

Evaluation of Growth of Grafted Tea (*Camellia sinensis* L.) Plants in Sealed Polythene Propagator at Nursery and Performance of Stock-Scion Combinations at Nursery and Early Stage in the Field

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ABSTRACT

An experiment was conducted at the Tea Research Institute of Sri Lanka, Talawakelle to evaluate growth performance of tea nursery plants of different graft combinations raised in sealed polythene propagator (SPP) in comparison to the conventional tea nursery. The compatibility of different graft combinations were also evaluated under field conditions. Selected graft combinations *viz* TRI 4046 (scion) on TRI 4006 (stock), TRI 4046 on TRI 3072, TRI 4046 on TRI 4053, TRI 4006 on TRI 3072, TRI 3072 on TRI 4053 and TRI 3072 on TRI 4006 and single node cuttings of respective scions (control) were raised in two environment conditions, *i.e.* SPP and the conventional nursery. Nursery period was 9 months and assessments were done at 4 and 8 months after planting (MAP).

Higher success rate was observed under SPP (87%) than of conventional nursery (60%) 4 MAP. There was no significant difference in plant height of grafted plants between two environments, 4 and 8 MAP. Graft combinations of TRI 4046 on TRI 4006, TRI 4046 on TRI 4053, TRI 3072 on TRI 4006, and TRI 3072 on TRI 4053 showed better performance in terms of relative growth rate (RGR) than the control in the SPP. The growth performances of field established graft combinations of TRI 4046 on TRI 4053 and TRI 3072 on TRI 4053 were also significantly greater than those of control (TRI 4046 or TRI 3072), 10 MAP.

Key words: Compatibility, grafting, sealed polythene propagator, tea

INTRODUCTION

Grafting is a common method used to combine two plant parts with different genetic constitution having different characters and produce a composite plant in horticultural industry. Grafting of tea was carried out for the first time, in Japan in 1902 (Katsuo, 1969) and commonly practiced in India and other countries. Bud grafting has been practiced in north and south India by using methods described in detail by Barua (1968) as well as cleft grafting as described by Grice (1968) and Haridas (1979). Cleft grafting

with single nodal cuttings is the most popular method used in tea nurseries. Upper and the basal parts are known 'Scion' and 'Stock or Root stock' respectively, and these two parts are combined to produce a composite plant. A number of experiments have been carried out in Sri Lanka to investigate the compatibility of scion and stock of tea, because, the most common problem in the development of a composite plant is the incompatibility between desirable cultivars (Pallemulla *et al.*, 1992). Hence, large number of combinations should be tested to select desirable combinations (Sharma and Satyanarayana, 1981). Grafting is one of the solutions to obtain composite plants with desirable characters such as high yield, high quality, and resistance to pests and diseases and drought conditions.

Planting materials of tea are conventionally produced in vegetatively propagated (VP) nurseries in large scale, where high or low shade provides favourable environmental conditions. However, the sealed polythene propagator (SPP) also provides more conducive conditions such as high relative humidity (RH), high temperature, and protects plants from pests and diseases. Keeping grafted plants under high RH condition supports successful healing of graft union (Haridas, 1979). A higher success rate (95%) was achieved in cashew softwood grafts raised in a propagator under a shade net (Karunathilake and Jayasekera, 2001). The major activities involved in grafting are preparation of cuttings, securing graft partners at the interface with a polythene strip and removal of it after graft union. However, these time consuming and labour intensive operations impose limitations on the output of the workers (Satyanarayana and Sreedhar, 1995).

Objectives of the present studies were therefore to evaluate the performance of grafted tea plants in a SPP in comparison with conventional nursery and the compatibility of different tea graft combinations in SPP and after field establishment.

MATERIALS AND METHODS

An experiment was carried out at St. Coombs Estate, Tea Research Institute of Sri Lanka, Talawakelle (longitude 80° 40' E, latitude 6° 40' N and 1394 m amsl), where the average maximum and minimum temperatures are 26 °C and 14 °C respectively and annual average rainfall is 2250 mm.

The effect of the SPP on the grafted tea nursery plants were investigated in comparison with conventional nursery. Conventional nursery was managed under high or low coir matting or synthetic shade net without SPP used to keep nursery plants at the initial stage of nursery period.

