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Effect of scion defoliation period and grafting methods on success of mango grafts var. Dashehari

Aaradhana Rathore, MS Paikra, Shishir Prakash Sharma, Toran Lal Sahu, Dikeshwar Nishad, Manish Taram and Katkar Ankush Haribhau

Abstract
The present investigation entitled "Effect of scion defoliation period and grafting methods on success of mango grafts var. Dashehari" was carried out during 2021-22 at the shade net of Horticulture Research Farm, under Pt. Kishori Lal Shukla College of Horticulture & Research Station Rajnandgaon, Chhattisgarh. The research was framed in Factorial Completely Randomized Design with 15 treatments which were replicated thrice. There were 2 factors, first factor with 5 levels of duration of defoliation viz defoliation on the day of grafting (D1), defoliation before 3 days of grafting (D2), defoliation before 6 days of grafting (D3), defoliation before 9 days of grafting (D4), defoliation before 12 days of grafting (D5) and 2nd factor with 3 levels of methods of grafting i.e. Wedge grafting (M1), Veneer grafting (M2), Tongue grafting (M3). The experiment was exempted to find out the effect of different scion defoliation period and methods of grafting on the success of mango grafts. The treatment combination D5M2 (defoliation before 12 days of grafting + veneer grafting) was found superior for growth parameters viz, minimum number of days taken for sprouting, for first leaf opening, maximum number of sprouts, number of leaves, graft height, rootstock and scion girth, leaf area, graft success and graft survival percentage.

Keywords: Mango, wedge grafting, veneer grafting, tongue grafting, duration of defoliation

Introduction
Mango (*Mangifera indica* L.) belongs to the family Anacardiaceae which grows as a perennial tree of medium to large size with a symmetrical top. Mango is a National fruit of India, Pakistan and Philippines and also known as "King of fruits" and is originated from Indo Burma region and grown almost all part of the world. It is related with certain religious and traditional rituals from the ancient times (Chattopadhyay 1976) [5]. It is one of the most important and oldest cultivated fruit crops in India for at least 4000 year. It is main family of tropical species with 73 genera. Besides this Anacardiaceous species also give many useful products like wax, Gum, Wood, Tanning material etc. Mangifera genus comprises of 69 species. The inflorescence of mango is small to broad conical panicle up to 45 cm the color of panicle may be light green, yellowish green with patches on branches. Panicle bears flowers about 500-6000 but only 1 to 70% is bisexual and other are male flowers. There are both male and Hermaphrodite flower produced in mango. Size of these flowers lies between 6-8mm in diameter. Pedicles are very small and missing (Bafod, 1988) [4]. In India, Mango covers an area of 2291 thousand ha with production of 20444 MT (Anon., 2020a) [2]. The main mango producing states in India are Uttar Pradesh (23.86%) Andhra Pradesh (22.14%), Karnataka (11.71%) etc. In Chhattisgarh the area under mango cultivation is 76.126 thousand ha and annual production of mango is 459.141 metric tonnes (Anon., 2021b) [3].
Mango is a highly cross pollinated and heterozygous plant. Sexual propagation have long juvenile phase and may not give rise to true to type plants so vegetative propagation is desirable as it enables to retain the characteristics of the mother plant.
The main advantage of grafting is that it changes the characteristics of plant and makes it superior than its mother plant. Other is that it increases the production by giving fruits in short time as compare to a sexual method of propagation. In case when the plant is raised from seed it gives non-uniform bearing and fruits are inferior. Grafting also play major role in improvement of Inferior varieties. It is common and preferred method of propagation. The main factor in grafting is compatibility. If both root stock and scion are compatible with each other, then growth of new shoot is started. The rootstocks are selected on the basis of desirable characters.

