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Research Article

Performance of Leaf Bud Cuttings of Tea Cultivars Under Different Fertilizer Management

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Abstract

The experiment was conducted to evaluate growth and development of leaf bud cuttings of eight tea cultivars/varieties under four fertilizer management practices in poly bag filled with soil at Kewacherra Division of Lackatoorah Tea Estate, Lackatoorah, Sylhet during July 2018 to May 2019. The eight cultivars/varieties were viz., BT1, BT2, BT4, BT6, BT12, BT16, TV1, and TV23 and the four fertilizer management practices were viz., F1 = Only native fertility soil i.e. no fertilizer was used, F2 = Chemical fertilizer at the ratio 2:1:1 (Urea: MOP: TSP) where 2 g of fertilizer was added in each poly bag, F3 = Chemical fertilizer at the ratio 2:1:1 (Urea: MOP: TSP) where 1 g of fertilizer was applied in each poly bag and in addition 1g of organic manure mixture (Compost: Rotten cow dung: Mustard Oil Cake: Bone Meal) at the ratio 1:1:1:1 was used and F4 = Only 2 g of organic manure mixture (Compost: Rotten cow dung: Mustard Oil Cake: Bone Meal) at the ratio 1:1:1:1 was used. The experiment was set up in a factorial Randomized Complete Block Design (RCBD) with three replications. Significant variations was observed in terms of growth and some growth characters of tea leaf bud cuttings due to different varieties as well as fertilizer management. It was observed that hybrid variety TV23 showed higher growth performances in respect of fresh weight, plant height, root length and root weight which was followed by the variety BT16. Different fertilizer managements had better responses in the cultivars TV1, BT12 and BT16. The combined effect of variety and fertilizer was better in shoot growth of the variety TV1 with F2 i.e., chemical fertilizer at the 2:1:1 (Urea: MOP: TSP) where 2 g of fertilizer was added in each poly bag. On the other hand, better root growth of the cuttings of the varieties TV1, BT12, BT16 and TV23 were observed with F4 where 2 g of organic manure mixture of Compost: Rotten cow dung: Mustard Oil Cake: Bone Meal at the ratio of 1:1:1:1 was used for in each poly bag.

Keywords: Fertilizer; Cuttings; *Camellia sinensis L*

Introduction

Tea (*Camellia sinensis L.)* is one of the oldest and the most extensively used drink, ranking second among the world's most consumed beverages. Every day the consumption and the popularity of tea are increasing. Almost three billion cups of tea are consumed every day around the world [1]. World tea production in 2021 increased to an estimated 6.5 million tonnes, from 6.3 million tonnes in 2020 [2]. China is the leading producer of tea, followed by India, Kenya, and Sri Lanka. Bangladesh is ranked 12th in tea production in 2020 (https://www.worldatlas.com).

In Bangladesh, tea is the second largest export-oriented cash crop following jute. Tea production has expanded more than 4.25

times since 1947, from around 20.11 million tons to 85.6 million tons in 2017-18 [3]. Currently 56846 hectares of land are occupied with tea cultivation having annual production of about 85.6 million tons with an average yield of 1505.6 kg ha^{-1} [4]. With the integrated effort by the tea researchers, planters and tea labours, our country is now very close to self-sufficiency in tea production.

Tea is often reproduced through two methods; seed propagation and tea leaf bud cuttings. However, tea leaf bud cutting is more popular because tea is a highly cross-pollinated plant, and seedlings differ from their parents if reproduced via seed. Additionally, the uniformity, quality and quantity of tea may deteriorate by seed propagation. On the other hand, tea cuttings are taken from selected mother plants which ensure genetically pure, high yielder and uniformity in quality as well as quantity. Nursery is the initial plant protection step to obtain healthy, vigorous plant for further field planting [5]. In our country, the main reasons for low yield and poor tea quality are due to wrong selection of tea varieties and poor nutrient management in nursery. Consequently, the weak plants are more susceptible to numerous diseases and pests. These plants develop slowly and, in most cases, exhibit poor growth and yield throughout their lives. Moreover, fertilization is an important factor for proper nourishment, growth and development of tea leaf bud cuttings. Insufficient nutrient can cause poor growth [6]. On the other hand, different cutting materials responds differently to management practices [5]. As a result, suitable plant materials and proper nutrition management required to find out; otherwise, the estate and the tea industry as a whole may suffer severe losses. Therefore, these problems can be minimized by properly managing the nutrients of the leaf bud cuttings grown in poly bags in the nursery bed. Keeping the above aspects in consideration, the following objectives were set for the study:

- To evaluate the growth performance and growth rate of the leaf bud cuttings of most popular and widely cultivated tea varieties under different nutrient managements.
- To determine the most suitable tea variety for this region using leaf bud cuttings and nutrient management options.

