Asian Journal of Plant Sciences

ISSN 1682-3974

science alert

ANSInet
an open access publisher
http://ansinet.com

Asian Journal of Plant Sciences 3 (5): 636-641, 2004
ISSN 1682-3974

Effect of Time of Operation and Age of Rootstock on the Success of Inserted Contact Grafting in Mango

[1]M.N. Islam, M.A. Rahim, M.N.A. Naher, M.I. Azad and M. Shahjahan
[1]Department of Horticulture, Bangladesh Agricultural University, Mymensingh, Bangladesh
Intercooperation-Strengthening Access to Agroforestry Knowledge,
Technology and Information, Rajshahi, Bangladesh

Abstract: An experiment on the inserted contact grafting in mango (*Mangifera indica* L.) was conducted to find out the best time and age of rootstock for grafting in best varieties of mango under Bangladesh condition. The experiment indicated that inserted contact grafting could be more successful in 16 May operations. The highest percentage of survived grafts (56.82%) was recorded in 16 May operation 120 days after the detachment of the grafts from the mother plant requiring less time (70.22 days) for graft success when grafted with 2-year-old rootstock in cv. Amrapali (BARI Aam–3).

Key words: Inserted contact grafting, time, age of rootstock, mango

INTRODUCTION

Approach grafting, a traditional method of vegetative propagation in mango was first reported by Naik[1] in India. The method was modified by Garg[2], known as inserted contact/approach grafting. In this method one-year-old seedlings rootstock of mango were dug up with a ball of earth round the roots and wrapped with moss around the earth ball, which was then enclosed in a polythene bag. Then the seedling is beheaded keeping one foot from the bottom and make like a peg (2-3 inches). Then the peg is inserted into the bark of the scion shoot attached in mother tree. Inserted contact grafting [locally known as 'Dal Kolom' (Dal = stem and Kolom = graft) and according to Giri[3] it is known as stem grafting] is the traditional grafting method of mango in mango growing areas (Chapainwabgonj and Rajshahi) of Bangladesh. The mango growers produce a big size graft with high incompatibility. They produce huge number of grafts from the same mother plant. As a result, after the harvesting of the grafts, the plant stands with very few branches, which hinders the growth of the mother plant and hampered mango production in a great extent. As a result, the national fruit production in Bangladesh is reducing day by day. Lots of work has been done by different investigators in different countries[4-9] concerning the standardization and recommendations regarding inserted contact grafting in mango but no investigation has been done so far for the standardization of inserted contact grafting and concerning recommendation under Bangladesh condition. So, this investigation was undertaken to standardize the inserted contact grafting method in mango and assess the relative efficacy of the method in relation to % survival of the grafts under Bangladesh condition.

MATERIALS AND METHODS

Experiments were conducted at the germplasm center (GP) of the fruit tree improvement project (FTIP) of the Department of Horticulture, Bangladesh Agricultural University (BAU), Mymensingh during April to July 2001. A three-factor experiment was conducted in a Randomized Complete Block Design with 5 replications having 5 grafts per replication. The factors were i) time of grafting (16 April, 16 May, 16 June and 16 July), ii) Mango Variety (Amrapali, a dwarf mango cultivar and Gopalbhog, a tall mango cultivar), and iii) Age of rootstock (1-year- old, 2-year-old, and 3-year-old) Thus, 600 grafts were prepared, 300 for cv. 'Amrapali' and 300 for cv. 'Gopalbhog' under this experiments. The collected data were examined, tabulated and analyzed by a statistical programme MSTAT-C following the appropriate design of the experiment[10]. The means for all the treatments were calculated and the analyses of variance (ANOVA) for most of the characters under consideration were performed by the 'F' variance test. The significance of the difference between pairs of means was performed by

Corresponding Author: Dr. Md. Nurul Islam, Coordinator, Agroforestry Knowledge Management (Research), IC – SAAKTI, 223/2, Housing Estate, Upashahar, Rashahi – 6000 Bangladesh
Tel: 880 721 810574 or 880 721 761893 E-mail: dr_nurul2003@hotmail.com

the Least Significance Difference (LSD) test taking the probability level 1% as the maximum unit of significance. The data were recorded on –I) days required for success and ii) percentage of survival. When there were a lots of roots in the base of the rootstock and the colour of the roots were dark brownish in colour, the grafts were detached from the mother plant and the days required for the success were recorded carefully and timely. The percentage of survival was recorded 120 days after detachment of the graft from the mother plant. The percent survival was calculated by the following formula:

$$\text{Percent survival} = \frac{\text{Graft survived 120 days after detachment}}{\text{Total number of grafts}} \times 100$$

