tipping' of shoots—a practice involving breaking back all shoots to a given height—was done only by the 7th month as the shoots of bushes pruned low had not reached the desirable height whereas under normal practice 'tipping' is done by the 4th month from prune. Some plantations adopt the practice of 'plucking-in' which involves commencing harvesting of shoots earlier than if 'tipping' is done. This practice does not result in any loss of har-

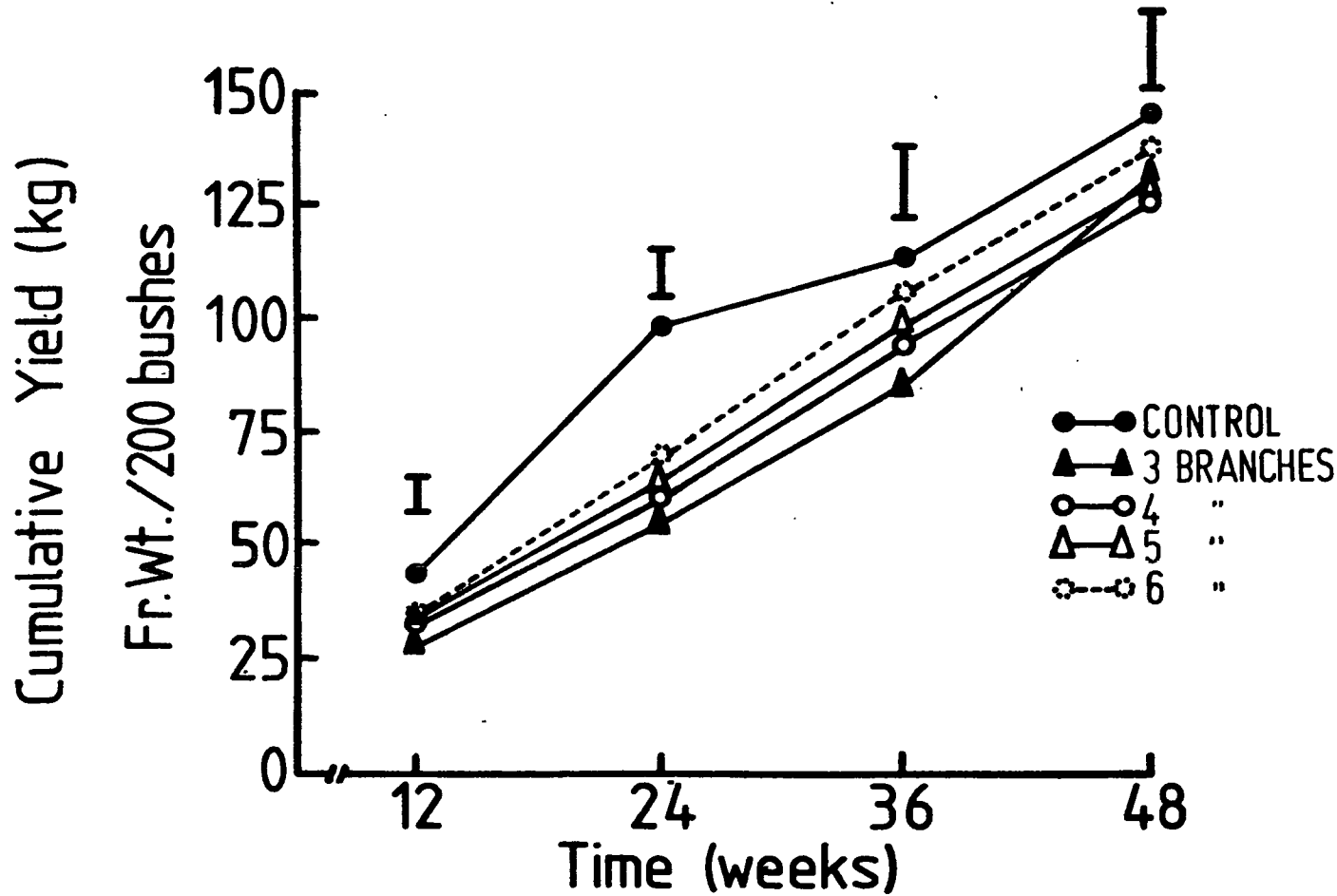
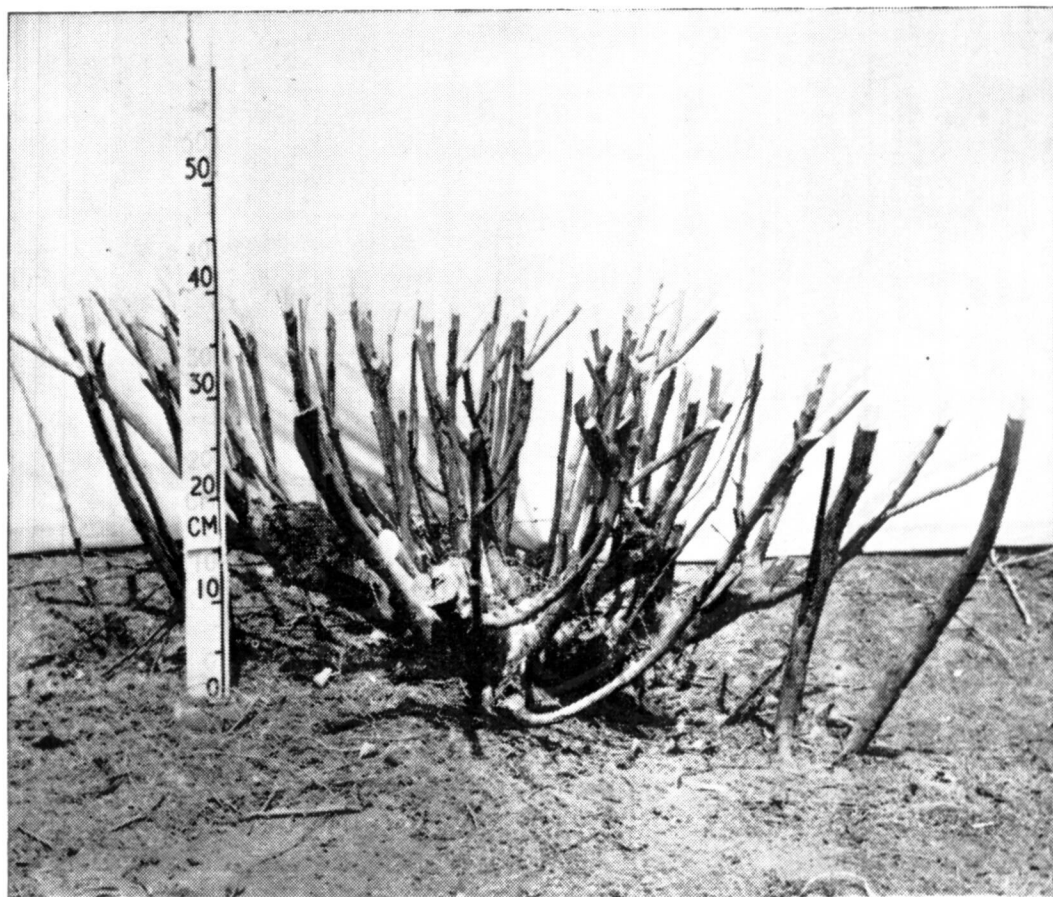


