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INFLUENCE OF THE SUBTENDING LEAF ON THE GROWTH OF AXILLARY BUD AND FORMATION OF BANJI BUD IN TEA

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SUMMARY

Harvesting of tea shoots with shear produced a large number of cut leaves on the bush canopy. The number of cut leaves increased with the increased period of shear harvesting. Damaged leaves showed a low rate of assimilation and translocation but rate of respiration was more. Reduction in the area of photosynthetic machinery and alteration of leaf metabolism due to injury, affected the growth characteristics of axillary bud and general bush health.

***Key words*: Axillary bud, banji bud, damaged leaves, subtending leaf, tea**

INTRODUCTION

A number of agricultural practices adopted in tea, affect the quantity and physiological efficiency of the maintenance foliage, which in turn influences the growth characteristics of tea shoots. Use of shears, for harvesting tea shoots is aimed to increase pluckers' productivity. Reports are available on the effect of this operation on total leaf weight, stem weight, biomass production, productivity and quality of made tea (Sharma and Satyanarayana 1993, Barbora 1994 and Marimuthu *et al.* 2001). The present study deals with the extent of damages suffered by maintenance foliage due to shear harvesting and the influences of subtending leaf on shoot growth and banji formation.

MATERIALS AND METHODS

A field experiment in randomized block design was carried out at the UPASI Experimental Farm located at an altitude of 1050 m in Valparai, Coimbtore District. A field planted with the clones, UPASI – 3, UPASI – 9, and UPASI – 17 along the contour in double hedge system at spacing of 135 x 75 x 75 cm was selected for the study. The experimental plots were under four treatments, viz. 1) continuous hand plucking (no shearing), 2) Integrated schedule of harvesting using hand held shears (i.e., hand plucking from mid December to March and mid June – mid September and shear harvesting during the remaining period – 6 months under shear harvesting), 3) Integrated schedule of harvesting using hand held shears (i.e. hand plucking from January to March and rest of the period under shear harvesting – 9 months under shear harvesting) and 4) Continuous shear harvesting (12 months under shear harvesting). Shears were introduced after 18 months from pruning. Each treatment had four replicates with 25 bushes in each plot.

Mother leaves (supporting leaf of new shoot) of different size (Fig. 1) were exposed to 25 ml of labelled sodium carbonate for one hour to determine the rate of assimilation (Hale and Weaver 1962). Respiratory losses were estimated following the method suggested by Rajkumar (1995). Pencil thick roots (about 2 cm diameter) were collected prior to and after pruning at

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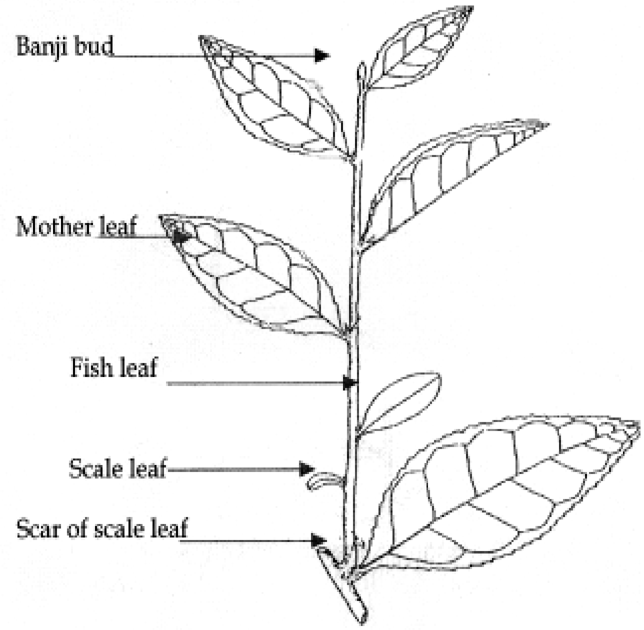

Fig. 1. Shoot development in tea.

monthly interval from each treatment. Processed root samples were subjected to carbohydrate analysis (McCready *et al.* 1950)

In the fourth year in field 25 shoots were tagged, on the basis of the nature of subtending leaf (a) full leaf (L), (b) leaf from which less than half portion is cut off (L1) & (c) leaf from which more than half portion is cut off (L2). Observations were carried out on the growth characteristics of axillary buds such as number of buds which resumed their growth, days required for the shoot to reach plucking stage and stage at which shoots turn banji (dormant), at 10 days interval. Biometric parameters of shoots developed in each category were quantified.