The rootstocks for the experiment were selected in the GP center of BAU, Mymensingh. The healthy, straight and non-branching rootstocks of 1, 2 and 3 years of age were selected. It was monoembryonic in nature of unknown varieties. The rootstocks were uprooted with a small amount of soil at their root zone (8-10 cm radius and 15-20 length as is the practice done by most of the farmers in Rajshahi region of Bangladesh). The soil of the rootstocks was wrapped with white transparent polythene. It was grafted with the mother scion shoot on the date of its uprooting. The mother scion shoot of cv. 'Amrapali' and 'Gopalbhog' were selected at the GP center of Fruit Tree Improvement Project of Bangladesh Agricultural University, Mymensingh. The age of mother-plant was about 10-25 years old. Grafting operations were performed with a sharp grafting knife. The selected rootstocks were prepared with a 3-4 cm long slanting cut with a small cut at the end of the slanting cut (similar to scion preparation in veneer grafting). The scion shoot attached to the mother tree was then prepared with a cut of 3-4 cm long with some wood (like the cut of the rootstock of veneer grafting). The rootstocks were then inserted into the mother stock attached to mother tree. The graft was then tied tightly with polythene tape. The grafts were detached from the mother tree when there were lots of roots produced in the root zone of the rootstock and the roots turned yellowish to brownish in colour. The grafts were detached with the help of sharp handsaw during the afternoon. The additional branches and leaves were removed to minimize the evapotranspiration loss. Then they were potted into 35x25x25 cm earthen pots and kept under 80% shade for 60 days. The plants were watered regularly as and when necessary. The percent survival was recorded 120 days after detachment.

RESULTS AND DISCUSSION

Effect of time of operation: When numerous fibrous roots were developed and the roots were brownish in colour at the base of the rootstock, the grafts were detached from the mother plants, as this condition was considered ideal for success of the grafts. The time of grafting affected the days required for the success of the grafts as the early grafting required the shortest number of days for the success of the grafts (Table 1). The lowest days required for success (85.40 days after grafting) was found when grafting operation took place on the 16 May but the highest days (167 after grafting operation) required when grafting was on 16 July. Grafting before and after the 16 May was found to take more time for success of the graft. The result revealed that May was the best time for inserted contact grafting in mango, which required less time for the success of the grafts.

The effect of the time of the grafting on the percentage of survival of the plants produced by inserted contact grafting is presented in the Table 1. The results revealed that the highest survival of the grafts (48%) was recorded when grafting operation was done on 16 May. The lowest % of survival (6.74%) was recorded in the July grafted plants. The results also revealed that grafting before and after May affected the percentage of survival of the grafts to a large extent. However, May was the best time for inserted contact grafting for survival of the grafts under the experimental conditions.

Performance of variety: The tall mango variety 'Gopalbhog' and the dwarf variety 'Amrapali' had no significant effect on the days required for success. The percentage of survival of the grafts counted 120 days after grafting was more or less same in both the mango varieties (Table 2).

Combined effect of time of grafting and variety: Time of grafting exerted significant combined effect on the tall and dwarf varieties of mango in respect to the days required for success of the grafts (Table 3). The earlier success was recorded (85.11 days after grafting operation) in the May grafted 'Gopalbhog' plants followed by 'Amrapali' plants grafted during the same time. The highest days (168.39 days after grafting) were required for 'Gopalbhog' in July operation. The early grafting required fewer days for success.

Time of grafting had highly significant influence on the percentage of survival of the grafts in two varieties of mango 120 days after the grafting operation (Table 3). The highest percentage of success (49.47%) was recorded in

Table 1: Effect of time of operation on the success and survival of the grafts

Time of grafting	Days required for success	% Survival (120 day after detachment)
16 April	91.91	43.94
16 May	85.40	48.08
16 June	117.98	32.55
16 July	167.55	6.74
LSD 5%	5.59	2.85
1%	7.40	3.77
Level of significance	**	**

** = Significant at 1% level

Table 2: Performance of varieties of mango on the days required to success and % survival

Variety	Days required for success	% Survival (120 day after detachment)
Amrapali	115.46	33.24
Gopalbhog	115.56	32.40
LSD 5%	3.95	2.02
1%	5.24	2.67
Level of significance	NS	NS

