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# Rejuvenation of Low and Unproductive Cocoa Trees

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**A field experiment was carried during 2012-2013 in a farmer's field at T. K. Pudur, Pollachi taluk, Coimbatore district, Tamil Nadu to standardize the grafting technique for rejuvenation of low and unproductive cocoa trees. The study aimed to reveal the success of graft union and growth characters in the rejuvenation process. The rejuvenation operations *viz.,* snapping, notching and girdling were taken up during the month of November, Grafting with scions of productive trees onto low and unproductive trees of cocoa on 60 or 90 days old stocks was done. The grafting on 60 days old stock, which had Involved snapping had recorded the highest graft success of 67.67 % compared to other treatments. Taking into consideration the performance of various rejuvenation methods and age of the stock on which grafting was done, it was found that the treatment of snapping and grafting on 60 days old stock would be a better and suitable technique for rejuvenation of low and unproductive cocoa trees.**

**Key words:** Cocoa (*Theobroma cacao* L.), Unproductive trees, Rejuvenation, Snapping and grafting

Cocoa (*Theobroma cacao* L.) is one of the important commercial plantation crops grown as an intercrop in arecanut and coconut gardens in India. Since cocoa is a perennial crop, it can be maintained for years together to get a continuous yield and profit. But, the trees in the whole orchard may not be uniform with respect to age, productivity and other yield related attributes. One of the major reasons for low productivity and yield of the existing cocoa plantations in our country is that, most of these plantations have been raised from seedling origin. Hence, high variability exists as they are highly cross pollinated and heterozygous in nature. As a result, plantations generally compose a mixture of low, medium and high productive trees in the field. If this low and unproductive trees are top worked with scions from high yielding plus trees of cocoa, there is a possibility to improve the productivity of the existing plantations as a whole.

In Kerala, method of improving old and already established populations of low yielding cocoa trees had been established (KAU,1990). In some cases the cocoa plantations are top worked by budding with high yielding scions to make them productive. Such methods have not yet been standardized under Tamil Nadu conditions, where hot tropical conditions prevail. With this background, the present studies were conducted to standardize the techniques for the rejuvenation of low and unproductive cocoa trees. Standardizing grafting techniques and studying the success rate of graft union along with recording the desired growth characters in the rejuvenation process have been formulated as prime objectives for the study.

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## Materials and Methods

Studies on rejuvenation of low and unproductive cocoa trees (*Theobroma cacao* L.) were conducted at T.K. Pudur, Pollachi taluk, Coimbatore district in Tamil Nadu. Selected Forastero type cocoa trees, aged more than ten years were used for the study. The experiment was laid out in a randomized block design with six treatments and five replications. The spacing in the experimental field was 3 × 3 m. The rejuvenation operations *viz.,* snapping, notching and girdling were taken up during the month of November, 2012 followed by grafting with scions of productive trees onto low unproductive trees on 60 or 90 days old stocks. The treatments included, T1 - snapping + grafting on 60 days old stock; T2 - snapping + grafting on 90 days old stock; T3 - notching + grafting on 60 days old stock; T4 - notching + grafting on 90 days old stock; T5 - girdling + grafting on 60 days old stock and T6 - girdling + grafting on 90 days old stock.

Snapping is the process of cutting the branches half way horizontally and bent outwards so that the cut portion is not completely removed from the tree. However, supply of food materials synthesized from the leaves at the tip of the branch is continued to flow through the joint (unbroken area of the stem). Notching is a process, wherein a small cut is made along with the removal of a piece of wood just above a bud, which would stimulate the bud below the notch to become more active. Girdling is also called ringing. It entails the removal of horizontal strips of rind or bark of stem around the circumference just above the dormant bud usually to check the free flow of conductive cells.

The scions used in the study were collected from the candidate plus tree *viz.,* 'SME 24' of cocoa from a farmer's field at Sethumadai, Anamalai block. They were grafted onto the new laterals of the rejuvenated low and unproductive trees at the T.K. Pudur field. The scions selected were of uniform thickness. They measured on an average of 3 cm in diameter with 4 to 5 pairs of leaves and precured before grafting. Plagiotropic shoots were used for grafting.

Morphological characters namely, time taken for new shoot emergence after the rejuvenation operations, number of laterals produced on rejuvenated branches, length of new laterals produced, thickness of the laterals (stocks) aroused at the time of grafting *i.e.,* 60$^{th}$ or 90$^{th}$ day after the rejuvenation operations, time taken for graft union, number of leaves emerged after grafting and graft success; physiological characters namely, leaf area (Suresh, 2011) and specific leaf weight and biochemical characters namely, chlorophyll content (Yoshida *et al.,* 1971) and total carbohydrates (Hedge and Hofreiter, 1962) were measured for the study. The statistical analysis of data was done by adopting the standard procedures of Panse and Sukhatme (1985).