Veneer grafting is most common propagation technique which is commercially adopted by fruit growers, nursery men, and Government agencies. This method of propagation possesses promise for mass scale commercial propagation. The method is simple, easier more economical and can be adopted with success (Roy *et al*. 1999) [20]. Softwood grafting gives an excellent response in initial success with least possibility of mortality, better and uniform orchard establishment. Softwood grafting provides 80-90% success in guava, aonla and bael and duration of bud burst is 10, 7, 7 respectively (Ram and Pathak, 2006) [16]. Tongue grafting is easy for quick multiplication and results in greater cambial contact between stock and scion due to formation of tongue (Patel *et al*. 2011) [15]. Defoliation should be done 8 to 12 days prior to grafting since after that sprouting occurs and grafting cannot be done in sprouted scion. Defoliation of scion sticks is done to minimize the transpiration of the scion sticks and prevent wilting of it.

Mango is grown in both tropical and sub-tropical region. It can tolerate wide range of climatic conditions. Due to wide variability of climate in Chhattisgarh, it is highly favorable for cultivation of mango even in the waste lands as mango trees are vigorous in nature and require less maintenance. Therefore present investigation was undertaken to find out the best duration of defoliation along with the best grafting method for the propagation of mango.

Material and Method

The experiment was conducted at the shade net of Horticulture Research Farm Pt. K.L. Shukla College of Horticulture and Research Station Rajnandgaon (C.G.) during the year 2020-21. The research was performed in Factorial Complete Randomized Design with 3 replication, There were 2 factors, first factor with 5 levels of duration of defoliation viz., defoliation on the day of grafting (D1), defoliation before 3 days of grafting (D2), defoliation before 6 days of grafting (D3), defoliation before 9 days of grafting (D4), defoliation before 12 days of grafting (D5) and 2nd factor with 3 levels of methods of grafting i.e. Wedge grafting (M1), Veneer grafting (M2), Tongue grafting (M3).

Defoliation of the selected scions was made at 0, 3, 6, 9, 12 days before grafting. Defoliation was done with sharp secateurs by clipping off the leaf blades and 1 cm length petioles are left on the scion wood intact. The scions were wrapped in a wet cloth immediately after separation and packed in polythene bag and were then brought to the grafting site on the respective day of grafting.

Wedge grafting, veneer grafting and tongue grafting were performed following standard methods. The prepared grafts were shifted to the net house and placed as per layout of the experiment and were maintained in good condition by removing off-shoots, polythene cap. The data were collected on the following parameters: Days required for bud sprouting, days required for first leaf opening, number of sprouts per graft, number of leaves per graft, graft height (cm), rootstock girth (mm), scion girth (mm), leaf area (cm2), percentage of graft success and percentage of graft survivability. Days required for bud breaking and leaf opening were calculated from date of operation. Growths of the grafts (graft height, rootstock girth, and scion girth) were recorded at 30 days interval up to 120 days after grafting. The collected data on the different parameters of study were statistically analyzed as described by Panse and Sukhatme (1985) [14] and significance was tested by 'F' test.

Results and Discussion

Days required for bud sprouting

The perusal of the data presented in Table 2 reveals that among various treatments combination which was found to be significant, the minimum number of days taken for sprouting (10.23 days) was observed in (D5M2) and was at par (11.47) with when wedge grafting was done before 12 days of grafting (D5M1). However, the maximum number of days taken for first sprouting (20.74 days) was observed when grafting was performed on the day of defoliation (D1M1).

The early sprouting of buds in the treatment (D5M2) may be due to abundant accumulation of carbohydrates and other food material in fresh scion shoot, which initiates bud activation and they are in a position to sprout early and also due to greater cambial contact between the rootstock and scion. This result is closely associated with the findings of Zimmerman (1958) [21].

Days required for first leaf opening

The experimental data given in Table 2 shows that the interaction effect of different duration of defoliation and methods of grafting resulted significantly, minimum number of days taken for leaf opening (12.30 days) was observed in (D5M2) and was at par with (13.33) when wedge grafting was done before 12 days of defoliation (D5M1). However, the maximum number of days taken for leaf opening (23.20 days) was observed when grafting was performed on the day of grafting (D1M2).

Minimum number of days taken for leaf opening may be due to presence of higher meristamatic activity in swallowed buds which is associated with better translocation of vital compounds between stock and scion. This result is closely related with the findings of Nahar *et al*. (2015) [11] in lime.