At the end of pruning cycle maintenance leaves from one square foot area of the canopy were removed and segregated into full leaves and cut leaves (L1 and L2). Total leaf area was determined, using L1-COR 1800 leaf area meter. The data obtained/generated were subjected to statistical analysis.

RESULTS AND DISCUSSION

Nature of maintenance foliage on bush canopy

Shear harvesting reduced the total number of maintenance leaves on bush canopy in all the clones tested (Table 1). There was 39, 35 and 42 percent reduction in the number of mother leaves (subtending leaf of an axillary bud) of the cultivars UPASI – 3, UPASI – 9 and UPASI – 17, respectively. The reduction in maintenance leaves was found to be directly proportional to duration of shear harvesting. Sharma (1983) noticed that the amount of foliage retained on the bush was determined by the severity of plucking. Moreover, most of the leaves removed were recently matured photosynthetically active ones, situated on the surface of bush canopy which play a major role in productivity and health of bush. Murty and Sharma (1986) found that productivity was jointly influenced by the leaf material in top 20 cm and wood (twigs) in the top 30 cm profile.

In the cultivar UPASI – 3, about 54 percent of maintenance foliage became cut leaves due to shearing within six months. This percentage was slightly lower in the other two clones and least value was recorded in UPASI – 9. Cut leaf percentage increased with the duration of shearing and reached to more than 80 percent in UPASI – 3 due to shearing for 12 months.

Response to shear harvesting varied with clones. Damage to leaf was more in Assam and Cambod plants. This might be due to variation in size or position of leaf. It was noticed that leaf angle, which varied with clones, had an important role in cut leaf formation. UPASI – 9 which had lesser leaf angle (31.8° - erect leaves), total number of cut leaves were more in comparison with UPASI – 3 and UPASI – 17 plants with leaf angles of 60.2° & 51.8°) . But the observation on type of cut leaves revealed that L1 type (big) of leaves were more in comparison with L2 type (small leaves) in China clone. While the trend was reverse in Assam and Cambod types of plants where most of the cut leaves were of L2 type.

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Table 1. Nature of leaves in relation to mode of harvesting at the end of pruning cycle.

Treatment	Total no. leaf	Number of leaves/square foot			Total leaf area (m^2)
		Full leaves (L)	> half leaves (L1)	<half leaves (L2)	
UPASI 3					
HP *1	516	516	-	-	1.29
6MS *2	414	188	102	124	0.86
9MS *3	372	132	94	146	0.74
12 MS *4	316	57	86	163	0.50
C.D. (P = 0.05)	9.2	15.8	15.7	14.2	0.06
UPASI 9					
HP	614	614	-	-	1.16
6MS	536	298	134	104	1.04
9MS	484	236	121	127	0.91
12 MS	396	111	129	156	0.75
C.D. (P = 0.05)	21.3	16.9	14.2	16.1	0.06
UPASI 17					
HP	579	579	-	-	1.10
6MS	466	239	93	134	0.78
9MS	424	191	82	151	0.74
12 MS	334	86	75	174	0.52
C.D. (P = 0.05)	16.8	12.5	8.7	4.2	0.05

*1 – Hand plucking, *2 – 6 months shearing, *3 - 9months shearing, *4 – 12 months shearing

Metabolic activities of leaves under shear harvesting

Metabolic activities of leaves showed that ^{14}C assimilation and translocation were lesser and rate of respiration was more in leaves injured due to shear harvesting (Fig. 2). Barman *et al.* (1992) reported that damage to maintenance foliage, the energy harvesting functional units, affected the photosynthetic carbon metabolism significantly. The total dry matter production by a crop may vary according to the changes either in the size of photosynthetic system or in its activity (Sanderson and Perera 1974, Kumar *et al*. 1993). From the above quoted works it can be deduced that the reduction in assimilation and translocation in cut leaves might be due to reduction in photosynthetic surface or utilization of energy for healing the wounds caused by shearing.