NS = Not significant

Table 3: Combined effect of time of grafting and variety on the days required for success and % survival of the grafts

Time of grafting	Variety	Days required for success	% Survival (120 day after detachment)
16 April	Amrapali	90.63	44.59
	Gopalbhog	91.60	43.28
16 May	Amrapali	85.69	49.47
	Gopalbhog	85.11	46.69
16 June	Amrapali	118.81	33.04
	Gopalbhog	117.14	32.05
16 July	Amrapali	166.70	5.88
	Gopalbhog	168.39	7.61
LSD 5%		7.91	4.03
1%		10.47	5.33
Level of significance		**	**

** = Significant at 1% level

Table 4: Effect of age of rootstock on the days required for success and % survival

Age of rootstock	Days required for success	% Survival (120 day after detachment)
1 year	115.21	33.36
2 year	104.89	39.13
3 year	126.41	25.99
LSD 5%	4.84	2.47
1%	6.43	3.26
Level of significance	**	**

** = Significant at 1% level

the ' Amrapali' plants grafted during May and that of the lowest (5.88%) was recorded in the 'Amrapali' plants grated during July operation. The surviving grafts were more in the May operation followed by lowest in the pre and post grafting operation of May.

Effect of age of rootstock: The age of rootstock influenced highly by the days required for success of the grafts (Table 4). The grafts were detached from the mother tree earlier (104.89 days after grafting) when the grafting operation was done with 2-year-old seedling rootstock followed by one year old (115.21 days) and 3-year-old (126.41 days). The result revealed that grafting with 2-year-old rootstock had significant influence on the days required for success and was better than rootstock of any other ages.

The percentage of the survival of the grafts (120 days after the grafting operation) was greatly influenced by the age of rootstock (Table 4). The highest percentage of survival (39.13%) was found which was grafted with 2-year-old seedling rootstocks. The result revealed that on the increase or decrease of the age of rootstock from 2 years, the percentage of survival decreased significantly. The lowest survival (25.99%) was noticed when grafted with 3-year-old seedling rootstock followed by 33.36% when grafted with 1-year-old seedling rootstocks.

Combined effect of time of grafting and age of rootstock: The time of grafting exerted a significant effect on number of days required for success of the grafts when grafted with different aged rootstock onto the mother stock in inserted contact grafting (Table 5). The earliest detachment (71.17 days after grafting) of the grafts from the mother plant was done when grafted on 16 May with 2 years old rootstock seedling followed by (74.13 days) the same aged seedling rootstock grafted on the 16 April. The result elucidated that the 2-year-old rootstock seedlings grafted on 16 May were the best for all combination of time giving success within the earliest period of time. The highest days (169.70) were required for success when the grafting operation was done with 3-year-old seedling rootstock followed by 1-year-old rootstock seedling grafted on the 16 July. So, the 2-year-old rootstock grafted on 16 May was the best combination for earliest harvest of grafts.

The time of grafting influenced significantly the survival of the grafts when grafted with different ages of rootstocks as data were recorded 120 days after grafting (Table 5). The highest percentage of survival (54.90%) of the grafts was recorded 2-year-old seedling rootstock. The lowest (2.36%) percentage of survival was recorded in the July grafted plants grafted with 3-year-old rootstock seedlings. A clear decline in the % of survival of the grafts was marked when grafted with 1 and 3-year-old seedling rootstock before or after 16 May. The result revealed that 16 May was the best time for inserted contact grafting when grafted with 2-year-old seedling rootstock.

Combined effect of variety and age of rootstock: The different ages of rootstocks had significant combined effect on the days required for success when grafted with

Table 5: Combined effect of time of grafting and age of rootstock on the days required for success and survival

Time of grafting	Age of rootstock	Days required for success	% Survival (120 day after detachment)
16 April	1 year	94.17	44.19
	2 year	74.13	51.93
	3 year	105.03	35.69
16 May	1 year	80.70	50.67
	2 year	71.17	54.90
	3 year	104.32	38.67
16 June	1 year	116.27	31.82
	2 year	109.90	38.55
	3 year	127.77	27.26
16 July	1 year	169.70	6.74
	2 year	164.36	11.13
	3 year	168.58	2.36
LSD 5%		9.69	4.94
1%		12.83	6.53
Level of significance		**	*

** = Significant at 1% level and * = Significant at 5% level

Table 6: Combined effect of variety and age of rootstock on the days required for success and survival

