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EFFECT OF GRAFTING FRESH CUTTINGS ON YIELD AND DROUGHT RESISTANCE IN TEA

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The effect of graft combinations of fresh unrooted cuttings of clones TRI 2023, TRI 2025, TRI 2026, DT 1, CY 9 and DN on yield and drought tolerance was studied. The technique employed for grafting was a modification of the cleft grafting method and sealing the composite plants in a polythene tent for 2-3 months. Determination of the yield over a 4-year pruning cycle and of the pruning weight of the pruned bushes as well as of the tipping weights after recovery showed that the graft combinations TRI 2023 on CY 9 and of TRI 2026 on DN gave higher yields even during periods of moisture stress.

INTRODUCTION

Most selection programmes undertaken are primarily concerned with the identification of high yielding bushes. However, with time it was noted that most high yielders did not perform well during periods of moisture stress resulting in low yields. Grafting of fresh tea cuttings in the nursery is a means of producing composite plants suitable for field planting that could withstand periods of moisture stress and ensure high yields.

Among the clones recommended to the industry some are moderate yielders but are able to withstand adverse weather conditions due to their deeper root systems (Nagarajah and Ratnasuriya, 1981) and would serve as ideal stocks to graft cuttings of high yielding clones. A problem most commonly met with in the development of a composite plant is that of compatibility between desirable clones as there is a distinct variation in clonal compatibility (Barua and Saikia, 1973; Sharma and Satyanarayana, 1981). It is also desirable that once compatible clones are found there is no breakdown in compatibility over prolonged periods of time. It is hence imperative that a large number of clones are tested with a view to obtain desirable combinations. For this purpose one would have to use only vigorous rootstocks with desirable characters such as drought tolerance so that this could support the continuous production of vegetative shoots even during periods of moisture stress.

In India both budding and grafting has been practised in North and South India. The method of cleft grafting in tea has been described in detail by Grice (1968) while fresh rootstock of grafts have been perfected in South India (Sharma, 1972; Haridas, 1974,1979); studies on compatibility have been conducted by Sharma and Satyanarayana (1981) and Kathiravetpillai (1989). Pethiyagoda (1971) successfully grafted a high yielding and a quality clone by the method of inarching while Nagarajah and Solomon (1981) studied the performance of cleft grafted composite plants in the nursery.

In this study, the effect of grafting fresh cuttings by the cleft grafting method is being examined for its influence on yield and drought tolerance. In a previous study (Kathiravetpillai, 1989) the success rates for grafts in the nursery stage between several popular clones that have been selected because of their yield and drought tolerance were studied. This paper reports the yield trends at the end of a first 4-year pruning cycle of the same study.

MATERIALS AND METHODS

The clones used in this study were TRI 2023, TRI 2025, TRI 2026, DT1 (high yielding) and CY 9 and DN (moderately yielding). Cuttings of these clones were used either as stocks or scions and compared with single and double node cuttings of the above clones; grafts involving cuttings of the same clones were also included to determine whether grafting itself had any influence on yield and other factors even though it was the same clone. Double node cuttings were included as the composite plant itself is a double noded one when grafted. There were four graft combinations – TRI 2023 on CY 9, TRI 2026 on DN, TRI 2025 on DN, TRI 2025 on DT 1. Cuttings of clones CY 9, DN and DT1 were used as stocks in view of their well-known drought tolerant properties.

The method of grafting employed was that of cleft-grafting. Cuttings for cleft grafting are obtained from the same type of shoots as employed for propagation of tea vegetatively. These are obtained from mother bushes after they are given a proper prune. The stock or the bottom component of the grafted plant is a single node cutting but with about 2.5 cm (1 inch) of stem extending above the node. The scion or the upper component is a single node cutting. In preparing the scion, the bottom 1.5 cm (0.60 inch) is tapered in the form of a wedge by making slanting cuts. In the stocks, a cleft is made in the stem above the node up to about 1.5 cm with a budding knife or other appropriate cutting devise. Care was taken to avoid too deep a cut and drying of the cuttings. The scion is then placed into the cleft ensuring proper alignment of cambial layers of stock and scion. The grafted portion is then tied with a polythene strip commencing from below and working upwards.