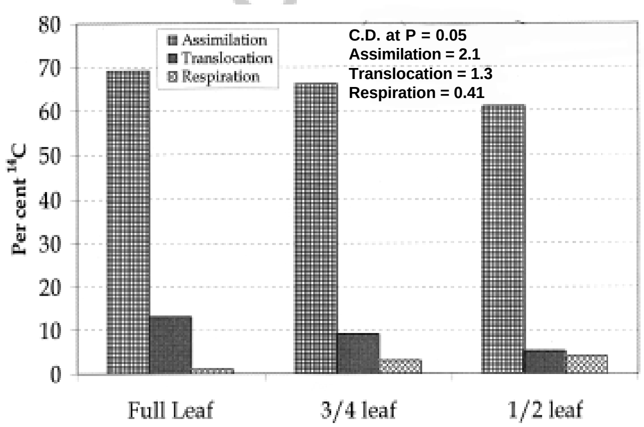

Fig. 2. Metabolic activities of leaves of different size formed due to shear harvesting of tea.

Reduction in maintenance foliage and alteration in metabolic activities in leaves influenced the carbohydrate reserve in roots (Fig. 3). Health and productivity of the bush are influenced by the physiological state of the maintenance foliage (Manivel and Hussain 1982). The study showed that there was no variation in root

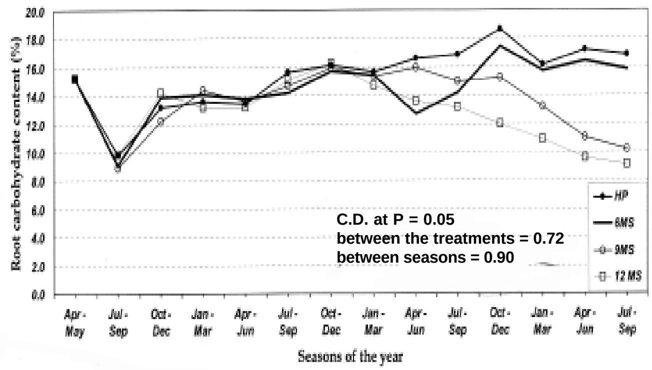

Fig. 3. Carbohydrate content in roots in different seasons with respect to different methods of harvesting in tea. (HP - Hand plucking, 6 MS - 6 months shearing, 9 MS - 9 months shearing, 12 MS - 12 months shearing)

carbohydrate content at the time of imposing treatments. Plants under continuous shear harvesting recorded low level of root carbohydrate in later stages. This might be either due to removal of the foliage that affected the source of supply of carbohydrates to the roots or an additional drain of root resources towards the developing new shoots since most of the mother leaves were injured due to shear harvesting (Nagarajah and Pethiyagoda 1965).

Growth of axillary buds and size of subtending leaves

Studies on shoot growth revealed that (Fig. 4) axillary bud with a subtending full leaf reached the plucking stage (three leaves and a bud) by 48th day, whereas, a bud supported by cut leaves of L1 and L2

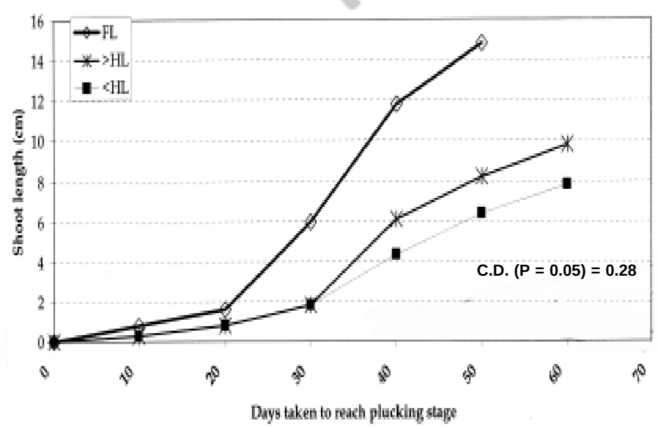

Fig. 4. Growth of axillary bud under different types of subtending leaves in tea. (FL - Full leaf, >HL - More than half leaf, <HL - Less than half leaf)

type took 54 days and 63 days, respectively, to reach the harvestable size. Although the buds have a full complement of photosynthetic apparatus, they depend totally upon maintenance foliage for photosynthesis (Marimuthu and Rajkumar 1997). The relatively large size of the photosynthetic machinery in full leaves was associated with high level of photosynthetic efficiency in assimilation and translocation of photosynthates which in turn helped them to increase the growth rate of their axillary buds considerably in comparison to cut leaves. Moreover, respiratory loss due to injury was less in full leaves. Barbora (1994) noticed that photosynthetic rate and respiration influenced the length of shoot growth cycle.

