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Effect of chemical pruning as an alternative for development of lateral branches in young newly planted tea

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Abstract
The present study was carried out to evaluate the effect of chemical pruning as a alternatives for development lateral branches in newly planted tea. The experiment was laid out in ten treatments with three replications in Randomized Block Design (RBD). In the experiments the applied chemical was chlormequat chloride in various concentrations i.e. 1000 ppm, 1500 ppm and 2000 ppm. Treatments which were treated with chlormequat chloride showing better results in number of laterals, number of leaves per lateral and plant, chlorophyll content as compared to conventional method. The treatment T9 (CMC @ 1500 ppm three times at 30 DAP, 45 DAP and 60 DAP) at 60 days, 90 days and 120 days after application was observed to be the most favorable treatment. The application of CMC as an alternative to frame formation prune is found to be viable over the conventional method of frame formation operation in young tea plants.

Keywords: Chemical pruning, chormequat chloride, chlorophyll, conventional method

Introduction
Botanically, tea is a perennial, leafy shrub of up to 1m in height with woody stems. But harvesting portion of tea is the young tea shoots which are plucked at certain plucking intervals and plucking is normally done at 7-11 day intervals in the plains of N.E. India. So, tea plants are needed to keep at a certain bush frame to generate more plucking points thus leading to higher production. Cultural practices, is one of the factors that has been shown significant influence on framing proper bush frame and higher growth for better yield and quality of tea. (Venkatesh *et al.*, 2007) [8]. Pruning is an important cultural practice in tea to limit the top growth and to stimulate the growth of the bush. It is a process to the tea bush which is given at a certain height to control the vertical growth and allow it expanding horizontally for comfortable plucking with renewed and vigorous branching pattern. By pruning young tea plant, a flat and even plucking table is developed in such a way so as to provide sufficient maintenance foliage and to allow free passage of light and air to the bush for maintaining the health and vigour required for continued production of shoots. Growth regulators are also being used as a tool for young tea pruning. Growth regulators help in promotion of laterals in young tea and it is also called as chemical pruning. Chemical pruning is the application of agricultural chemicals to remove the quantity of vegetative or reproductive plant parts on an individual plant in order to alter the shape, size, growth pattern, flowering or fruiting of a plant. It restricts the shoot growth of tea plant by suppressing the meristematic activity in the apical zone of leading stem. A number of chemicals are known to stimulate branching by suppressing meristematic activity in the apical zone of leading stem and have been tried both in the nursery and transplanted young tea plants (Manivel, 1977; 1988, Barbora *et al*. 1989) [4, 5, 1].
However, centering-out of the main stem will be necessary after growth of the laterals. Otherwise, chemical action in the plant is neutralized by this time and central stem may resume its growth. Clones were reported to vary in their response to treatments. New consumer demands create needs for higher production with higher quality in less time and at lower costs. Also scarcity of skilled workers creates difficulty in tea plantations, specially, in time specific operations such as pruning of young and mature tea. It also affects productivity of the crop leading to lowering of the profit margin. Chemical pruning or chemical regulation of plant growth in young tea may be justified as an answer in regulating plant growth to fit

Current needs for cultivating a commercially important crop such as tea; as this could do away with worker-intensive operations of frame formation prunes in young tea.

Materials and Methods

The investigation was carried out on a month old young tea plantation; during 2016-17 in section no 13 of the Experimental Garden for Plantation Crops, Department of Tea Husbandry and Technology, Assam Agricultural University, Jorhat. The experiment was conducted for evaluation of chemical pruning as an alternative, for cessation of top growth and promotion of laterals in young tea. The experimental site was situated at 26°47' N latitude and 94°12' E longitude and at an elevation of 96.5 m above mean sea level.

A. Planting material

In the present experiment TV 23 is used as a planting material. This vegetative clone was released by Tocklai Experimental Station (presently TTRI), Jorhat in 1976 and is extensively used for commercial cultivation in N.E. India. It is cambod type yield clone, tolerant to drought and good for CTC manufacture. The clone has a spreading and dense frame with medium leaf type and medium shoot size. It is a very good rooter having good tolerance to moisture stress.