The cultivars used as scions were TRI 4046, which is high yielding and Shot Hole Borer resistant, TRI 4006, which is high yielding, moderately resistant to Shot Hole Borer and Stem Canker and TRI 3072, which is moderate yielding, Blister Blight resistant and moderately resistant to Shot Hole Borer. The cultivars, TRI 4006, TRI 4053 and TRI 3072 were used as stocks, which are high rooting and drought tolerant. Selection of shoots was similar to the VP nursery and the grafting method employed was cleft grafting. The stock (basal part), which is a single node cutting with 2.5 cm of stem extending above the node was made with a 1.5 cm cleft at the end of stem. Scion is also a single node cutting, but stem length below the node is 1.5 cm. Wedge is prepared by slicing both sides of the scion stem. Wedge in scion firmly inserted into the cleft in stock and grafting interface wrapped by using a polythene strip from bottom to top. A single node cutting (2.5 cm stem below the node) of cultivar selected to scion is also used as control.

Selected graft combinations were TRI 4046/4006 (T1), TRI 3072/4006 (T2), TRI 4046/3072 (T3), TRI 4006/3072 (T4), TRI 4046/4053 (T5), and TRI 3072/4053 (T6). Whilst TRI 4006 (T7), TRI 3072 (T8) and TRI 4046 (T9) were used as the controls. The nursery period was 9 months (May 2006 to February 2007).

Ten plants of each of above graft combinations and controls were taken as replicates and placed in the SPP and another set of same was placed in the conventional (without polythene propagator) nursery in a complete randomized design (CRD). As per the TRI recommendation (Anon, 2009) the sealed polythene propagator height was 90 cm above the ground and 300 gauge transparent polythene was used to cover the bed and plants were properly air sealed after thorough watering. Both sets of grafted plants placed in SPP and conventional nursery were kept under coir mat high shade, at 180 cm above the ground level. Watering was done daily to the conventional nursery. Polythene propagator was removed gradually from 3-3½ months after planting (MAP) in order to expose plants to the conventional nursery environment and basic nursery practices were then continued in both plant sets as recommended for conventional nursery. All plants were gradually exposed to the sun at later stage in the nursery accordingly. Polythene strips in grafting interface were removed after confirming of proper union of scion and stock. Growth assessments such as success rate and plant height were made 4 and 8 MAP from each plant in each treatment.

To achieve the second objective *i.e.* compatibility of scions and stocks, the grafted plants together with control plants, which were raised only in the SPP were planted in the field after completion of nursery period as there were low plant casualties compared to conventional nursery plants. Plants were planted on contour lines at 0.6 x 1.2 m space and depth of each hole was 0.45 m and the diameter of surface was 0.3 m. All cultural

practices were adopted as recommended for young tea. Grafted combinations and controls (treatments) were arranged in a CRD with 2 replicates and five plants were in each treatment. Plant height, success rate, and centering weight were measured and number of shoots and leaves of all the plants were counted, 10 MAP from all plants. Relative growth rate (RGR) was calculated based on the plant height 4 and 8 MAP.

RESULTS AND DISCUSSION

Evaluation of growth performance in two environments

Effect of SPP on success rate of grafted plants

First assessment was done one month after removal of polythene (4 MAP) when healing process was almost completed. There was a significantly lower casualty percentage in SPP compared with conventional nursery. Success rate of grafted plants under SPP and conventional nursery, irrespective of graft combinations, was 86.7% and 60%, 4 MAP and 83.3% and 53.3%, 8 MAP, respectively (Table 1). Effect of propagator on survival of grafted plants could be evaluated more accurately 4 MAP, *i.e.* one month after removing propagator since, all plants were allowed to grow under the same open environmental conditions. Maintenance of RH and temperature in the propagator over a period of 3 months may have favourably affected on the fast healing process of the grafted plants thereby a higher rate of success, compared to open environment of conventional nursery. High RH may also have been contributed to reduce transpiration from grafted plants and wilting of scion. Although, watering was regularly done to the conventional nursery, healing process was found to be lower and this may be due to higher transpiration caused by low RH in its surrounding environment. Higher success rate (95%) was achieved in cashew softwood grafts raised in a propagator under a shade net (Karunathilake and Jayasekera, 2001).

