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# Influence of top working on growth and flowering of tea clones

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ABSTRACT

To study the impact of the top working method of grafting on flowering behavior in tea clones and its applicability in tea breeding two field experiments were carried out. Field established plants of the clone UPASI-9 was used as the rootstock in both the experiments. Recently released clones TRF-1, TRF-3 and TRF-4 were used as scions to study the influence of top working on flowering. One-year-old rooted plants of the clones used as scions field planted in the same year served as standards for comparison. Precocious flowering was noticed in all the top worked clones by eight months from grafting. In self- rooted plants of the scion clones only sparse flowering was noticed after eighteen/nineteen months. Similarly, the duration of flowering and total number of flowers were significantly higher in top worked plants compared to self-rooted plants. The top worked scions were significantly more vigorous than the corresponding self-rooted plants, except TRF-3. In the second experiment by top working the scions of two different clones on the same rootstock; four sets of combinations were tried. The clone TRF-4 was used as one scion in all the four sets and the clones TRF-1, SA-6, Yabukita and SMP-1 served as the other scions in each set. Early flowering as well as synchronization of flowering was observed in both the scion clones in three of the tested pairs. However, the growth and flowering of the common scion clone TRF-4 varied significantly in each set depending on the other clone used as a scion.

## 1. Introduction

Tea cultivation in India spans over 200 years and occupies second position next to China as a largest tea producing country. Total area of tea in India is around 0.6 million hectares and India contributed to around 23% of the world's total tea production in terms of domestic and international requirements. Three distinct taxa, *Camellia sinensis* (L.) O. Kuntze. ('China type'), *C. assamica* (Masters) Wight ('Assam type') and *C. assamica* ssp. lasiocalyx (Planch. Ex Watt) Wight ('Cambod type') (Sharma and Venkataramani, 1974) are involved in the development of the present day tea plant. The out-breeding nature of the tea plant within the three taxa and other closely allied non-tea producing species of *Camellia* L. led to the devel opment of tea populations with extreme genetic diversity (Sharma and Venkataramani, 1974). Exploitation of this wide heterogeneity in the existing seedling tea plantations by clonal selection over the years resulted in the development of several tea clones with desirable traits like high yield potential, high quality and high tolerance to drought. However, many of the high yielding clones exhibit mediocre drought tolerance. Similarly, most of the high quality clones are poor yielders and several drought tolerant clones possess average quality attributes (Ranjith and Ilango, 2016). Clones possessing a combination of at least two of the above mentioned traits are a rarity. This dearth of clones with a blend of all desirable traits is a limiting factor for the commercial acceptance of most of the existing clones. Therefore hybridization between the existing tea clones is important to develop new genotypes with the combination of all the desirable traits. It will encourage the farmers to replant their commercially unproductive fields with improved planting materials. Further, Satyanarayana and Sharma (1981) reported that clonal selection from the F1 progenies developed through hybridization of potential tea clones increases the scope of getting superior clones.

Hybridization in tea involves a series of steps including selection of parents (clones), planting in the field, cross-pollination after flowering, collection of hybrid seeds, raising in the nursery, field establishment, selection, mass propagation and field evaluation (Ranjith and Ilango, 2017). The entire process of developing a new clone takes a substantial amount of time of around 20–25 years. As a result of extensive hybridization programs over the years, many tea clones with improved traits were developed in all tea growing regions. Hybridization between such improved clones is another step forward in deriving outstanding genotypes and further diversifying the tea germplasm (Ranjith and Ilango, 2017).

However, the juvenile period of tea plants before flowering (3–4 years from planting) and limitations in the conventional hand pollination technique are the major obstacles in hybridization between the recently released clones. Satyanarayana and Sharma (1981) and Singh

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(1982) reported the low percentage fruit set (17%) and poor germination percentage of seeds obtained through hand pollination compared to the seeds produced under natural conditions.

Top working is a technique that involves grafting the scions of a desired variety on of shoots that emerge on pruned branches of field established plants. This technique is widely used in many fruit crops to induce vegetative growth and precocity thereby enhancing the productivity (Dasa et al., 2011). In tea, top working was used as a promising technique to overcome the problem of time lag in flowering (Ranjith and Ilango, 2017). However, no reports were available on the flowering behavior, flowering duration and distribution of flowering in top worked tea plants. A clear understanding of these variables in top worked plants compared to the self-rooted plants will aid in exploiting the maximum advantage of using the top working technique. Further attempt was made by grafting two scion genotypes in the same rootstock to study their growth and flowering. The flowering of two different scion genotypes top worked on one rootstock will facilitate open cross-pollination between them. This will help in increasing the possibility of obtaining a high quality/quantity of hybrid seeds compared to the conventional hand pollination technique in the upcoming breeding programs.

In this regard, two field experiments were carried out to study the impact of top working on flowering behavior and synchronization of growth and flowering in different clonal pairs top worked on the same rootstock for expediting hybridization.

