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Effect of Temperature in Breaking Bud Dormancy in Tea

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Abstract: In the present study nine tea varieties (Roupi, Jueking, Chyue, Hangshah, P-3, Turkish, Indonesian, Japanese and Serilankan) were exposed against four temperature (T0=10 °C, T1= 22 °C, T3=34 °C and T4=46 °C) treatments to select the most optimum temperature for braking bud dormancy. The study was carried out at National Tea and High Value Crop Institute (NTHRI) Shinkiari, Mansehra during 2012-2013. Data on various parameters *viz*; plant height, number of buds, number of leaves, leaf length, leaf width, stem thickness, chlorophyll contents and photosynthetic activities were recorded. The maximum number of buds was observed in Hangshah and Turkish at T2. On contrary, the minimum numbers of buds were observed in Indonesian, Jueking and Serilankan at T3. Significantly higher number (39.66) of leaves were recorded in Roupi followed by Turkish (35.66) and Hangshah (33.00) at T2, while the minimum number of leaves (2.00) was recorded in Serilankan at T3.The present results showed that though response of each tea varity to temperature treatments was different from one another however maximum; plant height, stem thickness, number of buds and number of leaves were observed at T2 (34 °C) in all the tea varieties. There was a differential response of each varity to all the treatment regarding leaf length and leaf width. It can be concluded from the study that T2 (34 °C) is the most suitable/optimum temperature for breaking bud dormancy and increasing plant growth, number of buds, number of leaves and ultimately yield of different tea varieties.

Key words: Dormancy · Tea · Temperature · Treatment

INTRODUCTION

Tea (*Camellia* spp) is ever green, dicotyledonous, cross pollinated and woody shrub, belongs to family Theaceae. Besides being a medicine, it is world's most popular beverage due to its palatability, comparative cheapness and other beneficial effects. It can adopt different agro-ecological conditions so can grow throughout the world. There are two main types of plant Narrow leaf or china type *(Camellia sinensis)* and Broad leaf or assam type *(Camellia assamica)* [1].

Tea contains a large number of possibly bioactive chemicals, including flavonoids, amino acids, vitamins, caffeine and several polysaccharides and a variety of health effects have been proposed and investigated. It has been reported that due the presence of catechins green tea is more effective in preventing certain obesity-related cancers such as liver and colorectal cancer, while both green and black teas may protect against cardiovascular disease [2].

The trend of world tea production was almost similar to as in case of area. The production from 1991 to 1997 was same as 2631.05 million Kg. On the other hand, in 1998 world tea production touched a new height of 3026.13 million kg. In 2000, it dropped to 2928.67 m kg with a compound growth rate of 1.20% during the period of 1991 - 2000. Again, from 2001 onwards production of tea increased gradually and reached 4162.33 m kg with a compound growth rate of 3.48% during the period 2001 – 2010. Thus over the two decades tea production has shown an increasing trend due to various reasons like increase in area for tea plantation, improved planting material, advanced technology including integrated package and practices for tea cultivation etc [3].

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In Pakistan, on the average per capita consumption of tea is one kg which is all being meeting through import. Pakistan is the third largest importer of tea after Russia and United Kingdom. Pakistan imports all its required tea from Kenya and Sri Lanka. During 2010-2011, Pakistan imported 127,316 tons of black tea costing Rs. 25.03 billion with the highest share from Kenya (55.01%) followed by India (17.13%) and Rwanda (5.69%), while green tea import was 3322 tons with the value of Rs. 353 million mainly from Vietnam with 64.38% followed by China with 29.76% [4].

Tea production is less than its demand as tea is usually multiply by clonal propagation but the major problem in clonal propagation is of bud dormancy because buds control growth in the vegetative developmental stages of many herbaceous plants and the juvenile stages of some trees [5]. While, low temperature is one of themajor cause of bud dormancy due to which tea plants remain dormant for 8 months and become active for only 4 months [6].

Therefore, the present study was designed to evaluate the effect of four temperature treatments on physiological traits of tea varieties to recommend the most suitable temperature that ensures high yield and best quality

MATERIALS AND METHODS

Study Area: The experiments were conducted at National Tea and High Value Crops Research Institute (NTHRI), Shinkiari Mansehra during 2012-13. District Mansehra is located at the eastern border of the Khyber Pakhtunkhwa, 244 km away from Peshawar and 170 km away from Islamabad. The district is geographically located at latitude (34.34 degrees) 34° 20' 24" North of the Equator and longitude (73.2 degrees) 73° 12' 0" East of the Prime Meridian on the Map of the world.