After making the graft, the composite cutting is treated as a normal vegetatively propagated cutting. In order to ensure a high degree of success, the bed was covered with a polythene tent and sealed as high humidity is essential at this stage. Prior to sealing the bed, the bags and the bed were thoroughly watered and the tent sealed to make it air tight. The tent was covered over with coir matting to prevent undue heating up of the polythene. The tent could be removed in 2-3 months time, by loosening the ends in stages over about 6 to 7 days in order to gradually harden the plants.

The axillary bud emerging from the stock was removed after about 5 months as early removal affects rooting of the grafted plant.

The graft combinations were planted in the field when they were ten months of age. There were 32 treatment combinations, replicated 3 times. Weekly yield records were maintained. In this study, the yield is given from July 1985 which was the time the bushes were brought into plucking. The bushes were pruned in July 1989 and the pruning weights were determined. Thereafter, the bushes were tipped and the tipping weights recorded.

RESULTS AND DISCUSSION

The results of the quarterly yield trends over 4 years of the first pruning cycle for the graft combinations TRI 2023 on CY 9 and of TRI 2026 on DN are given in Table 1 along with the rainfall figures over this period. A striking feature was that the graft combinations continued to give high yields even during periods of moisture stress as seen in the quarter of January to March of each year.

The stock clones of the successful composite plants in this study are well known drought tolerant clones with proven ability to withstand dry periods. The root system of these possess the virtue of two to three of its adventitious roots going vertically deep down simulating the growth of the tap root of seedling bushes. The increased yields obtained in both graft combinations compared to the ungrafted scion plants shows that the deeper root system of the stock plants were able to sustain the vegetative growth of the scions grafted on them even during periods of adverse weather conditions. The variation in the differences in yield indicate that there are clonal differences in the root systems of the rootstocks employed.

Overall, yield increases of the order of around 35% were obtained over the pruning cycle in each of the successful combinations. In evaluating the cost efficiency of a study of this nature one has to take into consideration the savings obtained in watering the nursery plants in the initial stages on account of the sealing by the polythene tent. Further, it should be noted that, after an initial outlay on the polythene sheet used for sealing, if this is carefully used, it could be used over three seasons. A polythene tent was used in order to ensure high humidity that is required for a high rate of success of the graft union. In the absence of such high humidity, the success rate is low. The cost of polythene is well offset by the saving on the cost of frequent watering for 3 months.

No yield differences were seen in the graft combinations TRI 2025 on DN as well as of TRI 2025 on DT 1.

This study has also demonstrated the nature of the varying compatibility between graft partners. Satyanarayana, Spurgeon Cox and Sharma (1991) have also made similar observations. In the nursery, in order to obtain a successful graft that would root well it is imperative that the right combination is found. Besides, one would like to have a composite plant where the compatibility lasts over prolonged periods. This would involve trying out a large number of combinations and rejecting those that are not compatible. This is time consuming and no short term measures are available. In certain combinations neither the stock nor the scion is influenced as a result of the graft but in others a stock-scion interaction is seen. Therefore, if this technique is to be employed to advantage the right stock-scion combination must be identified and now that the technique is available plantations could well try out various combinations and select those promising.

The pruning weights obtained at the end of 4 years of the cycle as well as the tipping weights of the bushes after recovery for the graft combinations TRI 2023 on CY 9 and TRI 2026 on DN are given in Tables 2 and 3 respectively. No differences in these attributes were noted in the graft combinations TRI 2025 on DN as well as of TRI 2025 on DT 1.

TABLE 1 – *Yield (kg ha-1) of graft combinations 2023 on CY 9 and of 2026 on DN with that of ungrafted TRI 2023 and TRI 2026 respectively in relation to rainfall.*

1985 - 1986

	Rainfall (mm)	TRI 2023/ CY 9	TRI 2023	LSD (P=0.05)	TRI 2026/ DN	TRI 2026	LSD (P=0.05)
Jul. – Sep.	667	286	319	123	201	286	NS
Oct. – Dec.	814	850	465	209	357	529	NS
Jan. – Mar.	480	1187	494	420	1021	265	411
Apr. – June	496	1005	554	439	955	274	398

