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Top-veneer Grafting: A New Approach to Mango Propagation

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Abstract: *Top-veneer grafting and veneer grafting were evaluated during 2000, 2001 in out door nursery and 2002 in greenhouse. Scion woods of some commercial mango (Mangifera indica.L) were grafted onto one year old wild rootstock by top-veneer and conventional veneer methods at a varying height of 10-40 cm from surface during July-August. About one half of the young rootstocks seedlings were 100 per cent defoliated by beheading up to 10-40 cm height and subsequent grafting was done by top-veneer method for top veneer grafting while rest was conventionally veneer grafted. The goal of this research work was to find out an alternative, viable and successful method to veneer grafting. Propagation trials were conducted with scion wood from four commercial cultivars viz., 'Amrapali', 'Mallika', 'Dashehari' and 'Malda'. Scion woods were precured (defoliated) 7-10 days prior to grafting operation. With regard to total success per cent, top-veneered plant recorded 92.49 per cent whereas 77.41 per cent success was found in veneer grafting method in 2001. As much as 25 cm scion growth (length) was obtained by top veneer method where as conventional veneer grafting accounted for 17.40 cm scion growth with in a stipulated period of 90 days. Plant from top-veneer grafting in second year had lower root-rootstock: scion ratio (1.65) which clearly indicated higher vegetative growth (scion length, leaf number and flash number) achieved within a short period (90 days) of time as compare to veneer grafting method (2.02). From method and cultivar interaction we found that in top veneer grafting method 'Dashehari' and 'Mallika' had (95.79%) and (95.13%) success, respectively in 2001. 'Amrapali' produced higher scion length (29.77 cm) and lower root-rootstock and scion ratio (1.39) in the same year. In a second study, field survival, top veneer grafted plant had better survival per cent (90.62) than that of veneer grafted plant (66.15). A third study in green house condition (T=32° C, RH=80%), showed that top veneer grafted plant attended the highest 25.36 cm scion growth with 98% success in 90 days. Veneer grafting had only 90.53 % success and 20.05 cm scion growth. We conclude that top-veneer grafting from young rootstocks is an effective way to multiply commercial clones of Mangifera indica, particularly when salable grafted plants are obtained 90 days after grafting operation.*

Keywords: *Top veneer grafting, success per cent, root shoot ratio, rainy season, nursery, greenhouse, field survival.*

INTRODUCTION

Mango (*Mangifera indica* L.), the king of fruits belonging to the family *Anacardiaceae*, is believed to be originated in south-east Asia. The demand for quality-grafted plants of high yielding cultivars is increasing adapted to different Indian agro-climatic condition. India being the homeland has vast scope for its economic production. Conventional veneer grafting technique for vegetative propagation was developed in Florida, USA and was successfully adopted in India during early sixties (Gour, 1988). In recent years various methods and techniques of propagation in mango have been gaining importance, while choosing a particular technique for propagating mango, time of operation and climatic condition taken in to consideration (Singh *et.al.*, 1984). July–August is the ideal condition for grafting in Indian sub continent as well as south East Asia (Singh and Srivastava, 1982). In a different experiment Singh (1979) *et.al.* observed that August was the suitable time for veneer grafting for Indian sub-continent. For veneer grafting, better success (70-80%) was recorded in the rainy season (June-July) in coastal humid conditions (Sadhu, 1999). In a different experiment Nayak and Sen (2000) reported that 78.8 % success was achieved during July-August compared to 75% in January-March. Gour (1988) reported that under Lucknow condition (Central Mango Research Station, India) grafting success is very poor (35 to 40% at salable graft stage). In the veneer and side grafting experiments conducted in south India revealed that better results

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were obtained during mild weather i.e. in the absence of strong winds, intense heat and heavy rains (Rao, 1967). Based on this observation, we designed a trial on grafting operation during rainy season. We took four mango cultivars from different region of India, i.e., north ('Amrapal' and 'Dashehari'), south ('Mallika') and north-east India ('Malda') to examine how different grafting methods perform and to assess the provenance effect for survival and scion growth on two successive years. In our knowledge, no studies were attempted to evaluate the new method and compare it with the traditional veneer grafting method in mango. Top veneer grafting with 100% defoliation by beheading the plant is the new concept, usually done during peak commercial season (July-August) in India. The objectives of this study were three fold. First, we wanted to examine the differences in success per cent, plant growth and root-rootstock and scion wood ratio among four cultivars of *Mangifera indica* over the course of their two typical mode of propagation by grafting in nursery. Second, we wanted to compare the field performance of the grafted plant obtained from two propagation methods. Graft performance of 'Amrapali' cultivars green house to produce graft plants through out the year with out location barrier (among major mango growing area of the world) was the third objective.