## 2. Materials and methods

### 2.1. Experimental site and design

Field experiments were conducted from 2013 to 2015 at the experimental farm of UPASI (United Planters Association of South India) Tea Research Institute, located in the Anamalais, Coimbatore District, India, at an altitude of 1050 m above msl. The average (for the past ten years) minimum and maximum temperatures range between 15.3 °C and 26.24 °C and the area receives an average annual rainfall of 3500 mm.

The clone UPASI-9 field planted during the year 2005 was used as rootstock in both the experiments. The experimental field consists of 480 plants of the clone UPASI-9 in eight double hedge rows. The rootstocks were planted in a flat terrain with similar soil conditions. The type of soil of the experimental fields is laterite. The style of planting is double hedge system with spacing of 135 × 75 × 75 cm (135 = distance between two double hedges, 75 = distance between plants in the rows, 75 = distance between plants in the hedge). The entire experiment field was pruned 3–4 months prior to grafting. Scions consisting of a leaf and a node with an axillary bud of the chosen clones were used for grafting.

### 2.2. Influence of top working on flowering

The experiment was initiated during May 2013 in a split-plot design. High yielding clones TRF-1 (TRF = Tea Research Foundation) and TRF-3 and the high yielding, high quality clone TRF-4 were selected as scion clones for top working to study their growth and flowering. Each scion clone was top worked on the randomly selected two rootstocks in the experimental field which were in similar vigor (visual assessment). Six to eight scions were top worked per plant by cleft grafting method on the branches of the clone UPASI-9. After the formation of graft union, four scions per rootstock were maintained by cutting away additional scions, if any. Each scion served as a replicate for the assessment of flowering behavior and vigor. Therefore the experiment consists of eight replicates. One-year-old self-rooted plants of the three scion clones planted in a randomized block design in the same field were used as standards for comparison. Eight plants were planted in each scion clone at a spacing of 150 × 75 (150 = distance between hedges, 75 = distance between plants in the rows).

### 2.3. Synchronization of growth and flowering of two clones used as scion on the same rootstock

The experiment was initiated during May 2014 in a randomized block design. High yielding, high quality clone TRF-4, the high yielding clone TRF-1, a Japanese clone 'Yabukita' and the blister blight disease tolerant clones SMP-1 and SA-6 were selected as scions for the study. Four sets of combinations were studied to evaluate synchronization of flowering and vigour of two scion clones top worked on a single rootstock to facilitate open cross-pollination. The clone TRF-4 was grafted as one parent in all the four sets of combinations and the remaining four clones served as the other parents in each set: Combination I (TRF-4 and TRF-1), Combination II (TRF-4 and Yabukita), Combination III (TRF-4 and SMP-1) and Combination IV (TRF-4 and SA-6). Each set of scion genotypes was top worked on the randomly selected two rootstocks which were in similar vigor (visual assessment). Three to four scions of each parent were top worked per plant and after the formation of graft union, two scions per parent (scion genotype) were maintained on the rootstock. Each scion served as a replicate for the assessment of flowering behavior and vigor. Thus the experiment consists of four replicates per parent (scion genotype) in a combination. A 10 m distance was maintained between the rootstocks top worked with different set of scion clones to avoid contamination from other pollen grains after flowering.

### 2.4. Grafting

Mother bushes of the clones selected for scion were pruned at a height of 60 cm from the ground level 3–4 months prior to top working. Bushes of the clone UPASI-9 used as rootstock were also pruned simultaneously at a height of 45 cm from the ground. Bushes with similar vigor were visually accessed and selected for grafting. Fertilizers were applied as per standard practice. Aperiodic shoots were collected from the mother bushes of the scion clones; the cut ends were immersed in water to prevent desiccation and brought to the experimental spot. Semi-hard wood cuttings comprising an axillary bud and a healthy leaf (from 4th nodal position to 9th nodal position) were used to prepare scions. Bushes of the clone UPASI-9 with healthy shoots were selected for grafting and top working was performed using cleft-grafting method. All the top worked plants were maintained in accordance with the standard practices.

### 2.5. Data collection

Observations were recorded on initiation, duration, and distribution of flowering and the number of flowers per scion during the flowering season. Generally in South India flowering season of matured tea plants begins after south-west monsoon (October/November) and ends during the onset of south-west monsoon (May/June) with the peak flowering during December to March. In this study, the very next flowering season after grafting/planting (October 2013–May 2014) of scions and self-rooted clones was considered as their first flowering season. If any sparse flowering continued after May 2014 but before October 2014, this was also considered as the first flowering season. In the same way, the period from October 2014 to October 2015 was considered as the second flowering season. The number of opened flowers in a day was counted on each scion of a composite plant, throughout the flowering season to quantify the total number of flowers. Growth characteristics of the top worked scions and self-rooted plants were measured after one/two years from grafting in terms of height, diameter of the stem, number and diameter of primary and secondary branches. Plant height was measured with a measuring tape from the graft union up to the final end of the tallest branch. Diameter of the stem was measured using a Vernier caliper at 5 cm above the graft union. Diameter of the primary