Table 1. Comparison of success rate in graft combinations raised in sealed polythene propagator and conventional nursery

Treatment	Rate of survival of grafted plants (%)			
	4 MAP		8 MAP	
	Propagator	Conventional	Propagator	Conventional
T1 - TRI 4046/4006	100	60	100	50
T2 - TRI 3072/4006	80	30	80	30
T3 - TRI 4046/3072	80	40	80	40
T4 - TRI 4006/3072	80	60	80	50
T5 - TRI 4046/4053	90	80	80	70
T6 - TRI 3072/4053	90	90	80	80
Mean*	86.7% ^a	60% ^b	83.3% ^a	53.3% ^b

*Means with the same letter are not significantly different

Impact of propagator environment on growth performance of grafted plants

There was no significant difference in plant height between two environments 4 and 8 MAP (Figure 1). Further, there was no significant difference in height between graft combinations raised in two environments 4 and 8 MAP (Figures 2 and 3).

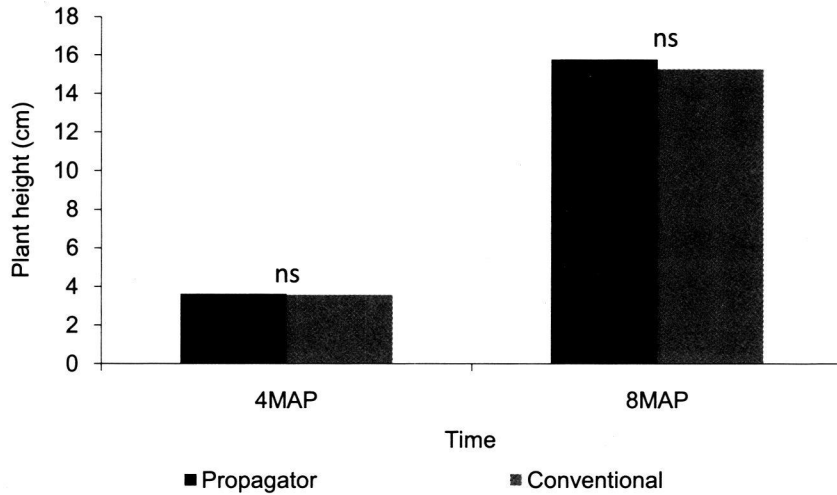


Figure 1. Mean plant height as affected by two nursery environments 4 and 8 MAP

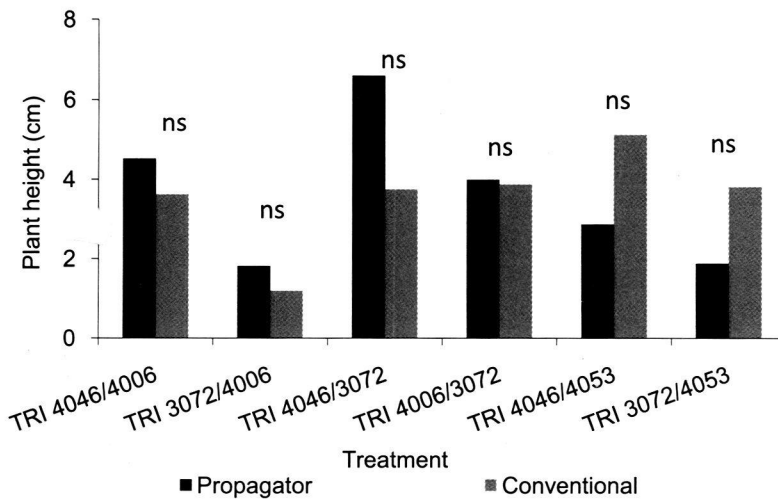


Figure 2. Mean plant height of graft combinations as affected by two nursery environments 4 MAP