Materials and Methods

The experiment was carried out in poly bag filled with soil at Kewacherra Division of Lackatoorah Tea Estate, Lackatoorah at Sylhet. The experiment was carried out under the supervision and monitoring of Department of Agronomy and Haor Agriculture, Sylhet Agricultural University (SAU). The experiment was conducted during the period of July 2018-May 2019. The experimental field is located at 24.95° N latitude and 91.87° E longitude at an average altitude of 15 m above the mean of sea level. The experimental area belongs to the agro-ecological zone of the Sylhet Basin (AEZ-21). The land was medium high and the soil was sandy loam, medium fertile with an acidic nature (pH 4.82) and low in organic matter content (1.0%). The drainage system was good and water does not stagnate in the experimental field since it is located on sloppy high ground. The experimental region has a tropical monsoon environment with high temperatures, high humidity, and heavy rainfall ranging from 3600 mm to 4200 mm with strong winds from April to September.

The experimental treatments consist of two factors, factor A-leaf bud cuttings of eight tea cultivars viz. V1 = BT2, V2 = BT4, V3 = BT6, V4 = BT12, V5 = BT16, V6 = TV1, V7 = BT1, V8 = TV23, (here BT varieties are developed by Bangladesh Tea Research Institute, TV developed by Tea Research Institute of India) and factor B-four levels of fertilizer management viz. F1, F2, F3, F4. Where, F1 = No fertilizer, i.e., a polybag (10"× 4") was filled with native soil and leaf bud cuttings were planted in it without any fertilizer, F2 = Soil combined with chemical fertilizer in a 2:1:1 ratio (Urea, MOP, TSP), with 2 gm of fertilizers mixed with soil in each poly bag of the same size for growing leaf bud cuttings, F3 = Soil combined with chemical fertilizer at 2:1:1 (Urea: MOP: TSP) while soil was mixed with 1 gm of fertilizer in addition to 1gm of organic manure mixture (Compost: Rotten cow dung: Mustard Oil Cake: Bone Meal) at the ratio of 1:1:1:1 in each poly bag of same size. i.e., F2+1 gm. of organic manure mixture and F4 = Soil with only 2 gm of organic manure mixture (Compost: Rotten cow dung: Mustard Oil Cake: Bone Meal) at the ratio of 1:1:1:1in each poly bag of same size.

The experiment was laid out in a Factorial Randomized Complete Block Design (RCBD) with three replications. All the treatment combinations were assigned at random. Leaf bud cuttings were collected from BTRI by the source of NTC (National Tea Company Ltd), Lackatoorah Tea Estate, Sylhet.

Leaf bud cuttings were dipped in a fungicidal copper oxychloride solution in a water bucket for 3-5 minutes. Then the cutting was transplanted into the nursery poly tube. Then, a high-

density polythene tube (HDPE) was filled with virgin sandy loam soil and placed on the bed. The bed was covered with a 0.5-inch-thick sand layer for proper drainage of the excess water. Then, the filled tube was placed on the nursery bed. A bamboo frame was built to support the HDPE tube, and the area was covered with an agro net 5 feet above the ground to protect them from the scorching sun, hail, storms, and heavy rains, while also providing an environment appropriate for the growth of tea cuttings. Weeds were removed, and irrigation was applied to the nursery bed as needed. Fertilizer was applied again in all the treated poly bags as per treatment except for the F1. The grown cuttings were marked and placed in the treatment plots according to treatments. The tubes were cleaned of dead cuttings and mother leaves, as well as dead cuttings and mother leaves on the tubes. After the cutting was established, two hand weeding's were performed at a 20-day interval after setting of cuttings. There were a few minor diseases, such as stem rot, die back, and root rot, which were controlled using "Champion" fungicide. The pesticide "Shengli' was used to protect from tea mosquito bugs, aphids, and other insects. The water supply was maintained at 4–5-day intervals in all plots throughout the dry season using the sprinkler irrigation system throughout the growth period to meet the water requirements of the tea plant. Excess water was drained from the plots immediately through the sand layer.