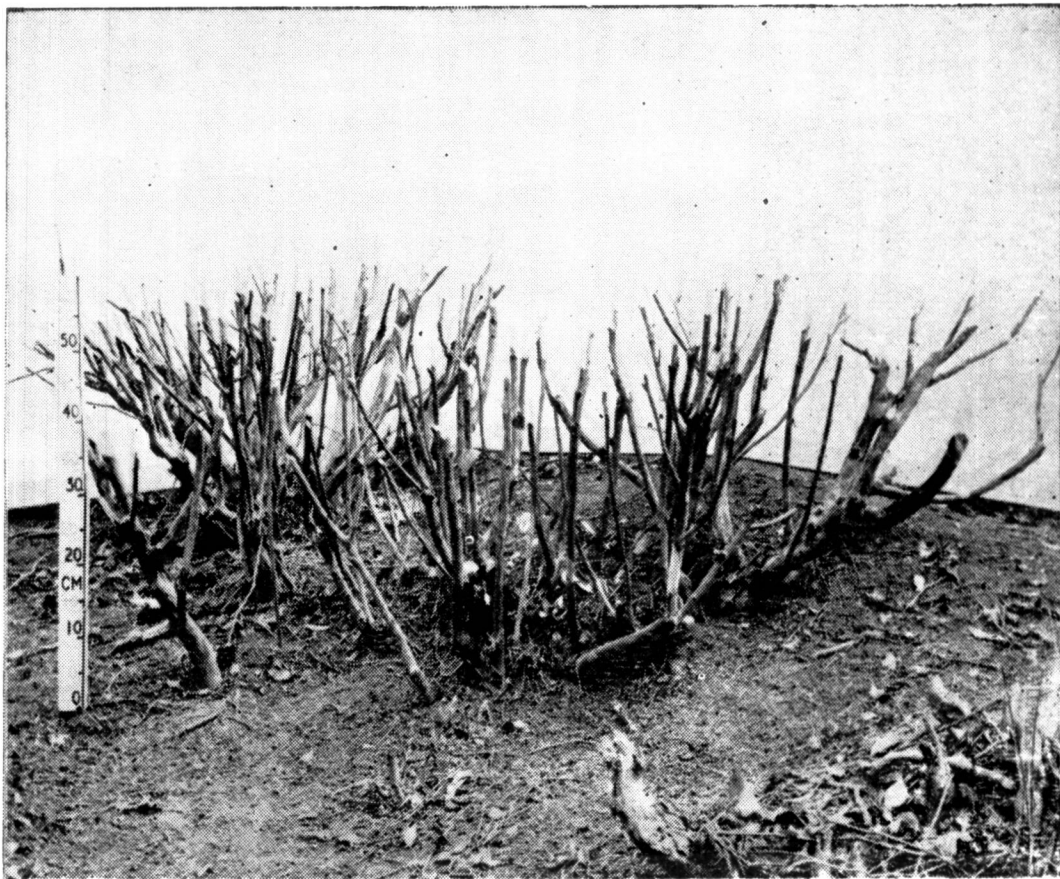
Fig. 2 — Effect of initial branch number on yield of tea. Vertical bars show LSD (P=0.05)