B. Plant growth regulator

The plant growth regulator used in the present experiment for promotion of laterals in young tea plant was Chlormequat chloride. Chlormequat chloride is an organic compound and most important inhibitor of gibberellin biosynthesis. It inhibits cell elongation, apical dominance, produces more branches and thicker stalks. Application of chlormequat chloride as a foliar spray is most effective when made under slow-drying conditions, such as early morning or on a cloudy day. Misting or watering should be avoided for at least six hours after application to ensure plant uptake of the PGR. In this experiment, Chlormequat chloride was applied at three concentrations *viz*, 1000 ppm, 1500 ppm and 2000 ppm at different time intervals.

C. Details of the experiment

Location	:	Experimental Garden for Plantation Crops, AAU, Jorhat-13
Design	:	Randomized Block Design (RBD)
Replication	:	3 (Three)
Treatment	:	10 (Ten)
Total number of plots	:	30 (Thirty)
Number of plants per plot	:	10
Net experimental area	:	204 m^2
Planting materials	:	TV 23
Chemical used	:	Chlormequat chloride ($C_5H_{13}ClN$)
Planting date	:	5th July, 2016
Chemical Application date	:	1st spray - 5th August, 2016 (30 days after planting) 2nd spray - 20th August, 2016 (45 days after planting) 3rd spray- 4th September, 2016 (60 days after planting)

D. Treatment details

The experiment was laid out in Randomized Block Design comprising 10 treatments and 3 replications. The details of the treatments used in the experiment are (Table 1):

Table 1: Treatment details

Treatments	Days		
	30 DAY	45 DAY	60 DAY
T1	Control*		
T2	CMC @ 1000 ppm	-	-
T3	CMC @ 1500 ppm	-	-
T4	CMC @ 2000 ppm	-	-
T5	CMC @ 1000 ppm	CMC @ 1000 ppm	-
T6	CMC @ 1500 ppm	CMC @ 1500 ppm	-
T7	CMC @ 2000 ppm	CMC @ 2000 ppm	-
T8	CMC @ 1000 ppm	CMC @ 1000 ppm	CMC @ 1000 ppm
T9	CMC @ 1500 ppm	CMC @ 1500 ppm	CMC @ 1500 ppm
T10	CMC @ 2000 ppm	CMC @ 2000 ppm	CMC @ 2000 ppm

* Control: After the plants are established in the field the growth of apical portion is ceased by adopting any of the TRA recommended methods such as debudding or lung pruning, followed by decentering.

E. Planting and aftercare operations

TV23 plants of uniform size and health were used in the experiment for planting. After establishment of the plants, by observing their growth habit, treatments were applied in conformity with the treatment detail. The experiment site was maintained by periodic weeding. A light irrigation was applied in 1st / 2nd / 3rd/ 4th week of October - November due to the onset of droughty condition.

F. Spraying

Chlormequat chloride was applied at three concentrations *viz*, 1000 ppm, 1500 ppm and 2000 ppm at 30 DAP, 45 DAP and 60 DAP. For preparation of 1000 ppm, 1 ml CMC added in 1000 ml of water. For preparation 1500 ppm, 1.5 ml CMC added in 1000 ml of water and for preparation of 2000 ppm, 2ml CMC added in 1000 ml of water. Uniform amount of spray fluid was applied to the plants using a high volume hand operated sprayer, thoroughly drenching the foliage. All the spray fluid concentrations were applied separately and spraying was done in early morning hours.

G. Details Observation

Effectiveness

(a) Number of laterals

Laterals developed from the main stem till 20 cm from ground level was recorded for each plant at monthly intervals and expressed as number of laterals.

(b) Number of leaves per lateral and per plant

The number of leaves per lateral and per plant in each individual plant was recorded monthly intervals.