Data on plant fresh weight (gm), the plant height (cm), number of branches per plant^{-1}, number of roots, root length (cm), plant fresh weight (gm), and root weight (gm.) were taken to determine the growth pattern following destructive sampling method. Plant height was measured from the base of the plant to the tip of the longest branch at 30, 75, 150, and 225 day intervals. Number of branches per plant-1 was counted after appearing of branch from 200 DAT to end of work... Root numbers were counted at 30, 75, 150, and 225 days intervals from the cutting. Root length also measured at same days intervals by taking the longest root. Root weight (gm) was measured at 75, 150, and 225 days intervals after washing the plants with water without disturbing the roots. The recorded data were compiled and analyzed using "R" Software. The mean differences among the treatments were tested with LSD following [7].

Results and Discussion

Effect of fertilizer management on growth parameters of tea cultivars

Fresh weight

The fresh weight of saplings of different tea cultivars significantly varied due to interactions among variety and fertilizer management (Table 1). The highest fresh weight (0.046 gm.) was recorded in V3F1 due to variety and fertilizer effects at 30 DAT, which was on par with V3F1 with a fresh weight of 0.044 gm. Though fresh weight showed a statistically significant difference at 75 and 150 DAT, the trend was not mentionable. Finally, at 225 DAT, the highest fresh weight was recorded at V8F2, i.e., TV23 with inorganic fertilizer management, which was at par with this V6F2 (TV1). Both are hybrid teas, and the positive response might be due to fertilizer management. It showed that as plant age increased, the fertilizer effect became more visible, with the highest in V8 (TV23) and the lowest in V7 (BT1).

Plant height

Plant height of different tea cultivar significantly affected due to interactions of variety and fertilizer management (Figure 1). The tallest plant (0.98 cm) was in at V6F1 due to variety and fertilizer effect at 30 DAT. Though plant height showed statistically difference at 75 and 150 DAT but the trend was not mentionable. Finally at 225 DAT (Figure 1d) highest Plant height recorded at V6F2 (36.74 cm) which was at par with this V8F2, V5F2 and V4F2. It indicates with the increasing of plant age fertilizer effect was visible and highest was in V6 i.e., cultivar TV1 and lowest was recorded in V7 i.e., BT1. Here the similar trend of better height of hybrid tea varieties was observed among all varieties in the experiment. Indian origin Assam tea variety i.e., TV cultivars or parent line showed better result in plant height with combination of full synthetic fertilizer management.

Fresh weight (g/saplings)				
Treatment	**30 DAT**	**75 DAT**	**150 DAT**	**225 DAT**
V1F1	0.011 c	0.40 e	0.80 fghi	2.06 m
V1F2	0.011 c	0.42 de	1.30 ab	5.06 bcd
V1F3	0.011 c	0.42 cde	0.76fghij	3.86 jk
V1F4	0.011 c	0.42 de	0.66 ij	4.33 ghij
V2F1	0.007 c	0.393e	0.70 hij	2.40 m
V2F2	0.010 c	0.403e	1.23 bc	5.13 bc

V2F3	0.012 c	0.410 e	0.70 hij	4.33ghij
V2F4	0.011 c	0.423 de	0.70 hij	4.33 ghij
V3F1	0.046 a	0.386 e	0.70 hij	2.33 m
V3F2	0.011 c	0.396 e	1.23 bc	4.76 cdefg
V3F3	0.044 ab	0.410 e	0.73 ghij	4.06 ij
V3F4	0.011 c	0.420 de	0.700 hij	4.53fghi
V4F1	0.016 c	0.483 abcd	1.100 cd	2.533m
V4F2	0.016 c	0.486 abcd	1.43 a	5.53 ab
V4F3	0.015 c	0.486 abcd	0.900 efg	4.700 cdefg
V4F4	0.016 c	0.520 a	0.700 hij	4.833 cdef
V5F1	0.016 c	0.433 bcde	1.060 cde	2.420 m
V5F2	0.011 c	0.483 abcd	1.300 ab	5.833 a
V5F3	0.016 c	0.486 abcd	0.766 fghij	4.633 defgh
V5F4	0.016 c	0.486abcd	0.700 hij	4.566 efgh
V6F1	0.015 c	0.520 a	1.100 cd	2.166 m
V6F2	0.016 c	0.433 bcde	1.100 cd	5.700 a
V6F3	0.016 c	0.493 abc	0.866 efgh	4.533 fghi
V6F4	0.017 c	0.496 ab	0.700 hij	4.733 cdefg
V7F1	0.011 c	0.226 f	0.610 ijk	1.393 n
V7F2	0.010 c	0.393 e	0.733 ghij	3.533 kl
V7F3	0.010 c	0.403 e	0.600 jk	2.266 m
V7F4	0.010 c	0.410 e	0.433 k	4.166 hij
V8F1	0.0200 bc	0.510 a	1.233 bc	3.196 l
V8F2	0.019 c	0.486 abcd	1.233 bc	5.966 a
V8F3	0.018 c	0.520 a	0.933 def	4.633 defgh
V8F4	0.020 bc	0.433 bcde	0.800 fghi	5.033 cde
CV (%)	94.84	9.63	13.73	7.18
LSD (0.05)	0.02	0.06	0.19	0.47