**Results and Discussion**

The rejuvenation of the low and unproductive cocoa trees showed different levels of expression for different rejuvenation methods and operations. The time taken for new shoot emergence (Table 1) after imposing the rejuvenation operations was found to be less in the treatments involving snapping as it might have imparted more stress to the branches of the trees. The treatment T1 - snapping + grafting on 60 days old stock required less number of days (15.25 days) and the treatment T2 - snapping + grafting on 90 days old stock was found to be on par with it (16.15 days). In general, the more is the severity of pruning (greater size or number of limbs removed), the greater will be the resulting regrowth. In essence, the plant is regrowing in an attempt to restore a balance between the top and the root system (Wade and Westerfield, 1999). Further, the response after 60 days of rejuvenation process was better than 90 days of observation. The better performance of snapping and observation on 60 days after rejuvenation might be due to continuous supply of synthesized food materials to the new laterals and a good compatibility and proper alignment of the cambium of stock and scion at earlier stages.

Rejuvenation techniques of snapping and notching resulted in more number of laterals (Table1) rather than girdling. The treatments T2 (snapping + grafting on 90 days old stock) produced more number of laterals (4.83), which was followed by T1 (snapping + grafting on 60 days old stock) (4.66). Snapping, being similar to regular pruning with the difference that the cut portion is still attached to the tree might have produced more laterals compared to notching. As a result of snapping of the branches in cocoa, the apical dominance was checked and the flow of xylem and phloem of the cut branch of the tree was interrupted. Any type of pruning generally stimulates regrowth near the cut. This would have led to the development of new laterals near the snapping region to replenish the loss in biomass.

**Table 1. Effect of rejuvenation methods and age of grafting on new shoot emergence after rejuvenation in cocoa**

| Treatment | Time taken for new shoot emergence (DAR) | Number of laterals produced | Stock thickness (cm) |
|---|---|---|---|
| T1 - Snapping + grafting on 60 d old stock | 15.25 | 4.66 | 3.20 |
| T2 - Snapping + grafting on 90 d old stock | 16.15 | 4.83 | 3.33 |
| T3 - Notching + grafting on 60 d old stock | 18.67 | 3.74 | 2.89 |
| T4 - Notching + grafting on 90 d old stock | 19.19 | 3.92 | 2.92 |
| T5 - Girdling + grafting on 60 d old stock | 40.13 | 2.50 | 0.94 |
| T6 - Girdling + grafting on 90 d old stock | 43.12 | 2.60 | 1.01 |
| S.Ed | 2.60 | 0.08 | 0.05 |
| CD (P=0.05) | 5.42 | 0.16 | 0.11 |

DAR – Days after rejuvenation

Among the three treatments of snapping, notching and girdling with grafting on 60 days old stock (T1, T3 and T5), the treatment T1 - snapping + grafting on 60 days old stock produced the longest new lateral growth of 33.27 cm on 60th day after rejuvenation. Among the remaining three treatments (T2, T4 and T6) with grafting on 90 days old stock the treatment, T2 - snapping + grafting registered the highest length of new laterals growth (42.53 cm). The length of the new laterals (Fig. 1) assessed in the present study also showed that with the increase in severity of cut, there was an increase in length of new lateral.

The stock thickness (Table 1) of the rejuvenated trees by different methods was measured and they also varied significantly. The highest value of the stock

thickness was measured in the treatment T2 - snapping + grafting on 90 days old stock (3.33 cm) and it was closely followed by T1 - snapping + grafting on 60 days old stock (3.20 cm). The least value was measured in girdling treatments, which showed a very less possibility of grafting on those lean and less developed laterals. The girdling treatments *viz., T5* and T6 recorded a stock thickness of 0.94 cm and 1.01 cm, respectively. The enhancement of the stock thickness in the snapping and notching treatments might be due to the fact that they imposed appreciable disturbance to apical dominance, wherein the griddling treatments might not have imposed any appreciable disturbance on apical dominance. Since the new laterals from the girdled trees had not developed well to an appreciable level even after 90 days, grafting was not carried out in the girdled trees

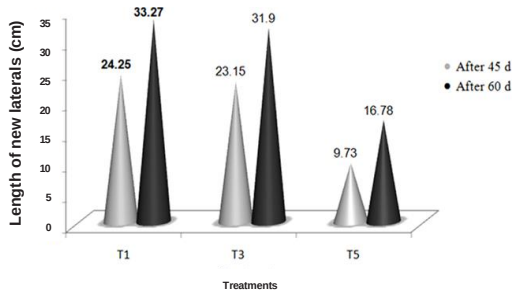


Fig 2. Effect of different methods of rejuvenation and age of stock on length of new lateral(cm) appeared after rejuvenation (for 60 days old stock) in cocoa