Plant Material and Experimental Design: The experiments were laid out in Randomized Complete Block Design (RCBD) having nine tea varieties and three replications. One year old tea plants of five varieties of *Camellia sinensis* (Roupi, Juking, Chyue, Hangshah, P-3) and four varieties of *Camellia assamica* (Turkish, Indonesian, Japanese, Serilankan) were used for experimentation with four treatments such as T0 (10 °C), T1 (22 °C), T2 (34 °C) and T3 (46°C). The experiment was carried out in laboratory and open field.

T0 was used as control and it was open field temperature (10 °C) at NTHRI, Shinkiari during November 1st 2102 to January 31st 2013. While T1 (22 °C), T2 (34 °C) and T3 (46 °C) were controlled growth rooms temperatures. Daily temperature readings in each treatment were calculated by thermometer. Each treatment having three plants of each verity and total of 27 plants. Hence total number of all the plants in all the treatments in was one hundred and eight (108). Cultural practices were kept uniformly both in the field and nursery.

Analysis of leaf pigment (chlorophyll) and photo synthetic activities were determined by the method of Arnon [7].

Following Parameter Were Studied: Data on following parameters was taken on regular interval of one month.

Plant Height (cm): Plant height of three plants was measured with the help of graduated scale.

Number of Buds and Leaves/Plant: Total number of buds and leaves per plant of three plants were counted and recorded on the mean basis.

Leaf Length and Leaf Width (cm): Lengths and width of three selected leaves from each plant were measured and then averaged.

Stem Thickness (mm): Stem thickness was measured 3cm above from the ground; it was measured by manual Venires Calipers, averages of three plants were recorded.

Data was collected on regular interval of one month by using the measuring tape.

Statistical Analysis: The data collected was interpreted using statistical software Statistix 8.1.

RESULTS

Plant Height: Statistical analysis showed significant variations in plant height at all the treatments (Fig.1). The obtained results explained that plant height was gradually increased at T0, T1 and T2 by increasing temperature and maximum increase was noted at T2 in all the Tea verities. However further increase in temperature treatments such as T3 caused great reduction in the plant height of all the verities as comparing to T2. The maximum plant height (45.00 cm) was recorded in Turkish followed by Hangshah (39.66cm) and Indonesian (30.66cm) at T2.

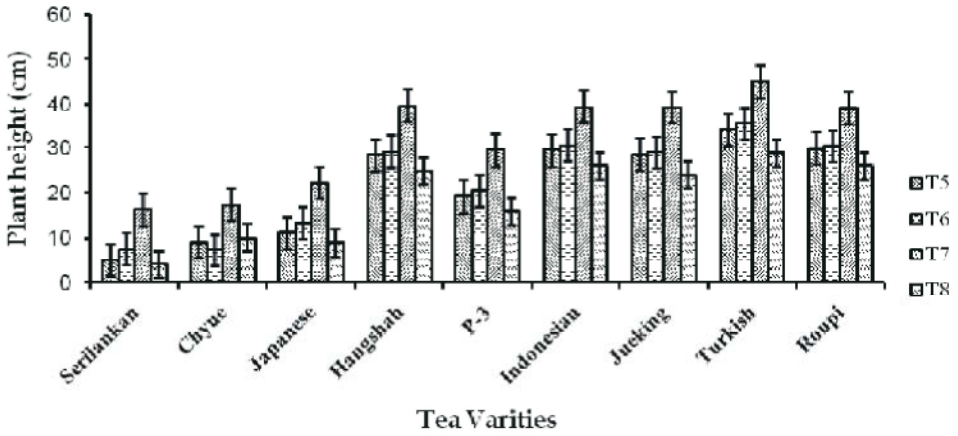

Fig. 1: The effect of temperature on plant growth of nine tea varieties (Roupi, Juking, Chyue, Hangshah, P-3, Turkish, Indonesian, Japanese, Serilankan. The data presented are mean of 3 replicates ± SE

