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EVALUATION OF FIELD SURVIVAL OF INTER-SPECIFIC GRAFTS IN *GARCINIA SPECIES*

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ABSTRACT

Garcinia, also known as Malabar tamarind holds significant economic importance due to its rich content of Hydroxycitric acid (HCA) which is used in diverse pharmaceutical formulations. In the present study, five species of *Garcinia* were subjected to inter-specific grafting in order to assess their survivability during the early stages of growth in the field. Among the tested graft combinations, T_1 (*G. indica rootstock* and *G. gummi-gutta* scion), T_3 (*G. gummi-gutta* rootstock and *G. indica* scion), T_6 (*G. xanthochymus* rootstock and *G. indica* scion), and T_7 (*G. xanthochymus* rootstock and *G. morella* scion) exhibited the highest survivability rates, each recording 100 %. Conversely, the lowest survival rates were observed in T_4 (*G. gummi-gutta* rootstock and *G. mangostana scion*) at 11 % and T2 (*G. indica* rootstock and *G. gummi-gutta* scion) at 22 %. None of the grafts survived in T_8 (*G. xanthochymus* rootstock and *G. mangostana* scion), T_9 (*G. mangostana* rootstock and *G. indica* scion), T_{10} (*G. mangostana* rootstock and *G. morella* scion), T_{11} (*G. mangostana* rootstock and G. gummi-gutta scion), and T_{12} (*G. mangostana* rootstock and *G. xanthochymus* scion). The *Garcinia mangostana* species exhibited poor compatibility with most other species of Garcinia, as evidenced by the lack of survival in several graft combinations. Additionally, graft compatibility barriers were observed between T_1 and its reciprocal combination, T_3. However, this research pinpointed a simple and effective approach for grafting different species of Garcinia together, offering important guidance on which graft combinations might be successful for future exploration and sustainable utilization.

***Keywords* :** Inter-specific grafting, survivability, compatibility and sustainable utilization

Introduction

India has rich wealth of important medicinal flora due to variable climatic conditions. Medicinal plants play major role in pharmaceutical industry. The use of these herbal drugs is not only cost effective but also safe and almost free from serious side effects. *Garcinia* is also one of the important medicinal plants and non-timber forest product tree species today. It assumed great significance in recent times ever since the finding that hydroxy citric acid present in these plants can control obesity in man. Several among the *Garcinia spp.* have been in traditional usage either as spice, source of camboge (colour), as fruit or for medicinal purpose in various parts of the world. However, the main problem associated with the *Garcinia* is it's a dioecious plant and it has monoembryonic seeds which, when planted, will not reproduce true to type and seed viability is also very less. There exists a great scope to grow grafted elite varieties in the homestead areas as well as in orchard to increase the production. The inter-specific grafting method is desirable because it enables to retain the characteristics of the mother plant, to get flower and fruit earlier, to remain initially relatively smaller with the benefit of more plant's accommodation per unit area and to give the owners earlier and much higher economic returns. This has in turn been used to improve the *Garcinia* varieties to dwarf, reduce maturity time and produce bigger fruits through grafting.

Grafting plant scions onto a rootstock of its own species is common because intra-specific compatibility is often very high (Black *et al*., 2003; Palada and Wu, 2008; Rivard and Louws, 2008). Intra-specific grafting has been shown to increase resistance to various environmental pressures such as flood, drought, cold, heat and pathogen stress, however in some cases the transferred tolerance is not strong enough, or a certain desired environmental tolerance does not yet exist within the rootstock germplasm of that species (Bloom *et al*., 2004; Sanders and Markhart, 1992; Venema *et al*., 2008; Zijlstra and Nijs, 1987). Intra-specific grafting would not be a viable cultural practice in these unique circumstances, but grafting is not always limited to intra-specific interactions. Plants with certain environmental susceptibilities will sometimes have graft-compatible relatives within the same genus that possess a natural resistance to that stress. Thus, inter-specific grafting can be used to broaden rootstock diversity when environmental pressures surpass the advantages that can be provided by intra-specific grafting alone. Inter-specific grafting is defined as grafting within genus with different species. To identify a useful rootstock for inter-specific grafting, first a relative with unique environmental resistances must be found, and then tested for rootstock compatibility. Inter-specific grafting compatibility is difficult to predict because the degree of taxonomic affinity necessary for compatibility varies widely across different taxa (Mudge *et al*., 2009). Four potential mechanisms of inter-specific incompatibility are identified by Andrews and Marquez (1993): cellular recognition, wounding response, plant growth regulators, and incompatibility toxins. Since prediction is difficult, individual grafting trials must assess compatibility.