Table 1: Effect variety and fertilizer management on fresh weight of different tea saplings at different days after transplanting (DAT).

Here, V1 = BT2, V2 = BT4, V3 = BT6, V4 = BT12, V5 = BT16, V6 = TV1, V7 = BT1, V8 = TV23.

F1 = No fertilizer i.e. only native fertility soil and leaf bud cutting (sapling} were planted, F2 = chemical fertilizer at 2:1:1 (Urea: MOP: TSP) 2 gm of fertilizer in each plants., F3 = chemical fertilizer at 2:1:1 (Urea: MOP: TSP) 1 gm of fertilizer in each plants in addition with 1gm of organic manure mixture (Compost : Rotten cow dung: Mustard Oil Cake: Bone Meal at 1:1:1:1), F4 = Only 2 gm of organic manure mixture (Compost: Rotten cow dung : Mustard Oil Cake: Bone Meal at1:1:1:1).

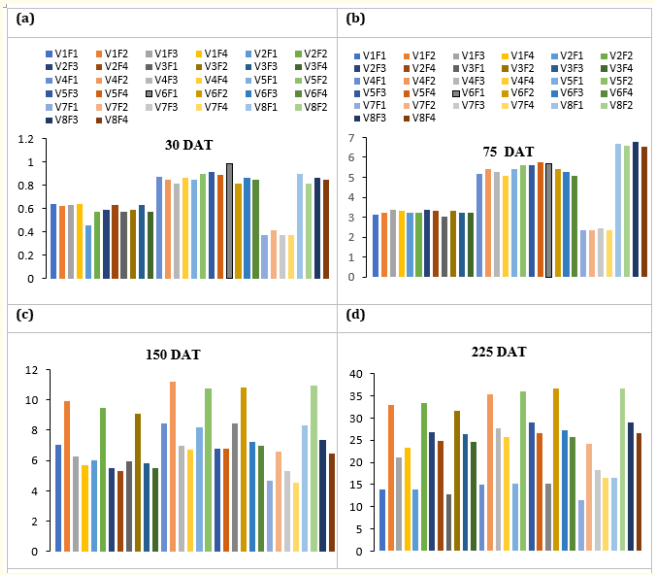

Figure 1: Effect of variety and fertilizer management on plant height of tea leaf bud cuttings at different days after transplanting (DAT).

Branch number

Branch number of different tea cultivar significantly affected due to variety and fertilizer management (Figure 2). The highest branching was marked at V7F4 (BT1, fertilizer management F4) at 225 DAT and lowest was recorded in V1F1 (BT2, fertilizer management F1). The results showed that F4 were better in almost all cultivars than other fertilizer management, its might be due to the addition of double amount of organic manure. Ipinmoroti [8] demonstrated that using organic fertilizer alone or in combination with urea can produce better results than using solely chemical fertilizer.

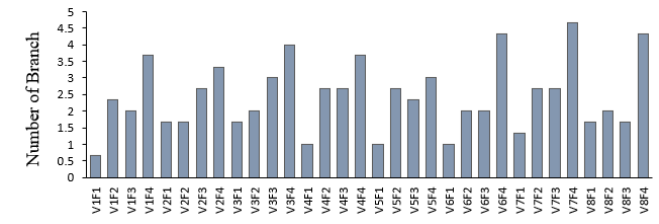

Figure 2: Effect variety and fertilizer management on Branch number of different tea saplings at 225 days after transplanting (DAT).