MATERIALS AND METHODS

The experiment was conducted at Horticulture and Agro Forestry Research Program at Ranchi under Indian Council of Agricultural Research Complex for Eastern Region, Patna. This area is situated 620 m above mean sea level (msl) and at 23° 25' N latitude and 85° 20' East longitude experiencing average annual rainfall of 80-140 cm. High humidity (78.14 - 84.14%) and low evaporation rate (4.04 mm/day) is experienced after June which continues up to onset of winter (Singh, 1999). During the winter (November-February) humidity is high and evaporation rate is low but after February it increases. Higher humidity favors better stands of plants in out door and at the same time the condition is favorable for growth and development of scion wood.

Trial 1. Collection of wild mango seeds began in July 1999 from Jharkhand forest areas. Seedlings were planted in poly-bags that were held in 1.5 m x 5 m shallow plot. In each plot, 125 poly-bags were placed for better accommodation. Filled poly-bags were covered with surface soil to curtail summer heat. In each poly-bags 0one-two, wild mango seedlings were raised. We started grafting operation on 13.08.2000. After one year (2000), when seedling mango attended a height of 50 cm and stalk thickness of 3-5 cm about one half (1500) of these plants were beheaded to a height of 10-40 cm to achieve 100% defoliation for top-veneer grafting and rest (1500) was conventionally veneer grafted. In the top-veneer grafting method, a shallow downward and inward cut of 3-5 cm length was made just below the top of the beheaded rootstock. The piece of wood and bark were removed by severing off the separated portion by making a clean cut at its base. The precured scion wood of (defoliated 7-10 days before grafting) of 3-4 months old shoots of 'Amrapali', 'Mallika', 'Dashehari' and 'Malda' cultivars were collected for grafting. These four varieties were also taken for veneer grafting.

The experiment was a factorial randomized block design. We took two grafting methods as two factors. Each treatment was replicated three times. An experimental unit consisted of 125 plants, grafting as replication from one of the 4 varieties. Propagation procedure for top-veneer grafting comprised of 4 x 3 replications. Twelve experimental units were similar and equal to another 12 experimental units for veneer grafting. Data were subjected to analysis of variance using general linear method (Panse and Sukhatme, 1961). Mean sprouting days were calculated when 80% sprouting (just unfurl condition) occurs whereas root-rootstock scion ratio was obtained from fresh weight of stock and scion (90 days growth).Number of mature leaves considered as functional leaf number. Number of flash was the number of fresh growth over previous one. Experiment was repeated in July-August (21.07.01-16.08.01) in 2001.

Trial 2. In order to assess the field survival of grafted plant in second trial was started on 27.07.01 by planting top veneered plant in main plot with square method. Planting distance was 6m x 6 m. Veneer grafted plants were planted on 8.10.01. An initial fertilizer dose of 73 gm nitrogen 18 gm P_2O_5 and 68 gm K_2O per plant was applied. In second year, same dose was repeated. Fertilizer was applied before arrival of monsoon (3rd week of June). Total 120 plants were taken for experiment where 15 plants were allotted for each treatment. Data with regard to plant survival was taken after two years. We finished our experiment on 27.7.03. Data were subjected to factorial randomized block design.

- *Trial 3.* These two grafting methods were also tried in green house in an attempt to determine suitable method for success per cent and its year round production. Temperature and humidity were determined from two years experiment and weather

data (Table 4). We came to a conclusion that for greenhouse trial temperature and humidity would be around 32°C and 80 per cent, respectively. Intermittent mist was automatically controlled over their set humidity. The night temperature was systematically lowered with 0.5°C per week. The wind side kept closed as long as possible. Only if the temperature in green house rose above 32°C. The wind side came open automatically. We took cultivar 'Amrapali' and its 96 plants for each method Growth data regarding scion growth, mean sprouting days were taken at 15 days interval. We winded up this experiment by 14th June. Data were subjected to ANOVA and treatment means were separated by Fisher protected LSD test ($p \leq 0.05$).