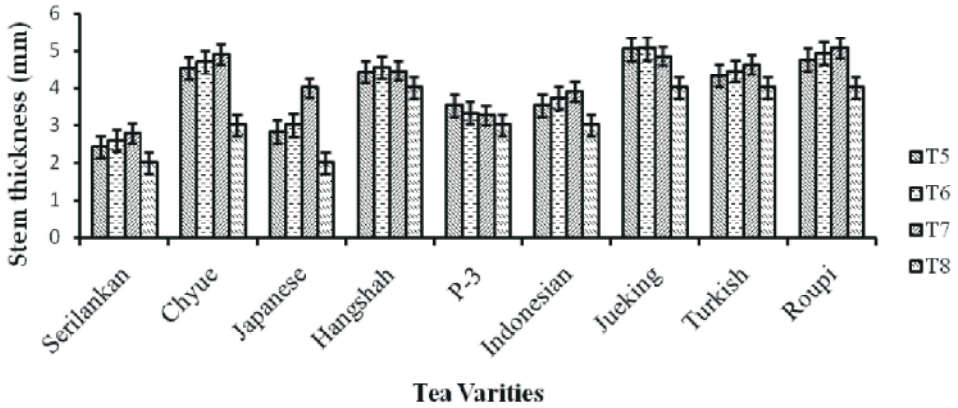

Fig. 2: The effect of temperature on stem thickness of nine tea varieties (Roupi, Juking, Chyue, Hangshah, P-3, Turkish, Indonesian, Japanese, Serilankan. The data presented are mean of 3 replicates ± SE.

Stem Thickness: Statistical analysis showed significant variations in stem thickness of different tea varieties at different treatments (Fig. 2). The maximum stem thickness (5.06 mm) was recorded in Roupi followed by Jueking (4.86 mm) and Turkish (4.63 mm) at T2, while the minimum stem thickness (2.00 mm) was observed in Japanese at T3. T0, T1 and T2 were statistically similar having non-significant difference with respect to Roupi, Jueking, Turkish, Serilankan, Chuye and Indonesian, while stem thickness of all the verities were significantly low at T4, except P3 where effect of all the treatments (T0, T1, T2, T3) are non-significantly different from each other (Fig.2).

Number of Buds: Statistical analysis of data showed significant variation in number of buds at all treatments over T3 (Fig.3). The maximum number of buds was recorded at T2 followed by T1, T0 and T3. Similarly response of each verity was also significantly different from each other at all treatments. The highest number of buds (9.66) were observed in Turkish followed by Hangshah (9.33) and P3 (09) at T2. While, the minimum number of buds (01) was recorded in Serilankan, Indonesian and Jueking at T3. T2 differ statistically from all other treatments, while T0 and T1 were found statistically similar with respect to number of buds in Serilankan and Indonesian but dissimilar from Jueking, while T3 was found significantly different from other treatments with respect to number of buds of Serilankan, Indonesian and Jueking (Fig.3).

Number of Leaves: Data presented in Fig.4 showed that the maximum number of leaves was recorded at T2 followed by T1 and T0, while the minimum was observed at T4. Similarly response of each verity were also differ significantly from each other at different the treatments.

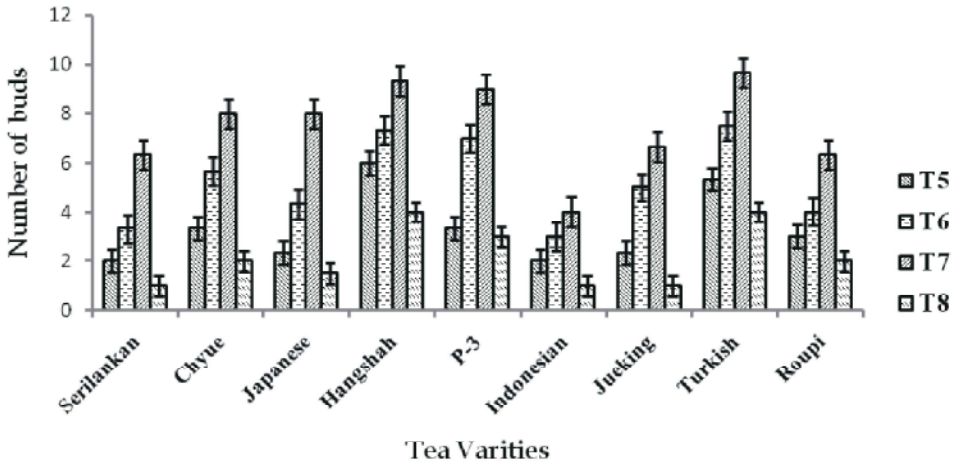

Fig. 3: The effect of temperature on number of buds of nine tea varieties (Roupi, Juking, Chyue, Hangshah, P-3, Turkish, Indonesian, Japanese, Serilankan. The data presented are mean of 3 replicates ± SE

