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EFFECT OF HARVESTING ON THE GROWTH AND YIELD OF LOW GROWN CLONAL TEA

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A field study was conducted under low country conditions to ascertain the optimal harvesting frequency for maximising crop, in the widely planted clone TRI 2023.

Higher harvesting frequencies (shorter rounds) were found to be more productive with a 4-day frequency giving 16% increase of crop over the standard 6-day frequency. This extra crop cost 89% more to harvest as compared to the standard frequency, but resulted in a substantial increase in income per unit area as no additional inputs were required, except the labour to harvest this extra crop. On plantations where labour for harvesting is not a constraint shorter rounds would be more productive.

As clonal variation is known to exist even under similar conditions, the results of this study are, in general, applicable to high yielding clonal tea (TRI 2023) under low country conditions.

INTRODUCTION

Commonly, the operation of harvesting crop in tea is termed plucking which involves the removal of the tender apical portion of secondary or higher order shoots; these are subsequently processed to give the commercial product. The unit thus plucked is called the flush and usually consists of a tender bud and two leaves immediately below it (Visser, 1960). Generally about 10 - 15 per cent of the total growth of a tea bush is harvested as crop (Ellis, 1978). Plucking is the most expensive item of tea production accounting for as much as 18 per cent of the total cost of production (Sivapalan, 1983) and consuming up to 70 per cent of all labour employed on an Estate (Ellis and Grice, 1976 ; Sivapalan, 1983).

To return them into an active vegetative phase tea bushes are pruned once in 2 - 6 years at a height ranging from 35 - 55 cm (14 - 22 in), and subsequently tipped leaving about 4 - 6 leaves above the pruning cut to bring it into plucking in the new cycle (Nathaniel, 1982). The shoots which appear above the plucking table are harvested at 4 - to 10-day intervals depending on climatic conditions, jat of tea and rate of growth (Wettasinghe, Nathaniel and Kroon, 1976). The plucking of tender shoots destroys apical dominance temporarily and, thus, promotes further axillary shoot production (Tubbs, 1937; Portsmouth and Rajiah, 1957).

The yield of tea is the product of the weight of shoots and their number per unit area, and these are generally complementary to each other (Rahman, 1977). With time, the plucking table increases in area and height, with a decrease in yield per unit area. Hence plucking must aim at removing much of the acceptable shoots as frequently as possible to maximise crop.

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The length of the plucking round influences the size of the harvest unit and variability in size from one harvest unit to the other (Tubbs, 1949). The average weight of the harvest unit on a fortnightly round is distinctly larger than on a weekly round, but a weekly round gave a higher yield (Tubbs, 1938; 1949; Pethiyagoda, 1967). Portsmouth (1957) found that longer rounds also increased the proportion of shoots with more than two leaves and reduced the manufacturing quality of the harvested crop; increase in the mean weight of individual shoots as a result of longer rounds was not sufficient to compensate for the reduction in the total number of shoots harvested and, thus, there was a net loss of crop. Kirthisinghe (1968, 1971) tested the effect of length of plucking rounds on manufacturing qualities of the harvest and found no difference in the valuation of the finished product.

Under South Indian conditions Varghese (1977) found that 15- and 25-day rounds produced a high mass of shoots, but these included a large proportion which could not be manufactured into acceptable tea; though the number of pluckers employed and leaf harvested per plucker per day was greater, the tea produced was poor. But 7-day rounds gave the maximum shoot density per unit area compared even to a 10- or 15-day round. Under North-east Indian conditions the most desirable plucking round was a 7-day one (Dutta, 1961). But Rahman (1977) has demonstrated that the most suited plucking round varies from clone to clone with a 7-day round being suited for clone TV 1 and a 14-day round for clone TV 9. Under similar conditions clone CNM 340 gave the highest yield on a 13-day round both in the pruned and non-pruned years (Anon, 1980).

In East Africa Templer (1971) found that plucking twice a week as compared to once a week, gave more sites of plucked shoots, produced smaller shoots, had slightly more dry matter and significantly increased yields. Later (1977) he concluded that longer intervals resulted in greater shoot weight and thus yield, mainly because of the extra time allowed for growing.

The present study was designed to obtain information on the optimal harvesting frequency that is desirable under low country conditions in clonal tea.