Number of sprouts per graft

The data recorded during the experiment according to different treatment combinations has been shown in Table 2 for better understanding. The interaction effect of different duration of defoliation and methods of grafting resulted significantly. Among various treatment combinations the maximum number of sprouts per graft (11.57) was observed when defoliation of scion was done before 12 days of grafting (D5M2) which was at par (11.29) with (D4M2). However, the minimum number of sprouts per graft (3.00) was observed when defoliation of scion was done on the day of grafting and wedge grafting was performed (D1M1).

The maximum number of sprouts in (D5M2) might be due to the fact that 12 days defoliated scion in veneer grafting contains more carbohydrates produces gave more number of sprouts. These findings are in harmony with Tandel *et al*. (2020) [20] in softwood grafting of mango.

Number of leaves per graft

The experimental data given in Table 2 shows that the highest number of leaves (15.13) was found in the grafts that received the treatment combination of veneer grafting method with the scion defoliated before 12 days of grafting (D5M2) which was significantly superior and was at par (13.92) with treatment combination of veneer grafting method with the scion defoliated before 9 days of grafting (D4M2) while it was the lowest (3.84) in (D1M1) for the treatment

combination of wedge grafting with the scion defoliated on the day of grafting.

The production of maximum number of leaves per graft could be due to climatic factors such as temperature and relative humidity, which encouraged increased cell activity and early sprouting; leading in more leaves. This result is in accordance with the findings of Kalalbandi *et al*. (2014) [8] and Pampanaa *et al*. (2001) [13] in softwood grafting of sapota.

Graft height

The experimental data given in Table 2 revealed that the interaction effect of scion defoliation periods and methods of grafting was found significant and the highest increase in graft height (34.27 cm and 56.33 cm) was found in the veneer method with the scion defoliated 12 days before grafting (D5M2) which was at par (33.76 cm and 53.52 cm) with (D5M1) at 30 and 120 DAG respectively. On the other hand, the lowest increase in graft height (26.81 cm and 45.90 cm) was recorded with the scion defoliated 12 days before tongue grafting and scion defoliated on the day of grafting respectively.

The highest increase in graft height may be due to favorable agro-meteorological conditions prevailing during the grafting period. This could be attributed to the vigorous growth of stock, which increased the growth and leading to maximum accumulation of stored metabolites at the time of grafting. Similar results were also found by Radha *et al*. (2000) [17] and Gurudutta *et al*. (2004) [7] in epicotyl grafting of mango.

Rootstock girth (mm) and Scion girth (mm)

Data which is presented in Table 2 indicated that among various treatment combinations the interaction among different duration of defoliation and methods of grafting was significant. Among various treatment combinations the maximum rootstock girth (6.73 mm and 9.23 mm) was observed when veneer grafting was done with defoliation before 12 days (D5M2), respectively which was at par with (6.45 mm) D3M3 and (8.54 mm) D3M2, (8.49 mm) D4M1, (8.43 mm) D4M2, (8.56 mm) D5M1 at 30 and 120 days respectively. Although, the minimum rootstock girth (4.55 mm and 6.01 mm) was observed when defoliation was done on the day of grafting (D1M1) at 30 and 120 days, respectively.

The perusal of the data presented in Table 2 reveals that the maximum scion girth (6.12 mm and 6.82 mm) was observed when veneer grafting was performed with defoliation scion before 12 days (D5M2), respectively which was significantly superior and was at par with mm) D3M1, (5.88 mm) D3M3, (5.97 mm) D5M1 and (6.77 mm) D3M2. However, the minimum scion girth (2.27 mm and 4.37 mm) was observed when wedge grafting was done with scion defoliation on the day of grafting (D1M1) at 30 and 120 DAG, respectively.

Maximum rootstock and scion girth may be due to high physiological activity and the callus bridge filled the stock and scion gap in 30 and 120 days, following which the xylem and phloem bridged the union leading to increase in scion girth. This also might be due to the better performance of stionic compatability and the perfectness of union. The present results are in harmony with the findings of Nalage *et al*. (2010) [12] in softwood grafting in tamarind and Mahunu *et al*. (2012) [9].