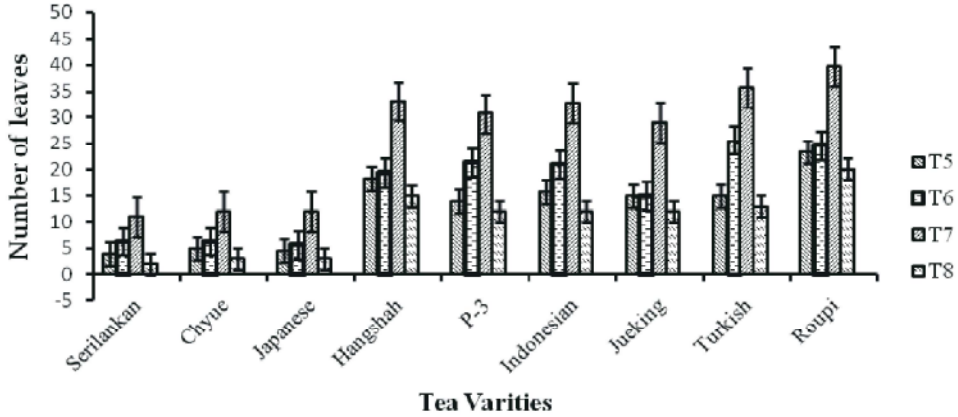

Fig. 4: The effect of temperature on number of leaves of nine tea varieties (Roupi, Juking, Chyue, Hangshah, P-3, Turkish, Indonesian, Japanese, Serilankan. The data presented are mean of 3 replicates ± SE

While minimum plant height (4.00 cm) was recorded in Serilankan at T3. T3 significantly differ from all the other treatments regarding plant height of Serilankan, Japanese, Hangshah, P3, Indonesian, Jueking, Turkish and Roupi. While, T0, T1 and T3 found statistically similar having non-significant difference with respect to plant height in each verity (Fig.1).

The highest number of leaves (39.66) was recorded in Roupi followed by Turkish (35.66) and Hangshah (33) at T2, while the minimum number of leaves (02) was recorded in Serilankan at T3. T2 differ statistically from all other temperature treatments with respect to number of leaf except for Serilankan, Chyue and Japanese where effect of T2 and T1 were non-significantly different from one another. While, T0, T1 and T3 were found statistically similar with respect number of leaves of Roupi, Turkish and Hangshah having non-significant difference among each other (Fig.4).

Leaf Length (cm): Statistical analysis showed significant variation in leaf length at all the tea varieties at all the treatments over T3 (Fig.5). The maximum leaf length was recorded at T2 followed by T1 and T0, while the minimum leaf length was observed in T4, moreover the response of each verity was also significantly different from each other at all treatments. The maximum leaf length (10.60 cm) was observed in Roupi followed by Hangshah (8.53cm) and Indonesian (8.9cm) at T2, while the minimum leaf length (02cm) was observed in Serilankan at T3. T0, T1 and T2 were found statistically similar having non-significant difference with respect to leaf length of Roupi, Indonesian and Hangshah but differ significantly from T3 in that regard (Fig.5).