MATERIALS AND METHODS

The experiment was laid out in May 1977 on three-year-old tea of clone TRI 2023 at the Tea Research Institute Southern Province Extension Centre at Talgampola, (elevation about 30 m amsl, mean monthly temperature 31.2° C annual precipitation 290.7 cm, mean daily sunshine 6.58 h). This field was in regular plucking for an year before treatments were effected. Harvesting frequencies of 4-, 5-, 6-, and 7-day were employed using a randomised block design with six replicates. Each plot consisted of 36 bushes and harvesting on the due dates based on the treatment frequency was strictly adhered to. The 6-day frequency was considered as the standard for purposes of comparison.

The economics of harvesting under the different frequencies was done by timing the operation of harvesting, commencing about three months after the imposition of treatments. This was carried out on days when at least three frequencies were harvested so as to eliminate variation due to weather factors hampering the movement of pluckers. For the purpose of timing, one plucker was employed per plot with pluckers in the different plots of a replicate commencing work at the same time. The timing was done continuously over a period of about 21 months.

Pluck analysis was carried out monthly, during the first cycle of treatment, by taking a random sample of 100 g fresh weight of flush from each plot and determining the number of two and three leaf units. Based on this assessment the per cent active shoots and the average weight of individual harvest units were determined.

The first prune, given in May 1979 after two years of imposition of treatments, was of the rim-lung type (Nathaniel, 1982) done at a mean height of about 45 cm. From each plot the weight was recorded separately for the leaves and stems of the pruned branches of three randomly selected bushes. In addition, the number and diameter of all the branches, excepting the lung branches, were determined, on the same three bushes, at the pruning height.

Tipping was carried out after 113 days from pruning, leaving about 2 - 3 leaves above the pruning height, into hard green wood using tipping knives. The number and weight of tipped shoots were assessed on three bushes per plot. The leaves were separated from the stems and their number were also recorded.

During the second cycle (1979 - 1982) of treatment no assessments were carried out, other than recording the yield at each harvest.

RESULTS

Yield

The yield of made tea in the second and third years of the first cycle (i.e. the period after the treatments were imposed) and the three years during the second cycle is presented in Table 1.

TABLE 1 — *Effect of frequency of harvesting on yield of made tea (kg per ha)*

	Frequency of harvesting				
	4-day	*5-day*	*6-day*	*7-day*	*LSD* ($P = 0.05$)
First cycle					
Second year	5,288	5,181	4,613	4,824	298
Third year	5,194	4,807	4,293	4,406	262
Average	5,241	4,994	4,453	4,615	427
Second cycle					
First year	1,092	1,030	958	864	128
Second year	4,863	4,392	4,523	4,591	336
Third year	3,595	3,522	3,332	3,098	213
Average	3,183	2,982	2,938	2,851	490

TABLE 2 — *Effect of frequency of harvesting on cost*

		Frequency of harvesting			
		4-day	*5-day*	*6-day*	*7-day*
Average number of rounds per year		90.5	73.0	60.5	52.5
Number of occasions timed		18	15	18	11
Time taken to harvest 1kg leaf (1)	(min.)	15.7 (70.6)	14.5 (65.3)	13.9 (62.6)	14.0 (63.0)
Crop harvested per year(2)	(kg/ha)	23,585 (5,241)	22,473 (4,994)	20,039 (4,453)	20,768 (4,615)
Crop harvested/plucker/day (intake) (3)	(kg)	24.8 (5.5)	26.9 (6.0)	28.1 (6.2)	27.9 (6.2)
Labour required per round (4)	(No./ha)	10.5	11.4	11.8	14.2
Cost of harvesting crop(5)	(Cts/kg)	96.8 (435.6)	89.2 (401.4)	85.4 (384.3)	86.0 (387.0)
Net income/year(6)	(Rs/ha)	186,789	179,734	161,020	166,740
Net gain over 6-day frequency/year	(Rs/ha)	25,769	18,714	—	5,720
Crop gain over 6-day frequency/year	(kg/ha)	3,546(788)	2,434 (541)	—	729 (162)
Harvesting cost for extra crop (7)	(Rs/kg)	1.61(7.26)	1.21 (5.42)	—	1.03 (4 .61)