Leaf area (cm2)

The experimental data given in Table 2 shows that among various treatment combinations which was found to be significant, the maximum leaf area (51.93 cm2) was observed when veneer grafting was performed by defoliating scion before 12 days (D5M2), which was at par with treatment combination D4M3 (49.83 cm2). However, the minimum leaf area (36.23 cm2) was observed when wedge grafting was done with scion defoliation on the day of grafting (D1M1) at 120 DAG.

The maximum leaf area might be due to when 12 days defoliated scion stick used for grafting produced more number of leaves and shoots in present investigation which ultimately produced more carbohydrates by photosynthesis and increased leaf area. Similar results were also found by Majeed *et al*. (2015) [10] and Roy *et al*. (1994) [18] in Mango.

Graft success (%)

The perusal of the data presented in Table 2 reveals that the grafting performed at different duration of defoliation with different methods had a significant increase in graft success percent. Among various treatment combinations the highest graft success (86.67%) was recorded when grafting was done was 12 days defoliated scion (D5M2), which was at par with (80%) in (D2M3). However, the minimum graft success (46.33%) was recorded when tongue grafting was performed on the 6 days before defoliated scion (D2) at 90 DAG, respectively.

The higher graft success was in (D5M2) may be due to defoliated scion had more stored food material which causes rapid formation of callus tissue that allow translocation of chemical compounds between stock and scion which leads to higher graft success. It also influenced growth parameters attributed to initiation of cambium activity which might have resulted from defoliation causing early and strong graft union. These results are in conformity with Roy *et al*. (1994) [11], Akter *et al*. (2016) [1] in mango.

Graft Survival (%)

The experimental data given in Table 2 shows that among various treatment combinations which was found to be significant, the highest graft survival percent (80.00%) was recorded in D5M2 (defoliation before 12 days of grafting + Veneer grafting) was observed when defoliation was done before 12 days of grafting which was at par (73.33%) with the treatment combination (D3M3) However, the minimum graft survival percent (36.67%) was observed in wedge grafting with scion defoliation on the day of grafting (D1M1).

The maximum graft survival percent was recorded in (D5M2) might be due to the sprouting percentage of grafts was positively correlated with survival percentage of graft. The increase in sprouting percentage also increased the percentage of survival. Similar results were also observed by Gunjate, *et al*. (1989) [6].

Table 1: Main effect of scion defoliation period and grafting methods on success of mango grafts var. Dashehari

Treatment Combinations	Days req. for bud sprouting	Days req for 1st leaf opening	No. of sprout s/graft	Graft height (cm)		No. of leaves	Rootstock girth (mm)		Scion girth (mm)		Leaf area (cm2)	Graft success percentage (%)	Graft survival percentage (%)
	(Days)			at 30 DAG	at 120 DAG	at 120 DAG	at 30 DAG	at 120 DAG	At 30 DAG	at 120 DAG	at 120 DAG	at 90 DAG	at 120 DAG
Duration of defoliation (D)													
(D1) 0 day	19.07a	21.71a	3.61d	31.21a	47.17c	4.69e	5.12a	6.18c	3.44b	4.71c	38.96c	50.56c (45.33c)	42.22b (40.46b)
(D2) 3 days	14.97c	17.81b	5.04c	32.06a	50.04bc	6.42d	5.64a	7.19b	5.2a	5.74ab	41.9b	51.56c (45.87c)	47.78b (43.70ab)
(D3) 6 days	17.6ab	19.44ab	7.29b	32.39a	50.92ab	9.63c	5.9a	7.93ab	5.63a	6.15a	41.16bc	66.33b (54.78b)	60a (50.99ab)
(D4) 9 days	16.94b	19.2ab	9.67a	29.34b	51.91ab	11.17b	5.62a	7.86ab	5.31a	5.4bc	45.34a	60b (50.93bc)	46.67b (43.06ab)
(D5) 12 days	12.14d	14.08c	10.6a	32.44a	53.63a	12.97a	5.91a	8.36a	5.85a	6.3a	45.49a	78.78a (62.83a)	65.56a (54.3a)
S.Em±	0.337	0.515	0.198	0.247	0.601	0.275	0.172	0.154	0.166	0.128	0.419	1.430(0.885)	2.108 (1.246)
C.D at 5%	0.974	1.486	0.573	0.714	1.735	0.795	0.496	0.444	0.480	0.369	1.209	4.130(0.685)	6.08 (3.61)
Methods of grafting (M)													
(M1) Wedge	16.21a	18.45a	6.54b	31.49a	50.27a	8.04b	5.31a	7.55ab	4.81a	5.5a	40.02b	62.67a (52.56a)	52a (46.11a)
(M2) Veneer	16.03a	18.16a	7.85a	31.51a	52.05a	9.84a	5.89a	8.08a	5.25a	5.86a	43.88a	62.8a (52.88a)	54a (47.51a)
(M3)Tongue	16.12a	18.73a	7.35ab	31.46a	49.89a	9.05ab	5.71a	6.88b	5.2a	5.62a	43.81a	58.87a (50.41a)	51.33a (45.90a)
S.Em±	0.261	0.399	0.154	0.191	0.465	0.213	0.133	0.119	0.129	0.099	0.324	1.108 (0.685)	1.633 (0.965)
C.D at 5%	NS	NS	0.443	NS	1.344	0.615	0.384	0.344	0.372	0.285	0.937	3.199 (1.532)	NS