Recently *Garcinia* species are being adopted into agroforestry system because of their increase economic importance. Inter-specific plants have good potentialities to diversify the plantation. An inter-specific grafting yields valuable fruits and comes up in drier condition also. For *e.g. G. gummi-gutta* is highly valued but needs very moist conditions and not tolerant to drier condition. But the rootstock of *G. indica* is resistant to drought (Kureel *et al.,* 2009). Grafting *G. gummi-gutta* scion on *G. indica* rootstock can easily come up on drier region. The studies have revealed the success of kokum grafting by using *G. gummi-gutta,* and species like *G. cowa, G. hombroniana* can be adapted to marshy or wet soil and can tolerate inundation of water (Lim, 2012). To induce adaptability to such soil conditions also grafting can be helpful. Keeping these points in mind attempt was made to assess field performance of different species of *Garcinia* through inter-specific grafting.

Material and Methods

Experiment on field performance of inter-specific grafts of *Garcinia* carried out at the Agriculture Research Station (ARS) Malagi, Taluk Mundagod in Uttar Kannada district which is situated at 14^0 43’ N latitude, 75^0 00’ E longitudes. Due to the efficiency and greater cambial contact provided by cleft grafting method, it was tried in the month of June. Rootstock of two and half year old *Garcinia* species was selected from different sources. Present season sprouts of about 8-15cm length were selected as a scion from female trees. After three months of nursery condition the inter-specific grafts were placed under full sunlight to avoid transplant shock at the time of field planting. Irrigation was reduced to once in three days. Saplings of 12 inter specific grafts were planted at 2 m × 2 m spacing with the following treatment details. The experiment was laid out in Randomized Complete Block Design (RCBD). In each treatment three plants were planted and the treatments replicated thrice.

Table 1: Treatment details

Treatments	Rootstock	Scion
T_1	*Garcinia indica*	*Garcinia gummi-gutta*
T_2	*Garcinia indica*	*Garcinia mangostana*
T_3	*Garcinia gummi-gutta*	*Garcinia indica*
T_4	*Garcinia gummi-gutta*	*Garcinia mangostana*
T_5	*Garcinia xanthochymus*	*Garcinia gummi-gutta*
T_6	*Garcinia xanthochymus*	*Garcinia indica*
T 7	*Garcinia xanthochymus*	*Garcinia morella*
T 8	*Garcinia xanthochymus*	*Garcinia mangostana*
T 9	*Garcinia mangostana*	*Garcinia indica*
T 10	*Garcinia mangostana*	*Garcinia morella*
T 11	*Garcinia mangostana*	*Garcinia gummi-gutta*
T 12	*Garcinia mangostana*	*Garcinia xanthochymus*

The number of grafts survived was counted after 150 days of planting in the field and was expressed in percentage using formula

$$\text{Survival per cent in field} = \frac{\text{Number of grafts survived in field}}{\text{Total number of planted grafts}} \times 100$$

Results and Discussion

The grafting compatibility is essential for achieving successful graft unions, ensuring plant performance, disease resistance, environmental adaptation, and efficient propagation. The present research experiment revealed that inter-specific graft compatibility is highly variable among genotypes and difficult to predict; the degree of taxonomic affinity necessary for compatibility varies widely across different taxa (Mudge *et al.,* 2009). There was a significant difference in survival per cent in field among 12 treatments. Cent per cent survival rate was observed in T_1 (*G. indica* rootstock and *G. gummi-gutta* scion), T_3 (*G. gummi-gutta* rootstock and *G. indica* scion), T_6 (*G. xanthochymus* rootstock *G. indica* scion) and T_7 (*G. xanthochymus* rootstock and *G. morella* scion) presented in Table 2**.** In different treatment combinations, T_1 and their reciprocal (T_3) showed best compatibility and survivability in field condition because they are phylogenetically more related compared to other species. Anusha Bhat (2015) has used the three gene regions to study the phylogenetic relation among the species of *Garcinia* and has observed a close relationship between *G. indica* and *G. gummi- gutta*. Further, scion of *G. gummi-gutta* on *G. xanthochymus* rootstock (T_5) also showed fairly good compatibility (66 %).