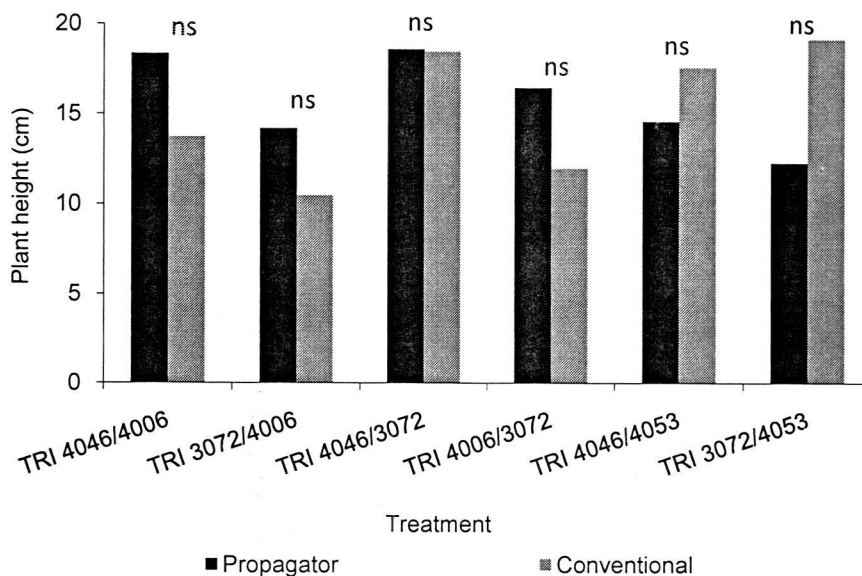


Figure 3. Mean plant height of graft combinations as affected by two nursery environments 8 MAP

Compatibility of different stock-scion combinations

Compatibility of graft combinations in sealed polythene propagator

Results of the stock-scion compatibility assessment 8 MAP are shown in Figure 4 and RGR is in Table 2. There was no significant difference in plant height of the graft combinations compared to their corresponding control (single node cutting of scion). Similar trend in plant height was shown 4 MAP. Although, there was no significant difference of plant height, a slight increment of plant height and slightly higher RGR of graft combinations of TRI 4046 on TRI 4006 (T1) and on TRI 4053 (T5) was observed compared with their control TRI 4046 (T9). RGR in combinations of TRI 4046 on TRI 4006 and TRI 4046 on TRI 4053 were 0.0117 and 0.0136 respectively, compared with its control (0.0063). Graft combinations of TRI 3072 on TRI 4006 (T2) and on TRI 4053 (T6) also showed slight increment in plant height compared with their control TRI 3072 (T8) and TRI 3072 on TRI 4006 (0.0171) and TRI 3072 on TRI 4053 (0.0156) showed a significantly higher RGR compared to its control TRI 3072 (0.0074). In contrast to these graft combinations, TRI 4006 on TRI 3072 showed a lower height than the control (TRI 4006) and the difference was not significant and its RGR was also more or less similar to the control. Kathiravetpillai (1988) has also reported that there was a lesser increase in plant height in the combinations of TRI 2023 on CY9 and TRI 2026 on DN compared to the ungrafted TRI 2023 and TRI 2026 respectively when nursery plants were 10 months old. Nagarajah and Ratnasuriya (1981) reported in some

clonal combinations stock-scion interaction can reduce shoot growth and such reduction was probably caused by growth inhibitors originating from the stock. Graft incompatibility is differentiated from graft failure that often results from environmental factors or lack of skill of budder. Physiological incompatibility may be due to lack of cellular recognition, wounding responses, growth regulators or incompatible toxins (Lee and Oda, 2002).

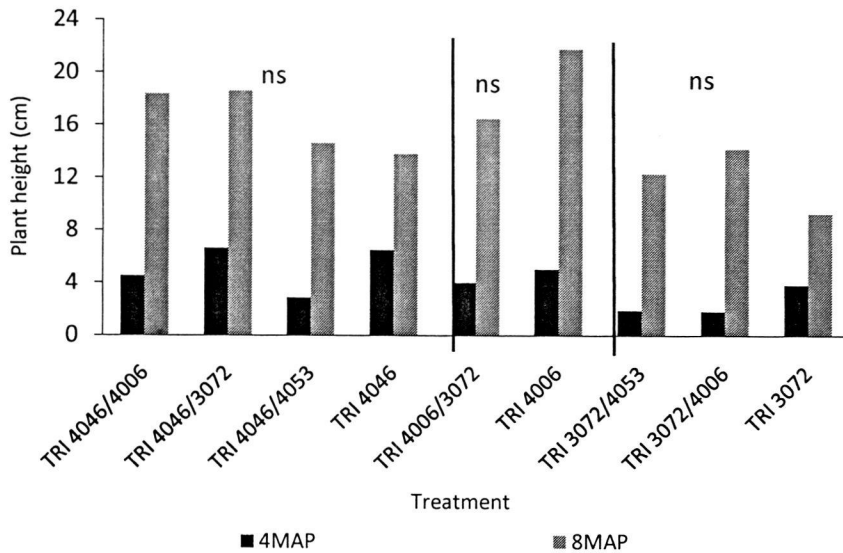


Figure 4. Mean plant height of different graft combinations with scion (i) TRI 4046 (ii) TRI 4006 and (iii) TRI 3072 initially under SPP, 8 MAP