(Figure in parentheses shows arc sin transformed value)
Means followed by same letter are not significantly different at 5% significance; using Duncan's Multiple Range Test

Table 2: Interaction effects of scion defoliation period and grafting methods on success of mango grafts var. Dashehari

Treatment Combinations	Days req. for bud sprouting	Days req for 1st leaf opening	No. of sprouts/ graft	Graft height (cm)		No. of leaves	Rootstock girth (mm)		Scion girth (mm)		Leaf area (cm2)	Graft success percent (%)	Graft survival percent (%)
	(Days)			at 30 DAG	at 120 DAG	at 120 DAG	at 30 DAG	at 120 DAG	at 30 DAG	at 120 DAG	at 120 DAG	at 90 DAG	at 120 DAG
Interaction (D × M)													
D1M1	20.74a	22.27ab	3g	30d	47.25ef	3.84h	4.55d	6.01g	2.27f	4.37h	36.23h	49.67de (44.79cd)	36.67e (37.21d)
D1M2	18.87bc	23.2a	3.71fg	31.68c	48.37def	4.93gh	5.35cd	6.45fg	4.35de	4.81gh	40.9defg	57cd (49.10cd)	46.67cde (43.06cd)
D1 M3	17.6cd	19.67bc	4.13fg	31.94bc	45.9f	5.3gh	5.47bcd	6.07g	3.69e	4.95fgh	39.74fg	45e (42.11d)	43.33de (41.13cd)
D2M1	12.53g	15.73ef	4.73ef	32.33bc	50.06cde	5.93g	5.69bc	6.75efg	4.72cd	5.26efg	42.88cd	55cd (47.85cd)	50bcd (44.98cd)
D2 M2	15.93def	18.57cde	5.22e	31.49c	51.03bcd	5.67g	5.48bcd	7.73bcd	5.5abc	5.83cde	40.51defg	53.33cde (46.89cd)	50bcd (44.98cd)
D2M3	16.43def	19.13cd	5.18e	32.36bc	49.02def	7.65f	5.75bc	7.08def	5.39abc	6.14c	42.3cde	46.33e (42.87cd)	43.33de (41.13cd)
D3M1	20.13ab	22.6a	6.8d	31.67c	49.01def	8.36ef	5.53bcd	7.93bc	5.74ab	6.19bc	39.18g	58.67c (49.98cd)	56.67bc (48.82bcd)
D3M2	17.4cd	17.93cde	7.44cd	33.29ab	51.04bcd	9.53de	5.71bc	8.54ab	5.28abc	6.77ab	41.58def	60.33c (50.94c)	50bcd (44.98cd)
D3M3	15.27ef	17.8cde	7.63cd	32.22bc	52.7bc	11c	6.45ab	7.31cde	5.88ab	5.48def	42.71cd	80ab (63.42ab)	73.33a (59.18ab)
D4M1	16.19def	18.33cde	8.07c	29.71d	53.52ab	9.38de	5.38cd	8.49ab	5.36abc	5.51defg	41.72def	73.33b (58.98b)	56.67bc (48.82bcd)
D4M2	17.73cd	18.8cd	11.29a	26.81e	53.47abc	13.92ab	6.18abc	8.43ab	5bcd	5.07fgh	44.47c	56.67cd (48.82cd)	43.33de (41.13cd)
D4M3	16.89de	20.47abc	9.65b	31.5c	48.75def	10.2cd	5.31cd	6.66efg	5.56abc	5.62cdef	49.83b	50de (44.98cd)	40de (39.21cd)
D5M1	11.47gh	13.33fg	10.1b	33.76a	51.5bcd	12.68b	5.4cd	8.56ab	5.97ab	6.17bc	40.07efg	76.67b (61.19ab)	60b (50.74bc)
D5M2	10.23h	12.3g	11.57a	34.27a	56.33a	15.13a	6.73a	9.23a	6.12a	6.82a	51.93a	86.67a (68.64a)	80a (63.4a)
D5M3	14.73f	16.6de	10.14b	29.28	53.07bc	11.11c	5.58bcd	7.3cde	5.47abc	5.92cd	44.47c	73b (58.67b)	56.67bc (48.82bcd)
S.Em±	0.584	0.891	0.343	0.428	1.041	0.476	0.297	0.266	0.288	0.221	0.73	2.477 (1.532)	3.651 (2.158)
CD at 5%	1.688	2.574	0.992	1.236	3.006	1.376	0.859	0.770	0.832	0.638	2.09	7.153 (4.447)	10.546 (6.263)
CV %	6.278	8.367	8.209	2.354	3.553	9.195	9.133	6.152	9.803	6.763	2.95	6.981	12.060