(c) Chlorophyll content

Chlorophyll content was estimated by non-maceration method. The Leaf slices weighing 0.5g were transferred to test tubes containing 5 ml Dimethyl Sulfoxide (DMSO). The tubes were then incubated at 65 ^{0}C for 2 hours. Absorbance of the extract was read at 645 nm and 663 nm using a spectrophotometer. Chlorophyll content was calculated using the following formulae and expressed in mg/g.

Chl. a (mg/g) = [12.7(A_{663}) - 2.69(A_{645})] × [V/ 1000×W]

Chl.b (mg/g) = [22.9(A_{645})-4.68(A_{663})] × [V/ 1000×W]
Total Chlorophyll (mg/g) = [20.2(A_{645}) +8.62(A_{663})] × [V/ 1000×W]

Where
V= Final volume made up (ml)
W= Weight of samples taken (g)
A_{663}= OD value at 663nm
A_{645}= OD value at 645nm

Statistical analysis
The data pertaining to various characters were statistically analyzed adopting the procedure of analysis of variance by Cochran and Cox (1963).Whenever variance ratio (F) was significant, critical difference (CD) was reported at 5 per cent probability level otherwise only SEm (+) was mentioned.

Results
(A) Number of laterals per plants
In the present experiment, the mean number of laterals per plant for various treatments at monthly intervals is recorded and presented in Table 2. It was observed that all the treatments showed significant difference at 60 days, 90 days and 120 days after application of CMC. The treatment T9 (CMC 1500 ppm three times at 30 DAP, 45 DAP and 60 DAP) maximum number of laterals per plant at 60 days (1.93), at 90 days (3.80) and 120 days (4.67) interval were recorded, which was followed by treatment T6 at 60 days (1.90), at 90 days (3.27) and at 120 days (4.53). The results of the present investigation are also in accordance with the finding observed by Bhuyan and Saikia (2001-02). The results of present investigation are also in accordance with the findings observed by Bhuyan and Saikia (2002), who reported that higher doses CMC (1000-2000) produced 4-5 laterals within 20 cm from the ground level after 120 days of application. The minimum numbers of laterals per plant was recorded in treatment T1 (control) at 60 days (1.40), at 90 days (2.77) and at 120 days (3.77) after application of CMC respectively. The recorded mean data are also presented in Fig 1 and corresponding analyses of variance are appended table 3.

Table 2: Effect of application of Chlormequat chloride on mean number of laterals in young tea plant

Treatments	At 60 days	At 90 days	At 120 days
T1	1.40	2.77	3.77
T2	1.43	2.93	3.97
T3	1.80	3.21	4.04
T4	1.68	2.70	3.90
T5	1.74	3.00	3.93
T6	1.90	3.27	4.53
T7	1.62	3.03	3.97
T8	1.47	3.07	4.23
T9	1.93	3.80	4.67
T10	1.60	3.07	4.37
F-test	*	*	*
S.Ed.	0.161	0.192	0.239
CD (0.05)	0.338	0.404	0.502
CV%	11.93	7.64	9.08

* Significant at 5% level

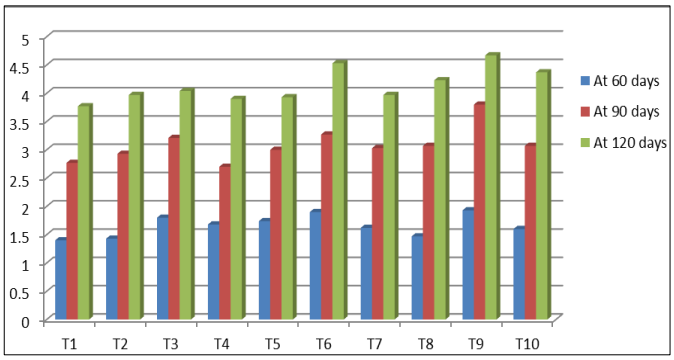

Fig 1: Effect of application of Chlormequat chloride on mean number of laterals in young tea plant

Table 3: Analysis of variance for number of laterals at 60, 90 and 120 days after application of CMC

Source of variance	d.f.	Mean squares		
		Number of laterals		
		60 days	90 days	120 days
Replication	2	0.09	0.059	0.043
Treatment	9	0.106	0.280	0.267
Error	18	0.039	0.055	0.858
Total	29			