*Fig. 1A — Renovation of old seed tea by pruning initially at 20 cm.*

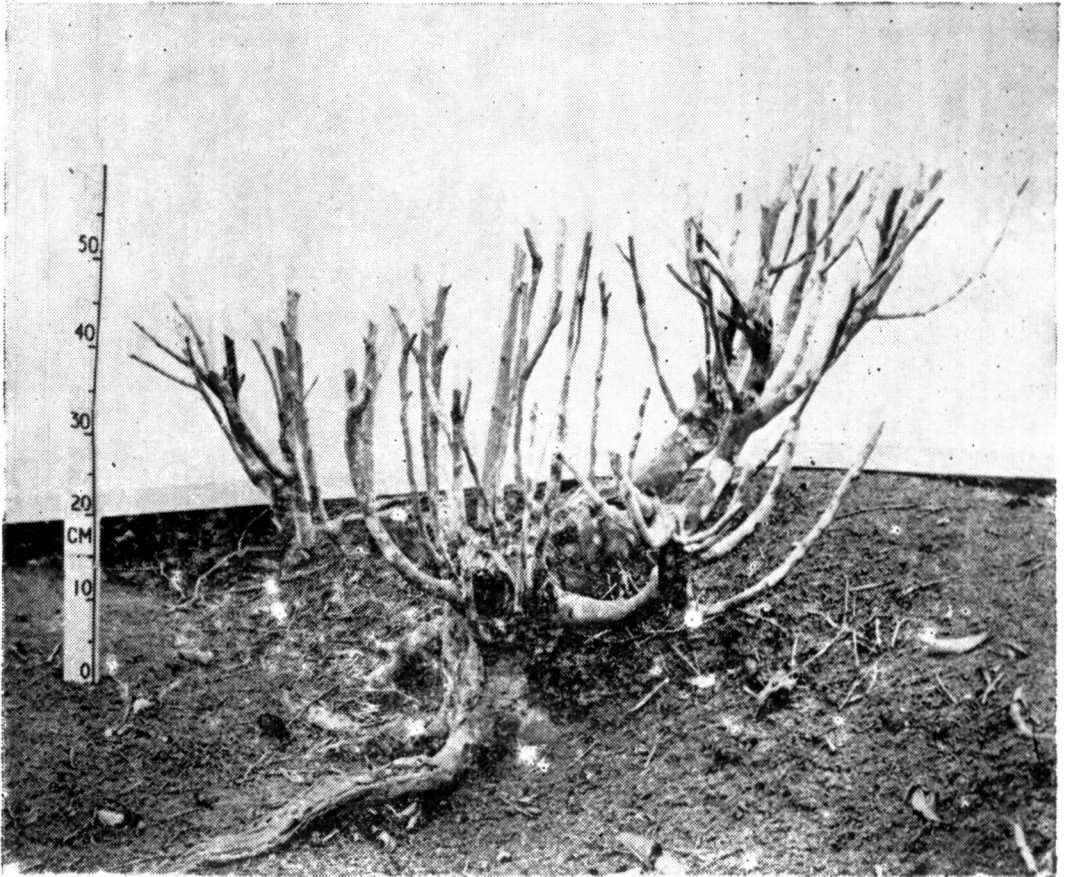
Note: Healthy new primary branches arising from the above treatment.