Table 2. Relative growth rate (RGR) of different graft combinations for 4 months period (4-8 MAP)

Treatment	RGR
T1 -TRI 4046/ 4006	0.0117 ^a
T3 -TRI 4046/ 3072	0.0079 ^a
T5 -TRI 4046/ 4053	0.0136 ^a
T9 -TRI 4046	0.0063 ^a
T4 -TRI 4006/ 3072	0.0118 ^a
T7 - TRI 4006	0.0123 ^a
T2 - TRI 3072/ 4006	0.0171 ^a
T6 - TRI 3072/ 4053	0.0156 ^a
T8 - TRI 3072	0.0074 ^b

*Means with the same letter are not significantly different

Field performance of graft combinations

Growth parameters of different graft combinations, which were initially under SPP environment, such as survival rate, plant height, number of shoots, number of leaves and centering weight 10 MAP are given in the Table 3. There was no difference in survival rate in all graft combinations compared with their corresponding controls. However, a lower survival rate was shown with TRI 4046 on TRI 4053 and TRI 4006 on TRI 3072. Significantly higher plant height, shoot number and leaf number per plant were recorded with TRI 4046 on TRI 4053 compared with its control and other relevant combinations. Centering weight was also the highest with same combinations. Shoot number, leaf number per plant and centering weight of TRI 3072 on TRI 4053 were significantly greater than those of controls and TRI 3072 on TRI 4006. Although, plant height was not significant, it was also slightly higher when compared with the control. Higher shoot number, leaf number and centering weight indicate that there was a good bush formation. Higher number of shoots together with higher number of leaves increase the plucking points and could produce higher amount of biomass. Other combinations which showed poor performance in growth may have developed resistant to pest and diseases. It is apparent that the cultivar TRI 4053, which shows high rooting ability and drought tolerance is the best root-stock for TRI 4046 and TRI 3072 scions, which are known to be resistant to pests and diseases.

Assessment on pest and disease resistance and yield will be undertaken following proper establishment of composite plants in the field.

Table 3. Comparison of growth parameters of different graft combinations with their controls 10 months after field planting

Graft combination	Survival %	Plant height (cm)	Shoot no./ plant	Leaf no./ plant	Centering weight (g/ plant)*
T1-TRI 4046/4006	90.9	40.8 ^b	11.8 ^b	55.8 ^b	114.0
T3-TRI 4046/3072	92.3	45.4 ^b	13.3 ^b	86.3 ^b	97.1
T5-TRI 4046/4053	76.9	72.4 ^a	29.7 ^a	175.6 ^a	167.4
T9-TRI 4046	92.3	50.0 ^b	17.6 ^b	97.5 ^b	57.5
T2-TRI 3072/4006	90.0	40.4 ^b	7.1 ^c	38.8 ^b	18.1
T6-TRI 3072/4053	90.9	83.0 ^a	27.1 ^a	146.1 ^a	131.4
T8-TRI 3072	61.5	66.9 ^a	15.9 ^b	79.4 ^b	87.5
T4-TRI 4006/3072	63.6	60.7 ^a	19.4 ^a	109.6 ^a	121.7
T7-TRI 4006	92.3	53.1 ^a	16.0 ^a	82.3 ^a	116.5

*Centering weight without replication

Means with the same letter are not significantly different

CONCLUSIONS

Use of sealed polythene propagator is found to be a good method to raise grafted tea plants at initial phase in the nurseries, as it increases the success rate significantly. Graft combinations of TRI 4046 on TRI 4006, TRI 4046 on TRI 4053, TRI 3072 on TRI 4006 and TRI 3072 on TRI 4053 are found to be the best combinations in the nursery and TRI 4046 on TRI 4053 and TRI 3072 on TRI 4053 are the best combinations recorded 10 month after field establishment. Both in nursery and field TRI 3072 on TRI 4053 was found to be the best combination in growth performances while cultivar TRI 4053 was proved to be the best root-stock in this study. However, further assessments need to be done repeatedly at the nursery and continued under field conditions to confirm the best combinations for pest and disease resistance and yield.

ACKNOWLEDGEMENT

Authors gratefully acknowledge all staff of the Tea Research Institute of Sri Lanka for their valuable guidance and assistance given to conduct the project successfully.

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