RESULTS AND DISCUSSION

Grafting Success and Mean Sprouting Days

Top veneer grafting and veneer grafting performed well in both years (2000, 2001) in sub-humid and sub-tropical conditions at Ranchi, India. In 2000, top-veneer grafting recorded success as high as 91.21 per cent (Table 1), which was similar to 2001 (92.49%);

Table 1
Effect of Grafting Methods and Cultivars on Graft Success and Scion Growth Characters after 90 Days (2000)

Treatment	*Success (%)*	*Mean sprouting days*	*Scion length (cm)*	*Leaf number*	*Flash number*	*Root-stock: scion*
Methods of grafting (M)						
Veneer (M1)	78.27	16.08	17.79	16.87	2.48	2.11
Top-veneer (M2)	91.21	10.96	24.01	19.83	2.67	1.71
Cultivars (C)						
'Amrapali' (C1)	85.19	13.00	23.80	16.36	2.67	1.67
'Mallika' (C2)	88.57	12.59	20.95	20.58	2.62	1.91
'Dashehari'(C3)	85.03	13.00	20.11	20.50	2.63	1.79
'Malda' (C4)	80.17	15.5	18.75	15.96	2.39	2.28
Treatment Interaction (M X C)						
MI X CI	79.36	16.00	18.16	15.26	2.63	1.78
MI X C2	81.39	15.33	16.90	17.73	2.20	1.98
M1 X C3	75.07	15.66	18.36	20.13	2.73	1.9
M1 X C4	77.26	17.33	17.73	14.36	2.35	2.79
M2 X C1	91.01	10.00	29.43	17.46	2.70	1.56
M2 X C2	95.75	9.86	25.00	23.43	3.03	1.85
M2 X C3	95.00	10.33	21.86	20.86	2.53	1.68
M2 X C4	83.08	13.66	19.76	17.56	2.43	1.76
Significance						
M	*2.32	*0.50	*1.75	*1.20	NS	*0.03
C	*3.27	*0.41	*1.93	*1.59	NS	*0.73
M X C	*6.57	*0.83	*3.67	NS	NS	*0.36

*Significance, NS. Nonsignificance, CD at o.o5,
Factorial randomized block design.125plants/block,
Out door nursery experiment, duration 90 days.

whereas veneer grafting accounted for lower success rate, i.e. 78.27 per cent and 77.41 per cent in 2000 and 2001, respectively. In respect of cultivar's success, Mallika had the maximum success of 95.75 per cent in top veneer grafting method in 2000, (Table 1), which was higher than that of 2001 (95.13%). However, the study was not conducted long enough for these varieties and limited to salable stage (90 days). Overall success of 2001were little bit higher because of humid climate (Table 4) prevailed for a longer time than 2000. In a study with conventional veneer grafting method of 'Langra' cultivar of mango, Singh *et al.* (1984) reported that veneer grafting with immediate top removal (50% defoliation) resulted in highest success of 81.0 per cent under (Uttar Pradesh) North Indian condition. Kumar *et al.* (2000) achieved more than 85% success when 'Dashehari' scions were grafted by veneer method at higher grafting height (75 and 100 cm). In a study with seasonal effect on success of veneer grafting in mango cultivar 'Amrapali' Bramachari *et al.* (1997) found that the maximum 91.13 per cent success was obtained in July grafting. However our result on success percentage of veneer grafting could not directly compared with those of Brahmachari *et al.* (1997). They conducted a preliminary season based experiment. We found a maximum of 78 per cent success in veneer grafting and it was also very low in two successive seasons than that of top-veneer grafting.

In our experiment, we found that mean sprouting days for top veneer grafting varied from 10.96 days in 2000 to 10.79 days in 2001. 'Mallika' had the lowest sprouting duration (9.86 and 9.50 days in top veneer grafting in 2000 and 2001, respectively). The veneer grafting method had the maximum mean sprouting days of 17.33 and 17.16 for 'Malda' cultivar in 2000 and 2001, respectively. Previous experiment laid down by Nayak and Sen (2000) revealed that the mean sprouting duration was 26 days for veneer grafting during July-August. All top veneer grafted variety showed lower mean sprouting days than that of veneer grafting, which clearly indicated that new method paved the way for quicker and heavier growth than that of traditional veneer grafting.

Grafting Methods and Vegetative Growth

Shoot growth of all cultivars in top veneer grafting method was higher than that of veneer grafting method in 2001 but not in 2000. Veneer grafted 'Amrapali' cultivar had 19.23 cm scion growth, which was higher than that of 'Malda' cultivar in top veneer grafting method. We obtained 25 cm scion growth