Pruned initially in June/July, 1975. Photographed in June, 1981 after pruning higher for clarity.



*Fig. 1B— Recommended general height of initial prune — 40 cm.*

Pruned initially in June/July 1975. Photographed in June 1981 after pruning higher for clarity.



*Fig. 1C — Renovation of old seed tea by retaining four primary branches at initial prune*

Note: Healthy new primary branches arising from the above treatment.

Pruned initially in June/July, 1975. Photographed in June, 1981 after pruning higher for clarity.

vesting units as in 'tipping' but retards growth in girth of primary branches. The difference in tipped shoot weight between the high and low pruned bushes includes a measure of the loss in crop due to low pruning. In the present study no differences in yields were noted between any of the pruning treatments except for two brief periods at the end of the first and fourth month from first harvest. It is possible that the low yields seen in bushes pruned at a height of 50 cm was due to the delayed recovery. (Kathiravetpillai and Kulasegaram, 1980). However by the end of the fourth month no yield differences were noted. Bushes pruned low had more shoots arising from the region of the collar and correspondingly fewer shoots arising on the pruned frames compared to those pruned higher after almost two years of harvests. In the same period, the total number of branches were less in bushes given a low prune while the surface area of the bush remained unaffected by pruning low. At the end of the cycle more viable branches arose from the collar only in bushes pruned at 40 cm compared to those pruned lower or higher (Table 2, Fig. 1A and 1B). This may be due to the continued higher rate of shoot production which takes place when pruned at this height compared to any of the other pruning heights. However, there was no difference in the number of branches arising on the pruned frame as well as in their total numbers between any of the treatments at the end of the cycle.

One objective of pruning is to invigorate the bush to produce vigorous vegetative shoots by eliminating most of the leaf-bearing branches thus minimizing competition between buds. The fewer buds that are left on the frame after pruning are thus able to obtain a greater quantity of the root factors for their growth but, the roots themselves draw on the carbohydrate reserves in the roots during recovery as there are no supplies of photosynthates from the leaves. Analyses of carbohydrates in samples of roots of bushes pruned at different heights showed that there was a greater reduction in their levels after pruning and a slower rate of build-up of reserves following recovery, particularly in bushes pruned low compared to the bushes pruned higher (Table 4). The levels in the unpruned but plucked bushes were initially high but showed a reduction with time indicating that root reserves were being used for growth and possibly a greater quantity for respiratory activity as the depth of canopy keeps decreasing towards the end of the pruning cycle and the contribution of photosynthates by the canopy decreases. Satisfactory recovery from pruning will be dependant on the state of activity of the root system and the level of reserves. The more severe the pruning, the longer the time taken for bud emergence and hence the level of reserves will be more important. The timing of pruning will also have a bearing on recovery.

The removal of the leaf-bearing branches at pruning also exposes the bark of the frame which has been shaded for 3-5 years. Such tissues are liable to scorch after a short period of exposure to direct sun due to rise in bark temperatures, which can be about 10-15°C above ambient air temperatures. Shaded leaves when exposed to the sun after pruning, also scorch within a few hours. Removal of shade trees can, therefore, accentuate scorch of bark and leaves. Thus, over several cycles of pruning, the scorched areas on the bark can increase and effectively reduce the number of emerging buds leading to a weakening of the bush, wood-rot and reduction of crop. With the low horizontal bending adopted in the early years, the frame is also more liable to scorch on the upper surfaces where most of the buds emerge from, particularly in the absence of trees. Thus, most of the old ageing tea have extensive areas of bark scorch, mainly on the branches but in some cases extending to the collar where wood-rot invariably sets in.