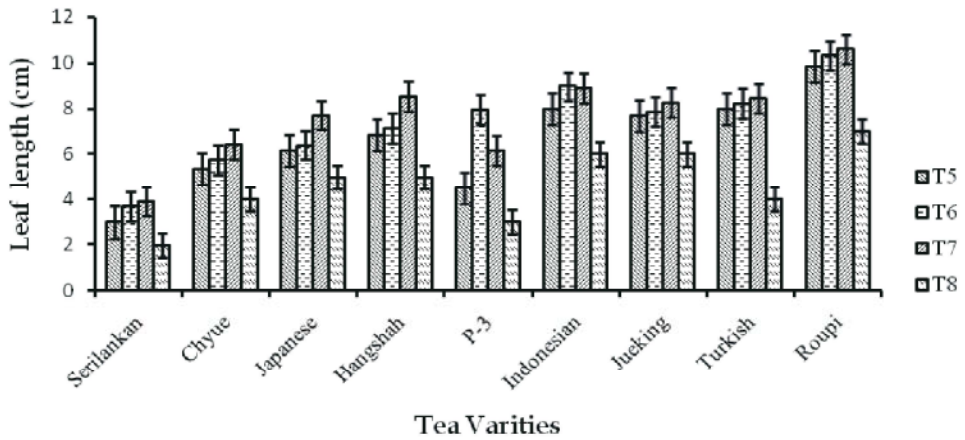

Fig. 5: The effect of temperature on leaf length of nine tea varieties (Roupi, Juking, Chyue, Hangshah, P-3, Turkish, Indonesian, Japanese, Serilankan. The data presented are mean of 3 replicates ± SE

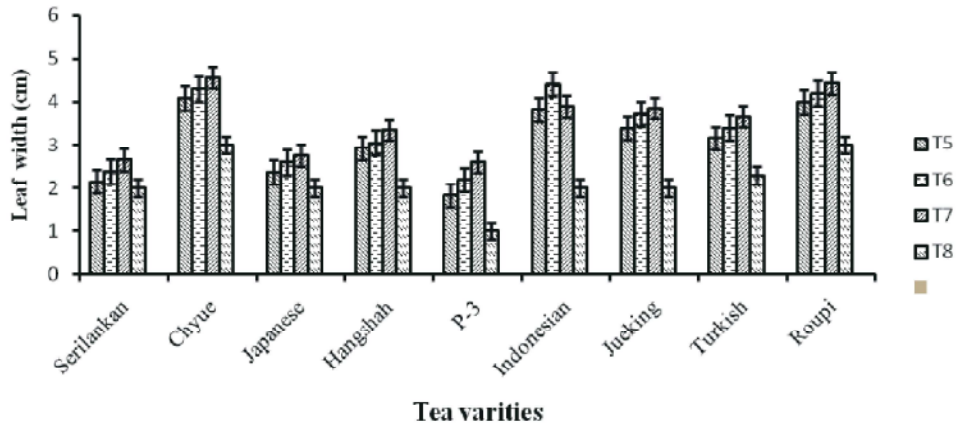

Fig. 6: The effect of temperature on leaf width of nine tea varieties (Roupi, Juking, Chyue, Hangshah, P-3, Turkish, Indonesian, Japanese, Serilankan. The data presented are mean of 3 replicates ± SE.

Leaf Width (cm): Data in Fig.6.showed significant difference in leaf width at different treatments over T3. The maximum leaf width was recorded in T2 followed by T1 and T0, while the minimum leaf width was observed in T4.The highest leaf width (4.56cm) was recorded in Chyue followed by Roupi (4.43cm) at T2 and Indonesian (4.40 cm) at T1. The minimum leaf width (01cm) was recorded in P3 at T3. T0, T1 and T2 were found statistically similar having non-significant difference with respect to leaf width of all the verities except P3 where T2 was significantly higher than T0. On the other hand, leaf width was significantly lower in all the verities at T3 (Fig.6).

DISCUSSION

Understanding the progressive forms in seed/bud dormancy is important for predicting the time of seed/plant germination, growth, development and yields. Seed-germination stage and sequential changes in dormancy in relation to environmental factors is still not well understood in tea plants. Thus, in the present study an attempt has been made to determine the effects of different temperature treatments on breaking dormancy in different tea varieties.

Tea varieties showed great variations in plant height at different temperature treatments. There was a gradual increase in plant height at T0, T1 and T2 by increasing temperature and maximum plant height was recorded at T2 in all the Tea verities. However further increase in temperature treatments such as T3 resulted in a significant reduction in the plant height of all the verities as compared to T2. The highest plant height (45.00cm) was recorded in Turkish followed by Hungshah (39.66 cm) and Indonesian (30.66 cm), while the minimum plant height (4.00 cm) was observed in Serilankan at T3. Response of

all the varieties to T0, T1 and T3 was non-significantly different from each other with respect to plant height. Findings of the present study are at par with the findings of Baskin *et al*. [8] who suggested that dormancy can easily be broken by suitable temperature conditions in *Capsella bursa-pastoris* and *Descurainia sophia*, species that originate in high northern latitudes. Stoller and Wax, [9] also reported more rapid decay in dormancy of weed seeds buried 1 cm deep and it might be related with greater temperature fluctuations close to the soil surface compared to those at 10 cm. These variances showed that suitable temperature is an important source to predict and break dormancy and resultantly enhance germination and growth. Moreover, low germination and low growth rates at T0 and T1 are attributed to decreasing temperature, which prevents the breaking of dormancy.