(Figure in parentheses shows arc sin transformed value)
Means followed by same letter are not significantly different at 5% significance; using Duncan's Multiple Range Test

T_1-D1M1: Defoliation on the day of grafting + Wedge grafting.
T_2-D1M2: Defoliation on the day of grafting + Veneer grafting.
T_3-D1M3: Defoliation on the day of grafting + Tongue grafting.
T_4-D2M1: Defoliation before 3 days of grafting + Wedge grafting.
T_5-D2M2: Defoliation before 3 days of grafting + Veneer grafting.
T_6-D2M3: Defoliation before 3 days of grafting + Tongue grafting.
T_7-D3M1: Defoliation before 6 days of grafting + Wedge grafting.
T_8-D3M2: Defoliation before 6 days of grafting + Veneer grafting.
T_9-D3M3: Defoliation before 6 days of grafting + Tongue grafting.
T_{10}-D4M1: Defoliation before 9 days of grafting + Wedge grafting.
T_{11}-D4M2: Defoliation before 9 days of grafting + Veneer grafting.
T_{12}-D4M3: Defoliation before 9 days of grafting + Tongue grafting.
T_{13}-D5M1: Defoliation before 12 days of grafting + Wedge grafting.
T_{14}-D5M2: Defoliation before 12 days of grafting + Veneer grafting.
T_{15}-D5M3: Defoliation before 12 days of grafting + Tongue grafting.

Conclusion

According to the findings of the research it may be concluded that among the different period of scion defoliation, the minimum number of days required for bud sprouting, minimum number of days for first leaf opening, maximum number of sprouts per graft, number of leaves per graft, graft height, rootstock and scion girth, leaf area and maximum graft success and survival percentage was recorded best when grafting was done before 12 days of defoliation of scion (D5).

Among methods of grafting veneer grafting had a positive effect for all growth parameters. The treatment combination D5M2 (defoliation before 12 days of grafting + veneer grafting) was found superior for growth parameters viz, minimum number of days taken for sprouting, for first leaf opening, maximum number of sprouts, number of leaves, graft height, rootstock and scion girth, leaf area, graft success and graft survival percentage.

Hence the treatment combination D5M2 (Defoliation before 12 days of grafting + veneer grafting) was found to be the most appropriate for graft preparation of mango and also can be recommended for the production of quality planting material of mango of agro climactic condition of Chhattisgarh plains.

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