Notes.— (1) Crop yield is in green leaf with made tea in parenthesis (on an out-turn of 22.22% green leaf to made tea).
(2) First cycle average yield – taken from Table 1.
(3) A working day is assumed to be 6 1/2 hours (390 minutes) of work.
(4) Ratio of crop harvested per round over the year to crop harvestable per plucker per day.
(5) A daily wage of Rs. 24/- is considered.
(6) Net income is considered to be a sales average (NSA) of Rs. 40/- per kg made tea *less* variable harvesting cost.
(7) Cost of harvesting per kg of extra crop (over 6-day frequency) is the difference between the cost of harvesting total crop in the respective frequencies and cost of harvesting total crop in 6-day frequency divided by extra crop harvested in that frequency.

In the first cycle there was no difference in the average yield between the 4- and 5-day frequencies. While the average yield obtained from a 4-day frequency was significantly higher than the 6- and 7-day frequencies, the average yield of the 5-day frequency was only higher than the 6-day frequency. In the second cycle though the highest yield was obtained from a 4-day frequency this was not significantly higher than any of the other frequencies, which too did not show differences among them.

However, in general, in each year of both cycles higher crop was obtained at 4-day frequency compared to 6- and 7-day frequencies; the crop from 5-day frequency also tended to be higher compared to lower frequencies.

Cost of harvesting

The operation of harvesting was timed on several occasions during the first cycle in order to estimate the labour requirement, and thus the cost of harvesting of the extra crop obtained in the different frequencies as compared to the 6-day frequency (Table 2).

Compared to the standard frequency, the net gain in income is greatest in the 4-day frequency. However, each extra kg of green leaf is harvested at a cost of Rs. 1.61 as compared to Rs. 0.85 for the standard frequency and Rs. 0.97 for total crop in the 4-day frequency.

Characteristics of crop shoots

The monthly assessments of 100 g random samples of flush from each plot is given in Table 3. It is seen that higher frequencies (shorter rounds) result in a greater number of active shoots, a larger proportion of which are 2-leaf shoots. Higher frequencies also produced a larger number of total shoots but with a proportionate decrease in individual shoot weight.

TABLE 3 — *Effect of frequency of harvesting on number and characteristics of crop shoots in a 100 g sample (fresh weight)*

	Frequency of harvesting			
	4-day	*5-day*	*6-day*	*7-day*
Active shoots : 2-leaf	85.8 a	85.4 a	79.6 b	77.6 b
3-leaf	16.9 a	16.9 a	17.5 ab	18.2 b
Total (Active shoots)	102.7 a	102.3 a	97.1 b	95.8 b
Dormant shoots : 2-leaf	10.9 a	11.3 a	11.0 a	12.1 b
3-leaf	4.2 a	4.5 a	4.3 a	5.2 b
Total (Dormant shoots)	15.1 a	15.8 a	15.3 a	17.3 b
All 2-leaf shoots	96.7 a	96.7 a	90.6 b	89.7 b
All 3-leaf shoots	21.1 a	21.4 a	21.8 a	23.4 b
Total shoots	117.8 a	118.1 a	112.4 b	113.1 b
Per cent Active shoots	87.1 a	86.6 a	86.4 a	84.6 b
Average fresh weight of harvest unit (g)	84.9 a	84.8 a	89.0 b	88.4 b

(Figures with the same symbol on horizontal lines do not differ significantly at $P = 0.05$)

Note.—Statistical analysis of data has been carried out using the following transformations: Number of shoots = $\sqrt{n}$; Percentages—Arcsine. Values given in table are back-transformed data.

Weight of prunings and number and diameter of branches

The fresh weight of prunings separated into foliage and stems, and the number and diameter of branches at the pruning height are given in Table 4.

TABLE 4 — *Effect of frequency of harvesting on foliage and stem production*

	Frequency of harvesting			
	4-day	*5-day*	*6-day*	*7-day*
Fresh weight of prunings per bush (kg)				
Foliage	0.849 a	0.863 a	0.822 a	0.722 b
Stems	2·125 ab	2.193 a	1.975 ab	1.816 b
Total	2·974 a	3.056 a	2.797 ab	2.538 b
Branches				
Number/bush	11.04 a	11.14 a	9.69 a	9.26 a
Mean diameter (mm)	10.86 a	11.64 a	11.08 a	10.72 a

(Figures with the same symbol on horizontal lines do not differ significantly at $P = 0.05$).
Note.—Statistical analysis of data has been carried on $\sqrt{n}$ transformed data for number of branches. Values given in table are back-transformed data.