In the branch number trial, reducing the number of branches from eight to three significantly decreased the number and fresh weight of tipped shoots (Table 5). It must be pointed out that in this experiment the branches were reasonably healthy and the reduction was too drastic. If the branches were extensively scorched or rotted, as is usually the case and the number of branches reduced were fewer, the differences would have been smaller. Nevertheless, though there were no statistically significant differences after 96 weeks of harvests between any of the treatments in the number of branches arising at the collar there was a clear trend indicating that more branches arose at the collar when fewer branches were left (Table 5) and this assumed significance towards the end of the cycle (Table 6, Fig. 1C). Furthermore, correspondingly fewer branches arose from the pruned frame in bushes where fewer branches were left compared to those where more branches were left, a trend which was maintained even towards the end of the cycle (Tables 5 and 6). However, there were no differences in the total number of branches cut between any of the treatments at either period. There was no reduction in the total area of the bush after almost two years of harvests (Table 5). Bushes with few branches left showed a reduction in yield only for about a year (Fig. 2).

It will be noted that in both trials the number of branches on the pruned frame and, as a consequence, the total were less at pruning than during the earlier stage in the cycle (Tables 1, 2, 5 and 6). This may be due to the fact that though more buds developed following recovery, all of them did not turn out to be productive shoots towards the end of the cycle. Furthermore, the reduced number of branches towards the end of the cycle may be due to increased competition among the developing branches and to reduced light intensity associated with rise in plucking table and canopy depth.

Pruning of old seed tea, therefore, deserves special treatment compared to that of vegetatively propagated tea. Hence in seed tea areas not earmarked for replanting in the near future, apart from a vigorous program of infilling of vacancies, appropriate pruning methods have to be employed if further yield decline is to be prevented. Rejuvenation pruning had at one time or another been suggested as a means of overcoming bush senility and renovating the plant (Kandiah and Wimaladharma, 1980). Rejuvenation pruning would serve the purpose of frame renovation with reasonably healthy high jat bushes on better soils as was shown under South Indian conditions (Venkata Ram, 1976) but the operation is too drastic and may result in high percentage of deaths in addition to delayed recovery with our predominantly low jat seed tea on shallow eroded soils. Plantations in the high country, over the years, have pruned the tea at 20-30 cm which delayed recovery, resulted in poor frames and even caused the death of bushes. To avoid casualties and obtain quicker recovery a lighter form of pruning is advocated for high grown tea. It has been shown that bushes pruned at about 40 cm recovered earlier and showed vigorous growth than those pruned lower or higher (*loc. cit.*). Furthermore, bushes pruned lower have not given extended periods of high yields, as is often thought of, compared to bushes pruned higher.

It is at pruning time that all weak and debilitated branches, cankers, knots, snags and rotted branches are removed from the frame of old seed tea. Bushes in a weak condition will not respond to the same extent and will have to be treated less drastically if recovery is to be satisfactory and deaths avoided. Where there is an accumulation of wood-rot and cankered branches due to faulty pruning in the past, it may be difficult and not desirable to clean out the frames in one operation. In such instances the renovation should be phased over two to three cycles. A factor which seriously mitigated against bush

renovation would be loss of crop. A significant feature which clearly emerged from this study was that there was no reduction in surface area of bush or of yield by a low prune or reduced branch numbers at the end of 96 weeks from first pluck (Tables 1 and 5). It thus follows that while maintaining a certain height of prune throughout a field, individual bushes with extensive wood-rot and die-back could be pruned low or the affected branches removed or a judicious combination of both practices adopted effectively with advantage without loss of crop. Once renovation of primary branches has been effected in this manner successive prunes have to be done at a higher level so as to increase the cropping potential by increasing the area of bark on which buds could develop which will eventually increase the number of flushing points thus contributing to higher crop. A lower prune then should be resorted to only when there is sufficient justification to do so perhaps after three or four prunes, when height becomes unmanageable. Unnecessary reduction of frame either by a lower prune or by removing good healthy branches is inadvisable.

It is desirable to protect the main branches by having shade trees which will lower the ambient temperature, and thereby reduce scorch. Shade trees increase the humidity, prevent fluctuation of soil temperature, protect the soil and conserve moisture during the early phases of a drought. This is particularly important in a perennial crop like tea. In addition it may also be desirable to leave lungs at the time of pruning as a further insurance even for high country seed tea.

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