(A) Numbers of leaves per laterals
In the present experiment, data recorded on mean number of leaves per laterals at monthly interval of growth under influence of various treatments are presented in Table 4. It was observed that there was no significant difference amongst the treatments with respect to mean number of leaves per lateral at 60 and 90 days after application of CMC. At 60 and 90 days, the highest number of leaves per lateral was recorded in T9 (4.31 and 4.86). The minimum number of mean leaves per lateral was observed in treatment T1 (control) both at 60 days (3.29) and 90 days (3.67). At 120 days after application of CMC, the treatment T9 (14.27 cm) had the highest mean number of leaves per lateral which was significantly higher than the mean number of leaves recorded in the treatments T1 (4.23), T2 (4.33), T3 (4.68), T4 (4.41), T5 (4.37), T7 (4.67) and T8 (4.42). However, the mean number of leaves per lateral were similar and statistically at par in the treatments T6 (5.21), T9 (5.64) and T10 (5.02). The treatment T1 (4.23) recorded the lowest mean number of leaves per lateral at 120 days after application of CMC. The results of the present investigation are also in accordance with the results obtained by Sahewalla *et al.* (1996) [6] who reported that Paras Photosynth (0.25% w/w) when sprayed in combination with micronutrient mixture (Tracel 5%) improves the overall growth of nursery tea plants significantly with increase in the number of leaves per lateral, number of total leaves and number of laterals per plant. Kumar and his co-workers (2012) [3] also reported that Cycocel application at 2400 ppm was found to be most effective in marigold plants as it gave the highest number of leaves per plant and maximum number of main branches per plant. The recorded mean data are presented in Fig 2 and corresponding analyses of variance are appended in table 5.

Table 4: Effect of Chlormequat chloride on mean number of leaves per lateral.

Treatments	At 60 days	At 90 days	At 120 days
T1	3.29	3.67	4.23
T2	3.32	3.82	4.33
T3	3.51	4.30	4.68
T4	3.33	3.76	4.41
T5	3.31	4.23	4.37
T6	3.55	4.43	5.21
T7	3.26	4.24	4.67
T8	3.40	4.29	4.42
T9	4.31	4.86	5.64
T10	3.71	4.25	5.02
F-test	NS	NS	*
S.Ed	-	-	0.319
CD (0.05%)	-	-	0.671
CV%	-	-	8.34

* Significant at 5% level
NS- Non Significant

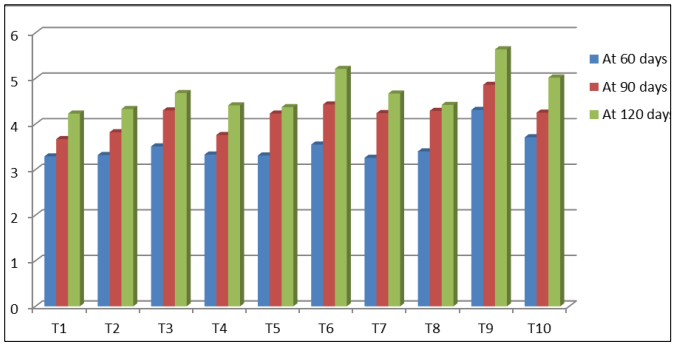

Fig 2: Effect of Chlormequat chloride on mean number of leaves per lateral

Table 5: Analysis of variance for number of leaves per lateral at 60, 90 and 120 days after application of CMC

Source of variance	d.f.	Mean squares		
		Numbers of laterals per lateral		
		60 days	90 days	120 days
Replication	2	0.10	0.22	0.32
Treatment	9	0.40	0.37	0.62
Error	18	0.45	0.23	0.15
Total	29	-	-	-