The total weight of prunings in the 4-day frequency was found to be significantly different only from the 7-day frequency. Frequency of harvesting had no significant effect either on branch number per bush or on their diameter.

Recovery from pruning

The number of new shoots and of leaves as well as the weight of stems following tipping are given in Table 5.

TABLE 5 — *Effect of frequency of harvesting on the number and weight of new shoots after pruning*

	Frequency of harvesting			
	4-day	*5-day*	*6-day*	*7-day*
Number of tipped shoots/bush	15.11 a	13.37 a	11.32 a	13.43 a
Number of leaves above tipping height /bush	93.51 a	82.26 a	77.56 a	78.71 a
Fresh weight of total tippings per bush (g)	204.75 a	185.85 a	195.30 a	177.19 a

(Figures with the same symbol on horizontal lines do not differ significantly at $P = 0.05$).
Note.—Statistical analysis of number of shoots and leaves were carried out on $\sqrt{n}$ transformed data. Values given in table are back-transformed data.

There were no significant differences on these growth parameters as a result of different frequencies of harvesting.

DISCUSSION

This study indicates that under low country conditions, increased frequencies of harvesting clonal tea results in higher crop yield and advantageous if adequate labour is available for use in harvesting (Table 1). Though the yield of tea is the product of the weight of shoots and their number per unit area, delaying harvesting by adopting extended rounds, to obtain heavier shoots is not a desirable practice. Such a strategy will not increase yield per unit area, as weight of harvested shoots and their number per unit area are complementary to each other, but would result in a larger proportion of unacceptable leaf reaching the factory.

Higher harvesting frequencies resulted in a greater number of active shoots, a larger proportion of which were 2-leaf shoots. This further explains the reason for the less frequent harvesting rounds resulting in more unacceptable or coarse leaf. Though higher frequencies of harvesting produced a larger number of shoots, a proportionate reduction in individual shoot weight negated much of this advantage, thus resulting in a lower intake per plucker per day (Table 2).

On the basis of the assumptions made in Table 2, the net annual income was about 16 per cent more in the highest harvesting frequency (4-day) than in the standard 6-day frequency. However, it cost about 89 per cent more to harvest that extra crop when compared to the cost of harvesting per kg of total crop in the standard frequency (Rs. 1.61 as against Rs. 0.85). The over-riding advantage is that the extra annual income (Rs. 25,769 per ha) is obtained through an increase of crop (788 kg made tea per annum) which does not necessitate any additional inputs other than the labour to harvest this crop (requiring 143 labour units per ha per annum). Similarly the 5-day and the 7-day frequencies also are more profitable than the standard 6-day frequency. The reason for profitability of a 7-day frequency over a 6-day standard appeared puzzling initially. Further investigations revealed that the psychological outlook of the pluckers was such that in the 6-day frequency they tended to leave some shoots on the bush which they considered immature at one round, but found them to be over-mature at the next occasion. In the 7-day frequency, however, such shoots of uncertain maturity were harvested so as to, perhaps, keep the height of the plucking table within manageable limits. This was confirmed by the fact that there are more 3-leaf shoots harvested in the 7-day frequency, than in the 6-day round (Table 3), suggesting that the shoot which would have been left behind as immature in the 6-day round is harvested here as an acceptable 3-leaf shoot.

Pruning weight was significantly reduced only in the 7-day frequency, and that too in the pruned foliage, perhaps due to the above mentioned reason, due to inadequate build up of maintenance foliage at the level of the plucking table (Table 4). However branching and branch thickening were not affected by different frequencies of harvesting. The lack of difference in weights of tippings and number of new branches developing after pruning, indicate that post-pruning developmental vigour of the bushes are not influenced by frequencies of harvesting.

The findings of this experiment are valid only for clone TRI 2023, which has been extensively used in replanting, under low-country conditions. As shown by Rahman (1977) under North Indian conditions, the most suited plucking round could vary from one clone to another even under similar conditions of soil and climate.

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