Regarding the span of time for graft union, the treatment which took minimum time for the graft union was the first treatment T1 - snapping + grafting on 60 days old stock (17.23 days after grafting), which was closely followed by treatment T2 - snapping + grafting on 90 days old stock (18.63 days after grafting). Less time taken for graft union might be due to favourable climatic conditions *viz.,* moderate temperature and maximum relative humidity that prevailed during the period of rejuvenation. These favourable conditions would have activated the cambium cells. The new callus tissue arising out of the cambial region composed of thin walled turgid cells, which could easily get dessicated and die off wherein, high relative humidity could protect such cells in the cambial region of the graft union (Hartman and Kester, 1979). Here again, the assured supply of food materials from the left over primary branches would have led to better success in early grafting *i.e.,* grafting on 60 days old stock resulted in better graft union.

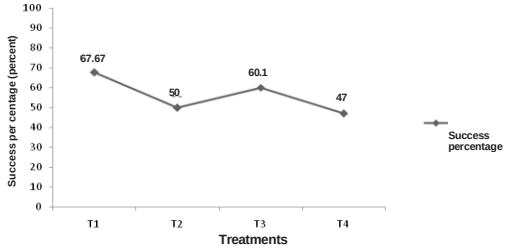


Fig 2. Effect of different methods of rejuvenation and age of stock on graft success after three months of grafting in rejuvenated cocoa

Note: Grafting was not taken up in T5 and T6 since there was not enough growth

The graft success (Fig. 2) was observed after ninety days and T1 (snapping + grafting on 60 old stock) registered the highest percentage of success (67.67 %). There may be several reasons for the highest graft success in T1, which involved snapping, resulting in enhanced continuous supply of food materials for the production of new healthy laterals and early graft union. The quality of the scions (mature and healthy) and of the rootstocks, strongly determine the success of grafting through the appropriate unification between the two components (Usman, 2008).

In general, the grafting is to be done during monsoon period. In the trial, although the grafting was taken up during the month of January, 2012 the field received little rain during the later months *viz.,* February and March of rejuvenation treatments, which would have played a role in graft take. . Cleft grafting was highly successful as top working method in February-March on apple in the North Western Himalayan temperate region (Das *et al.* 2011).

The prevailed weather conditions were also conducive for better success of the grafts in the treatment T1 - Snapping + grafting on 60 days old stock (67.67 %). This was followed by T3 - notching + grafting on 60 days old stock (60.10 %). As already mentioned, grafting was not carried out in the girdled trees, since the new laterals from the girdled trees had not developed well to an appreciable level even after 90 days. So grafting was followed in first four treatments only.

Though notching produced less number of new laterals than snapping, the graft success was more only in the treatment involving snapping operation. In both the treatments, the grafting was done on 60th day after the rejuvenation operations *viz.,* snapping and notching. This might be due to the fact that the alignment of the cambium cells of both the stock and scion of the treatments involving notching would have been compatible like in the treatments involving snapping.

Among the biochemical characters observed, T2 - snapping + grafting on 90 days old stock exhibited higher chlorophyll a, chlorophyll b and total chlorophyll content which were recorded after rejuvenation and after grafting (1.66, 0.62 and 2.28 mg. g-1, respectively during the first stage and 0.71, 0.42 and 1.13 mg. g-1, respectively during the second stage). T2 - snapping + grafting on 90 days old stock recorded a higher carbohydrate content. The higher carbohydrate content was observed in both the leaves and wood during the first stage (18.42 and 18.19 %, respectively) and in second stage, it was recorded high in leaves (12.94 %). Availability of carbohydrate content in leaves and wood after rejuvenation and better union of the stock and scions for the continuous flow of the available nutrients would have been resulted in the better graft success.

Thus, the study on rejuvenation of low and unproductive cocoa trees with snapping, notching

and girdling revealed that snapping would be the best method, adjudged by more number of laterals and higher percentage of graft success. This was further supported by biochemical characters like chlorophyll and carbohydrate contents. Between the grafting operations done on 60th and 90th day after rejuvenation operations, early grafting on 60th day was found to be more successful in terms of graft success percentage, early sprouting and leaf area. Hence, it is concluded that snapping followed by grafting with scions of productive trees in low and unproductive trees of cocoa will enhance graft success, further growth and development.

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