(C) Chlorophyll content

In the present experiment the chlorophyll content of leaf under influence of various treatments recorded at the end of the season are presented in Table 6. It is observed that highest chlorophyll a was recorded in the plants under treatment T9 (0.21 mg g^{-1}). Lowest chlorophyll a content was recorded in plants treated with T4 (0.1 mg g^{-1}) and T8 (0.1 mg g^{-1}). However, although a variation in chlorophyll a content was observed amongst the treatments, statistically the content was at par with no significant difference. Similar findings have been observed by Sorte *et al*. (1989) [7] who reported that an increase in concentration of CMC resulted in an increased chlorophyll contents of leaves in peanut. However, it has been suggested that the variation in chlorophyll content amongst the treatments due to the application of CMC may be attributed to inhibition of cell division, decreased chlorophyll degradation, increased chlorophyll biosynthesis and the development of chloroplasts. Similarly the highest chlorophyll b content of 0.19 mg g^{-1} was recorded in plants under T9 and lowest chlorophyll b (0.13 mg g^{-1}) was recorded in T1, T3 and T10. Variation in the chlorophyll b content amongst the treatments existed but the difference was statistically non-significant.

Total chlorophyll content was also highest in the treatment T9 (0.37 mg g^{-1}) and T3 (0.37 mg g^{-1}) where lowest total chlorophyll content recorded in T2 and T8. Variation in the total chlorophyll content amongst the treatments showed no significant difference. The recorded mean data of chlorophyll content are presented in Fig 3 and corresponding analyses of variance are appended in table 7.

Table 6: Effect of Chlormequat chloride on mean chlorophyll content of chlorophyll a, b and total chlorophyll (mg g^{-1})

Treatments	Chlorophyll a	Chlorophyll b	Total Chlorophyll
T1	0.17	0.13	0.29
T2	0.18	0.15	0.30
T3	0.20	0.13	0.37
T4	0.15	0.17	0.30
T5	0.16	0.16	0.34
T6	0.19	0.14	0.35
T7	0.17	0.15	0.34
T8	0.15	0.14	0.29
T9	0.21	0.19	0.37
T10	0.17	0.13	0.31
F-test	NS	NS	NS
S.Ed	-	-	-
CD (0.05)	-	-	-
CV%	-	-	-

NS- Non Significant

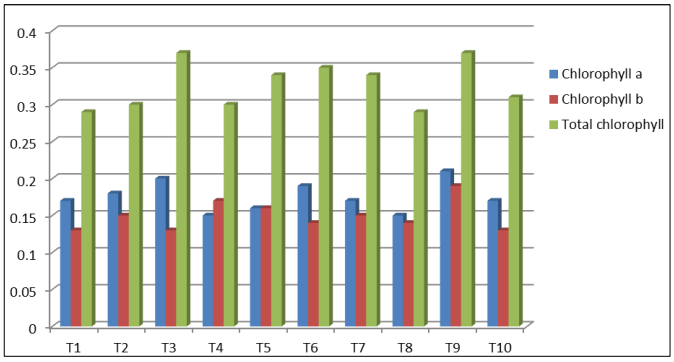

Fig 3: Effect of Chlormequat chloride on mean chlorophyll content of chlorophyll a, b and total chlorophyll (mg g^{-1}).

Table 7: Analysis of variance for chlorophyll content

Source of variance	d.f.	Mean squares		
		chlorophyll		
		Chlorophyll a	Chlorophyll b	Total chlorophyll
Replication	2	0.002	0.00029	0.0045
Treatment	9	0.001	0.0011	0.0031
Error	18	0.001	0.0011	0.0020
Total	29	-	-	-

Conclusion

It can be concluded from the findings of present investigation that treatments which were treated with chlormequat chloride showing better results in number of laterals, number of leaves per laterals and chlorophyll content as compared to conventional method. The treatment T9 (CMC @ 1500 ppm three times at 30 DAP, 45 DAP and 120 DAP) at 60 days, 90 days and 120 days after application was observed to be the most favorable treatment in relation to in number of laterals,

numbers of leaves pr laterals. Significant difference was not observed in relation to total chlorophyll content of the young tea plants in all the treatments. However, highest total chlorophyll content was observed in treatment T9 (CMC @ 1500 ppm three times at 30 DAP, 45 DAP and 120 DAP) amongst all the treatments.

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