The maximum stem thickness was observed in T2 followed by T0 and T1, while the minimum stem thickness was recorded at T3. The highest stem thickness (5.06 mm) was recorded in Roupi followed by Jueking (4.86 mm) and Turkish (4.63 mm) at T2, while the minimum stem thickness (2.00 mm) was observed in Japanese at T3. Our results were also supported by Zhu *et al*. [10] who indicated that plant height and width were increased with increasing temperature up to a certain level because at low temperature, plant cells become dormant due to dehydration caused by the formation of ice in the intercellular spaces and protoplasts shrinks and the cell turgor decreases. But as we increase the temperature swelling can observed due to water expansion with the liquid solid phase change, metabolic activities increases that ultimately enhance plant growth.

Response of each tea variety regarding number of buds was also different from each other at different temperature stresses. The maximum number of buds was recorded at T2 followed by T1, T0 and T3. The highest number of buds (9.66) was observed in Turkish followed by Hangshah (9.33) and P3 (09) at T2. While, the minimum number of buds (01) was recorded in Serilankan, Indonesian and Jueking at T3. T2 differ statistically from all other treatments, while T0 and T1 were found statistically at par with each other regarding number of buds in Serilankan and Indonesian but dissimilar from Jueking. The present results indicated that though suitable temperature for each variety is different from each other but optimum temperature for all the varieties is T2. These results are in confirmation with those reported by Vimala [11], who stated that optimum temperature is necessary for germination and bud induction of each and every variety of alfalfa however further increase in temperature causes photorespiration, depletes storage carbohydrates and ultimately exert adverse effect on bud induction and leaves production.

Effect of different temperature treatments on number of leaf, was also significant. The maximum number of leaves was recorded at T2 followed by T1 and T0, while the minimum observed in T3. The impact of T2 was significantly higher from all other temperature treatments with respect to number of leaf except for Serilankan, Chyue and Japanese where effect of T2 and T1 were non-significantly different from one another. This may be due to the reasons that increase in temperature causes breakage of dormancy and resultantly leaves number increased however further increase in temperature i.e. above 34 °C adversely affect the plant metabolic activities and reduce number of leaves in plant. While, differential response of each varity at same temperature may be due to difference in their genetic makeup. Similar results were quoted by Vimala [11], on cabbage. They suggested that though numbers of leaves plant^{-1} have significant effect on yield. But there exist huge variations in the number of leaves even at the same temperature due to genetical characters of cultivars. While, different varieties of plants must have different number of leaves plant^{-1} according to the temperature treatment. Though each verity showed different response to various temperature treatments but significantly higher leaf length was noticed in all the varieties at T2, except Roupi, Indonesian and Hangshah where T0, T1 and T2 showed non-significant differences. While, the minimum leaf length (2.00 cm) was observed in Serilankan at T3. Mahdavi *et al.* [12] concluded that increasing in temperature to a certain level results in increasing the length and width of leaves, green leaf yield and cured leaf yield but further increase in temperature damage the cells, enhance photorespiration and reduce leaf length and width.

However all the temperature treatments showed significant difference in leaf width over T3. The highest leaf width (4.56 cm) was recorded in Chyue followed by Roupy (4.43 cm) at T2 and Indonesian (4.40 cm) at T2. The minimum leaf width (1.00 cm) was recorded in P3 at T3. T0, T1 and T2 non-significantly different from each other with respect to leaf width of all the verities except P3 where T2 was significantly higher than T0.Similar results were also quoted by Schurr *et al*. [13], they suggested that temperature had a significant effect on photosynthetic activity leaf area that is the key determining aspect affecting light interruption by crop and biomass

production. Therefore, any reduction of leaf expansion rate is usually associated with reduction of photosynthesis and consequent decrease in above-ground biomass, grain yield and quality etc.

CONCLUSION

Based on these results it can be concluded that temperature treatment (T2= 34 °C) is best treatment for breaking bud dormancy and enhance growth and ultimately yields of tea.

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