from 90 days growth during 2001 in top veneer grafting. Similar results were also found in 2000 (24.01 cm). Among variety and method interaction it has been observed that 'Amrapali' accounted for 29.77 cm scion growth where as 'Malda' in veneer grafting gave lowest scion wood growth of 15.58 cm in 2001. In a different experiment Bramachari *et al.* (1997) observed that veneer grafted plant of cultivar 'Amrapali' attended the maximum 18.70 cm scion growth in 180 days in June. Upadhayay and Prasad (1988) achieved higher scion growth of 26.4 cm from 180 days growth period of 'Dashehari' cultivars of mango when veneer grafted in the month of June. As shown in Table 1, leaf number produced in new method was 19.83 in 2000 and 21.15 in 2001which was significantly higher than that of year 2000 (16.87) and 2001 (14.92) in veneer method. Interaction among methods and cultivars in respect of leaf number was significant in 2001 but not in 2000 (Table 1). Though leaf number is a genetic character; it is not influenced by different methods of grafting. Here more leaves were produced through quick immergence of flush that led to more leaf production. Two methods significantly differed in respect of flush number in 2001 but not in 2000. Same trend was also observed in methods and cultivars interaction. We observed that more flush was produced by top veneer grafting method and cultivar 'Amrapali' produced highest flush number of 2.86 (Table 2), which was only significant in 2001 but not in 2000 (2.70). Flush production depends on length of the internodes and growing duration. Internodes length was cultivar's character therefore we got significant result in at least one year (2001)

Table 2
Effect of Grafting Methods and Cultivars on Graft Success and Scion Growth Characters after 90 Days (2001)

Treatment	*Success (%)*	*Mean sprout-ing days*	*Scion length (cm)*	*Leaf number*	*Flash number*	*Root-stock: scion*
Methods of grafting (M)						
Veneer (M1)	77.41	15.66	17.40	14.92	2.26	2.03
Top-veneer (M2)	92.49	10.79	25.00	21.15	2.65.	1.65
Cultivars (C)						
'Amrapali' (C1)	85.30	12.66	24.50	18.80	2.64	1.68
'Mallika' (C2)	87.40	12.16	21.18	18.55	2.44	1.90
'Dashehari' (C3)	85.47	12.58	22.54	20.66	2.50	1.79
'Malda' (C4)	81.65	15.50	16.59	14.13	2.23	2.28
Treatment Interactions (M X C)						
MI X CI	78.18	15.50	19.23	15.5	2.42	1.60
MI X C2	79.67	14.83	16.60	14.88	2.10	2.02
M1 X C3	75.16	15.16	18.20	16.33	2.33	2.01
M1 X C4	76.64	17.16	15.58	12.96	2.20	2.47
M2 X C1	92.41	9.83	29.77	22.10	2.86	1.39
M2 X C2	95.13	9.50	25.77	22.23	2.78	1.83
M2 X C3	95.79	10.00	26.89	24.98	2.68	1.62
M2 X C4	86.66	13.83	17.60	15.30	2.26	1.75
Significance						
M	*2.43	*0.75	*1.82	*1.28	*0.20	*0.31
C	*3.18	*0.53	*1.89	*1.72	*0.25	*0.45
M X C	*6.73	*0.98	*3.95	*1.94	*0.34	*0.42

*Significance, NS Nonsignificance, CD at o.o5,
Factorial randomized block design.125plants/block,
Out door nursery experiment, duration 90 days.

Grafting Method and Root-rootstock and Scion Ratio:

Top veneer grafting significantly increased overall scion growth in fresh weight basis in both the years than vegetative growth possessed by conventional veneer grafting propagation. We have achieved an interesting result from root-rootstock and scion ratio. Cultivar 'Amrapali' had the minimum ratio of 1.39 and 1.56 in 2001 and 2000, respectively. The highest ratio (1.7) was found in 'Malda' cultivar in both the years (2000, 2001). Lower the ratio, higher is the vegetative growth. Cultivar 'Amrapali' in combination with top veneer grafting method recorded maximum growth.

Field Survival of Grafted Plants: Grafted plants from both methods were planted during 27.01.01 and 8.10.01. They thrived well under Ranchi agro climatic condition. Evaluation was done during 2 years. Top-veneered plants had highest survival percentage (90.62) than veneer-grafted plants (66.15) (Table 3). All four varieties in new method had greater survival over conventional method. It had been found that cultivar 'Amrapali' had 100 per cent field survival followed by 'Mallika' (90%) in new method, whereas lowest survival percentage was recorded in 'Amrapali', 'Mallika' and 'Malda' cultivars (60% each) in conventional veneer grafting (Table 3).