Percentage of banji buds, which affected the quantity and quality of final product, is considered as an indicator of stress in tea plant. Higher rate of banji bud formation was recorded where axillary buds were supported by cut leaves. In L1 type of leaves maximum number of shoots turned banji at two leaf or three leaf stage, whereas, in L2 type this happened even at one leaf or two leaf stage itself (Table 2). Higher rate of dormancy is associated

Table 2. Influence of style of plucking on banji formation.

	Stage of banji formation				
	Aborted bud	1L*1	2L	3L	Active bud at 3L
UPASI 3					
Full leaf	2	-	-	24	74
>half cut leaf (L1)	30	-	24	32	12
<half cut leaf (L2)	50	18	28	4	-
UPASI 9					
Full leaf	4	-	-	15	81
>half cut leaf (L1)	18	-	19	30	33
<half cut leaf (L2)	38	11	26	18	7
UPASI 17					
Full leaf	6	-	2	19	73
>half cut leaf (L1)	27	-	19	40	14
<half cut leaf (L2)	46	14	22	25	3

*1- leaves

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with reduction in the supply of reverse food materials (Ajayakumar and Vinod 2002).

Clonal variation in growth characteristics of axillary buds was observed under different treatments (Table 2). In UPASI – 9, a higher percentage of axillary buds with subtending leaves of different size reached the 3 leaf stage with active bud, when compared to the other two clones. Also the number of axillary buds aborted were minimum. This confirmed the comparative resistance of China clone to shear harvesting. Barbora and Baruah (1996) also noticed that Chinary type plants performed better results in response to shear harvesting.

Biometric parameters of shoots such as length, weight, diameter of internode and area of first leaf decreased with a decrease in the area of the subtending leaf of axillary bud (Table 3). Haridas *et al*. (1982) noticed that shoots developed from the axils of mother leaf was more vigorous than those around the axils of small leaves. The present results showed that even the reduction in size of the subtending leaf by shearing affected the size of the new shoot. This results in confirmation with the observation of Krishnamurthy *et al*. (2000) regarding the influence of subtending leaf on its axillary shoot growth.

Reduction in the size of the subtending leaf increased the leaf : stem ratio of shoot. This would influence enzyme-subtrate ratio which may have direct bearing on the quality of made tea. It has been reported that a major portion of the subtrate (polyphenols) for quality of made tea is in leaf lamina (Muraleedharan and Hudson 2000) and that enzymes are present in internodes of shoot (Stephen and Sheshadri, 1990).

Table 3. Biometric parameters of shoots developed under different types of subtending leaves.

	Full leaf	>half cut leaf (L1)	<half cut leaf (L2)	CD at 5 %
Length of shoot (cm)	15.40	12.61	8.42	0.28
Weight of shoot (g)	3.21	2.76	1.81	0.05
Diameter of internode (mm)	3.20	2.60	2.10	0.48
Area of 1st ML (cm^2)	26.10	24.70	21.30	4.42
Leaf weight (g)	1.91	1.71	1.29	-
Stem weight (g)	1.30	1.05	0.55	-
Leaf/stem	1.47	1.63	2.34	-

ML – Mother leaf

The study has revealed the role of subtending leaf on the growth of the axillary bud and banji formation. Continuous shear harvesting increased the production of cut leaves of smaller size which in turn reduced shoot growth. Moreover, carbon dioxide assimilation and translocation were adversely affected in cut leaves which ultimately led to the reduction of bush health and productivity. A full leaf or big cut leaf (that retains at least half of its area) was found to be essential for an axillary bud to grow up to standard plucking stage of three leaf and a bud, within the minimum time.

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