Table 2: Survival per cent of various inter-specific grafts in *Garcinia* species after 5 months of filed planting

Treatments	(Rootstock X Scion)	Survival (%)
T1	*G. indica* X *G. gummi-gutta*	100(90.00)
T2	*G. indica* X *G. mangostana*	22(27.97)
T3	*G. gummi-gutta* X *G. indica*	100(90.00)
T4	*G. gummi-gutta* X *G. mangostana*	11(19.37)
T5	*G. xanthochymus* X *G. gummi-gutta*	66(54.33)
T6	*G. xanthochymus* X *G. indica*	100(90.00)
T7	*G. xanthochymus* X *G. morella*	100(90.00)
T8	*G. xanthochymus* X *G. mangostana*	0.00
T9	*G. mangostana* X *G. indica*	0.00
T10	*G. mangostana* X *G. morella*	0.00
T11	*G. mangostana* X *G. gummi-gutta*	0.00
T12	*G. mangostana* X *G. xanthochymus*	0.00
Mean		41.58
SEm±		2.37
CD@5%		6.91 (15.23)

Figures in parentheses are arcsin – transformed values

Among different treatment combinations, least survival per cent was found in T_4 (*G. gummi-gutta* rootstock and *G. mangostana* scion) of 11 % and T_2 (*G. indica* rootstock and *G. gummi-gutta* scion) of 22 %. It was found that no grafts were survived in T_8 (*G. xanthochymus* rootstock and *G. mangostana* scion), T_9 (*G. mangostana* rootstock and *G. indica* scion), T10 (*G. mangostana* rootstock and *G. morella* scion), T_{11} (*G. mangostana* rootstock and *G. gummi-gutta* scion) and T_{12} (*G. mangostana* rootstock and *G. xanthochymus* scion). These results showing that both the rootstock and scion of *G. mangostana* was not compatible with most species of *Garcinia*. Up to 2-3 months the mangosteen grafts showed the survival with slow growth later on it showed the delayed incompatibility. No survival was observed in duration of five month after planting. This might be due to the immaturities of scion, lack of reserved food material and lack of amount of nutrient supply to the growing shoot. These results are in line with the findings of M. Bin Osam and A. Rahmon Milon (2006). They used *G. kydia* and *G. venulosa* as a rootstock for *G. mangostana* scion and recorded 10 per cent success for *G. kydia* and 12 per cent for *G. venulosa* rootstock. Jill (1976), Fairechild (1915), Galang (1955) and Ochse *et al*. (1961) reported that *G. tinctoria* (Syn. *G. xanthochymus*), *G. lateriflora*, *G. hombronaina* and *G. livingstonei* have shown fairly successful result as rootstock for *G. mangostana* but the present study did not find sufficient support for pursuing these alternatives due to poor subsequent growth. Though a good union is possible, subsequent growth was so poor that the effort was not worth pursuing. These results are also in conformity with the findings of the Mathew *et al.* (2005) who reported that for *G. mangostana* its own seedlings are best rootstock for good graft take. But the scion of *G. mangostana* on *G. gummi-gutta*, *G. cowa* and *G. tinctoria* (Syn. *G. xanthochymus*) died within one year of planting. Those on *G. hombronaina* remained alive for more than three years but without any further growth. As already reported by Jill (1976), growth of mangosteen grafts even on its own seedlings was very slow. Thus, compatibility ensures high success rates in grafting, leading to consistent and reliable propagation of elite cultivars for commercial production. By understanding and selecting compatible rootstock-scion combinations, growers can harness the full potential of grafting to improve crop productivity, sustainability, and economic viability.

Conclusion

Indeed, the study highlights a critical grafting compatibility while some inter-specific graft combinations within the genus Garcinia exhibit potential for successful cultivation, especially when involving closely related species, achieving compatibility with *G. mangostana* remains a significant challenge. This underscores the necessity of considering both taxonomic relationships and practical outcomes when selecting graft combinations for successful cultivation. The findings emphasize that successful grafting is not solely determined by taxonomic proximity but also by the practical outcomes such as survival rates and subsequent growth. Thus, while certain species may appear phylogenetically related and theoretically suitable as rootstocks or scions based on taxonomic studies, their compatibility in real-world cultivation scenarios can vary significantly. Thus, identifying suitable grafting combination helps in species propagation for sustainable farming and uplifting farmers income and livelihood.

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