Root length

Root length of different tea cultivar significantly affected due to variety and fertilizer management (Figure 3). The highest root length (0.82 cm) was found at V8F1 at (30) DAT. Though root length showed statistically difference at 75 and 150 DAT but the trend was not mentionable. Finally at 225 DAT highest root length recorded at V8F1 i.e., TV23 which was at par with this V8F4, V4F1 and V6F4. It indicates with the increasing of plant age fertilizer effect was visible and highest was in V8 in TV23 and lowest was recorded in V7. Hamid *et al.,* 2000 also found considerable effect of fertilizer treatment on root number, length and root weight after considerable time period.

Root number

Root number of different tea cultivar per saplings significantly affected due to variety and fertilizer management (Figure 3). The maximum root number was recorded in tea cultivar BT16 without any fertilizer or native fertility level (V5F1) due to variety and fertilizer effect at (30) DAT. Though root number showed statistically difference at 75 and 150 DAT but the trend was not mentionable. Finally at 225 DAT highest root number (8.66) recorded at V3F1 i.e., BT6 without any fertilizer, which was at par with this V7F1. On the other hand, root number was decreased at V8F4. Indian origin Assam tea variety or parent line Assam cultivars i.e., TV with fertilizer management F1 i.e.no fertilizer produced longer root due to low inorganic nutrient availability, thus plants grew longer roots to meet up their nutrients from soil. However, the ability to create adventitious roots has also been related with the characteristic of the cutting materials which is supported by Hartmann., *et al.* [9] and Mwangi [10].

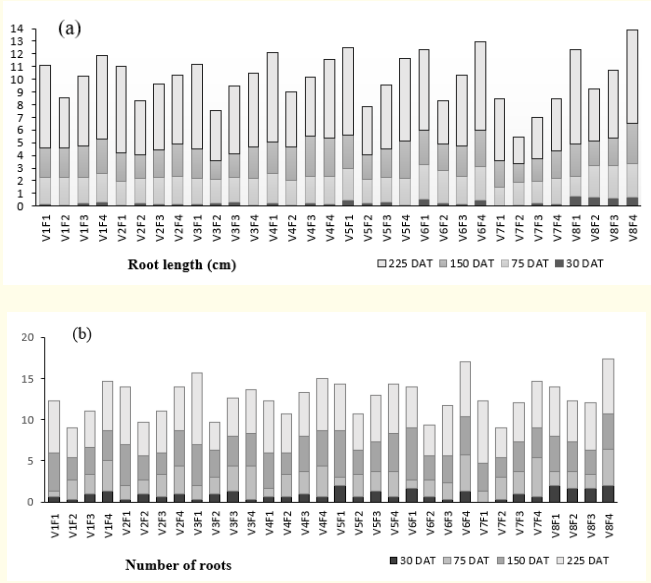

Figure 3: Effect of variety and fertilizer management on root length, number of roots and root weight of tea leaf bud cuttings at different days after transplanting (DAT).

Root weight

Root was just visible at 30 DAT. The root weight of different tea cultivars is significantly affected by variety and fertilizer management (Figure 3) at 75 DAT and onwards. The highest root weight (2.3 g) was in at V8F4 due to variety and fertilizer effect at 225 DAT. Though root weights showed a statistical difference at 150 DAT, the trend was not mentionable. Finally, at 225 DAT, the highest root weight recorded was at V8F4 which was at par with this V6F2, V5F2 and V4F2. It shows that as plant age increased, the fertilizer effect became more visible, with the highest in V8F4 and the lowest in V7F2. Assam tea variety or parent line cultivars, i.e., TV, in combination with fertilizer management F2, i.e., inorganic

fertilizer, plants grew more roots at first to meet up with their nutrients from the soil, but proper and continuous nutrient availability helped to grow healthy roots.

Conclusion

The results revealed significant differences in various growth characteristics such as fresh weight, plant height, root length, and root weight of the leaf bud cuttings owing to variety and fertilizer management. The hybrid variety TV23 demonstrated superior growth performance in terms of fresh weight, plant height, root length, and root weight, followed by the high yielding variety BT16. Different fertilizer management strategies resulted in improved responses in the cultivars TV1, BT12, and BT16. The combination of variety and fertilizer was superior for shoot growth of the variety TV1 with F2, i.e., chemical fertilizer, at a 2:1:1 ratio (urea: MOP: TSP), with 2g of fertilizer supplied in each poly bag. On the other hand, F4, which employed 2 g of an organic manure mixture of compost, rotting cow dung, mustard oil cake, and bone meal at a ratio of 1:1:1:1, resulted in better root development of the cuttings of the cultivars TV1, BT12, BT16, and TV23.

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