1986 - 1987

	Rainfall (mm)	TRI 2023/ CY 9	TRI 2023	LSD (P=0.05)	TRI 2026/ DN	TRI 2026	LSD (P=0.05)
Jul. – Sep.	835	656	515	169	830	455	275
Oct. – Dec.	396	988	698	270	797	616	157
Jan. – Mar.	188	373	232	128	290	158	96
Apr. – June	714	615	506	105	888	450	315

1987 - 1988

	Rainfall (mm)	TRI 2023/ CY 9	TRI 2023	LSD (P=0.05)	TRI 2026/ DN	TRI 2026	LSD (P=0.05)
Jul. – Sep.	444	490	380	135	486	327	137
Oct. – Dec.	547	1444	1154	267	852	957	NS
Jan. – Mar.	243	755	560	181	538	427	98
Apr. – June	638	1271	1058	205	897	870	NS

1988 - 1989

	Rainfall (mm)	TRI 2023/ CY 9	TRI 2023	LSD (P=0.05)	TRI 2025/ DN	TRI 2026	LSD (P=0.05)
Jul. – Sep.	833	809	775	NS	641	910	255
Oct. – Dec.	368	1228	1117	102	857	600	NS
Jan. – Mar.	58	535	420	109	532	453	NS
Apr. – June	1007	331	274	NS	350	265	NS

Note: The yield trends of the other combinations and those of single-node stock clones have been omitted as there were no significant differences between them.

TABLE 2 – *Effect of grafting on pruning weights of pruned bushes and on tipping weights after recovery of graft combinations of TRI 2023 and CY 9 compared to other treatments*

Treatments	*Weight of prunings (kg ha-1)*	*Weight of tippings (kg ha-1)*
TRI 2023	20.18 a	1.46 ab
TRI 2023 (double nodes)	17.02 a	1.33 a
TRI 2023/TRI 2023	11.71 a	0.86 a
TRI 2023/CY 9	51.10 b	3.92 d
CY 9/TRI 2023	18.72 a	1.33 a
CY 9	49.47 b	2.93 c
CY 9 (double nodes)	52.64 b	3.94 d
CY 9/CY 9	44.36 b	2.56 bc

Values followed by same letter are not significantly different at P=0.05

TABLE 3 – *Effect of grafting on pruning weights of pruned bushes and on tipping weights after recovery of graft combinations of TRI 2026 and DN compared to other treatments*

Treatments	*Weight of prunings (kg ha-1)*	*Weight of tippings (kg ha-1)*
TRI 2026	17.31 a	1.14 a
TRI 2026 (double nodes)	9.82 a	0.43 a
TRI 2026/TRI 2026	18.38 a	0.86 a
TRI 2026/DN	61.14 c	4.40 c
DN/TRI 2026	10.73 a	0.24 a
DN	31.08 b	2.62 b
DN (double nodes)	33.93 b	2.70 b
DN/DN	30.47 b	2.17 b

Values followed by same letter are not significantly different at P=0.05

It will be noted that the graft combination TRI 2023 on CY 9 showed greater weight of prunings as well as of tipping shoots compared to that of the ungrafted TRI 2023 alone (Table 2). A similar trend was seen in the graft combination TRI 2026 on DN (Table 3). It is probable that the deeper root systems of the rootstocks employed in these combinations have minimised the adverse effects of moisture stress resulting in healthier branches that sustained increased crops.

It is known that clone TRI 2023 notably performs poorly during periods of dry weather. The performance of clone TRI 2026 too is poor during such periods. Vast extents planted to these clones especially in the lower elevations have resulted in considerable loss in yields incurred by several plantations. It is to be noted that these clones were initially preferred because of their high yielding capacity. The results of this study assume importance especially in view of the increasing intensity of droughts experienced and offer a simple technique of mitigating the adverse effects of dry periods and to enable plantations to continuously tap the true potential of these clones which were bred for their high yields. Combining several characters in one clone is a long-term approach needing different techniques. The technique of grafting described here enables the possibility of combining high yields with that of drought tolerance.

The technique of grafting is only a means of artificially developing composite plants, with limited known desirable characters (two or more desirable characters), suited for locations with specific environmental stress conditions, which combined tolerance and economic productivity may not be satisfactorily achieved by any of the presently available clonal selections.

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