Green House Performance of Grafted Plants: Two methods were also practiced on 'Amrapali' cultivar under green house condition. The experiment was started on 14.03.02. Temperature and humidity were maintained 32°C and 80%, respectively. We completed our experiment by 15.06.02. Success per cent mean sprouting days and scion growth were the characters of choice. We found that top-veneer grafting achieved the maximum 98% success over veneer grafting (90.53%). A close perusal of Table 5, revealed that mean sprouting days for top-veneer grafting and veneer grafting were 22 days and 30 days, respectively. Here we observed that days taken for sprouting were a little longer. Intermittent mist

Table 3
Field Survival of Grafted Mango Plant (27.7.01 to 27.7.03) as Affected by Different Propagation Methods

Treatment	*Field survival (%)*
Method of grafting (M)	
Veneer (M1)	66.15
Top-veneer (M2)	90.62
Cultivar (C)'	
Amrapali' (C1)	80.0
'Mallika' (C2)'	75.0
Dashehari' (C3)'	85.0
Malda' (C4)	73.0
Treatment interactions (M x C)	
MI X C1	60.0
M1 X C2	60.0
M1 X C3	84.6
M1 X C4	60.0
M2 X C1	100.0
M2 X C2	90.0
M2 X C3	85.7
M2 X C4	86.8
Significance	
M	*17.52
C	*4.5
M X C	*14.7

**Significance, NS. Nonsignificance, CD at o.o5,
Factorial randomized block design.5 plants/block,
Out door field experiment, duration 2 years.

Table 4
Meteorological Observation as Recorded at Horticulture and Agro-forestry Research Program, Ranchi during Experimentation Period

	Total rainfall (mm)		*Temperature Max.-Min. (°C)*		*Relative humidity (%)*	
Months	*2000*	*2001*	*2000*	*2001*	*2000*	*2001*
June	214	503.5	28.23-25.53	30.50-20.90	82.58	79.30
July	309	326.5	29.43-24.89	29.20-21.60	83.14	77.30
August	223	185.5	31.87-29.26	30.90-23.00	84.13	79.30
September	243	92.0	30.48-29.00	30.60-22.70	82.17	82.20
October	190	32.0	30.30-18.72	29.70-18.80	70.58	70.50
November	**	**	28.36-13.70	28.40-13.80	70.10	73.80

** No rainfall

Table 5
Success Per cent, Mean Sprouting Days and Growth of Scion of Mango Plant (90 days) as Affected by Propagation Methods in Greenhouse Conditions (T= 32° C, RH = 80%) during 2002

Method	*Success (%)*[z]	*Mean sprouting days*[z]	*Mean scion growth (cm)*[z]
Veneer grafting	90.53[b]	30[a]	20.05[bw]
Top veneer grafting	98.00[a]	22[b]	25.36[aw]
Significance	*2.098	*1.982	*2.045

[z] Mean separation within column by Fisher protected LSD $p \leq 0.05$.
All values are means of four blocks, 24 grafted plants/block.
[w] grafted 14 March, kept under greenhouse 90 days.

followed by drifted wet air and imposed shade resulted in quite slow rate of sprouting. However, scion growth was quite normal (25.36 cm) for top-veneer grafting followed by conventional method (20.05 cm).

Based on these two years of nursery (Figure 1) testing in one location, all of the four cultivars popularly grown in different region that we examined were particularly well adapted for top veneer grafting for large scales multiplication in the sub humid sub-tropical plateau region of Eastern India. Better success was obtained in cultivars 'Mallika' and 'Dashehari' whereas maximum vegetative growth was achieved in 'Amrapali' in the newly adapted method as compared to conventional veneer grafting. Result of our second study suggested that top veneer grafted plant had better field survival capacity irrespective of cultivar's impact. From green house performance of 'Amrapali' cultivar, in the both methods, we conclude that top- veneer grafting may be viable for greater success of commercial benefit in major mango growing area of the world without location and season barrier.

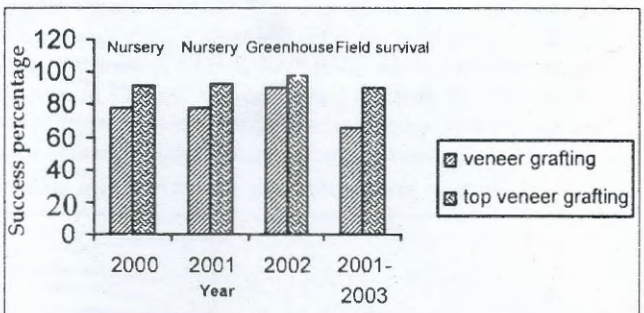

Figure1: **Differences Recorded between Two Methods in Respect of Success in Nursery (2000 and 2001), Greenhouse (2002) and Transplanted Plant (2001-03)**

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