Variety	Age of rootstock	Days required for success	% Survival (120 day after detachment)
Amrapali	1 year	117.69	33.68
	2 year	102.26	39.96
	3 year	126.43	26.09
Gopalbhog	1 year	112.73	33.03
	2 year	107.52	38.29
	3 year	126.43	25.90
LSD 5%		6.85	4.03
1%		9.07	5.33
Level of significance		**	**

** = Significant at 1% level

Table 7: Combined effect of time of grafting, variety and age of rootstock on the days required for success and percent survival

Grafting time	Variety	Age of rootstock	Days required for success	% Survival (120 day (after detachment)
16 April	Amrapali	1 year	94.05	44.60
		2 year	72.27	51.29
		3 year	105.65	37.88
	Gopalbhog	1 year	94.29	43.77
		2 year	75.99	52.57
		3 year	107.01	33.51
16 May	Amrapali	1 year	84.69	52.85
		2 year	70.22	56.82
		3 year	101.64	38.73
	Gopalbhog	1 year	72.70	48.49
		2 year	71.61	52.98
		3 year	104.51	38.58
16 June	Amrapali	1 year	119.72	33.14
		2 year	107.41	38.81
		3 year	129.33	27.17
	Gopalbhog	1 year	112.82	30.51
		2 year	112.39	38.29
		3 year	126.22	27.35
16 July	Amrapali	1 year	172.30	4.14
		2 year	158.63	12.95
		3 year	169.17	4.57
	Gopalbhog	1 year	167.10	9.34
		2 year	170.09	9.34
		3 year	167.99	4.14
LSD 5%			13.70	6.98
1%			18.14	9.23
Level of significance			**	**

** = Significant at 1% level

Fig 1: A devastating mango plant after harvesting the grafts

Fig. 2: Highly incompatible mango grafts supporting with heavy bamboo sticks

Fig. 3: Heavy labour consuming and laborious activity from grafting to harvesting and marketing of the grafts

different varieties of mango (Table 6). The earlier success (102.26 days after grafting) was noticed in the cv. 'Amrapali' grafted with 2-year-old rootstock and the higher days (126.43 days after grafting) were required in both the varieties when grafted with 3-year-old rootstock. The 2-year-old rootstock performed the best in respect of earlier success of inserted contact grafting in mango.

The treatment combination was highly significant in respect of percentage of survival of the grafts 120 days after the grafting operation (Table 6). The highest percentage of survival (39.96%) was recorded in the 'Amrapali' plants produced by grafting with 2-year-old rootstock and the lowest (25.90%) was recorded in the 'Gopalbhog' plant produced by grafting with 3-year-old rootstock. The 2-year-old rootstock performed the best in comparison with the 1 and 3-year-old rootstock for surviving of the grafts in the both variety of mango 120 days after grafting operation.

Combined effect of time of grafting, variety and age of rootstock: Time of grafting and age of rootstock had significant effect on the number of days required for success when grafted in different varieties of mango (Table 7). The lowest days (70.22) required for the success of grafts in cv. Amrapali grafted with 2-year-old rootstock in May grafting operation but the highest days (172.30) was required in cv. Amrapali grafted with 1-year-old rootstock in July operation. The result revealed that May was the best time for inserted contact grafting in mango with 2-year-old rootstock in all varieties of mango in respect of early graft union.

Combined effect of the treatment was found to differ among the treatments. The time of grafting and the age of rootstock had significant effect on the percent survival when grafted on different varieties of mango (Table 7). The result showed that July grafting with 1 and 3-year-old rootstock gave the lowest % of the survival of the grafts.

The lowest time required for the success of the grafts performed during May might be due to the active growth of the plants, which enhanced rapid cell division and callus formation resulting rapid success of the grafts. Singh[5] and Rao[11] elucidated that approach grafting should be done when plants are in active growth with sap flows, which is in agreement with this finding.

The highest percent success in May operation might be due to the active growth stage of the plants and prevailing excellent environmental condition which enhanced the graft union process by quick cell division following rapid callus formation, intermingling of the vascular bundle of both of the rootstock and mother stock and ultimately giving a good percent survival. The finding is in disagreement with the findings of Kumar and Mitra[7]. They reported that the highest grafting success with mango cv. 'Himsagar' was obtained with inarching on 30 July in Indian condition. This might be due to the different climatic conditions prevailing under Bangladesh and Indian experimental condition. The condition favourable for the inserted contact grafting is suitable during July under Indian Condition but May is favourable for Bangladesh condition[12].

The shortest time required for success and highest percent survival when grafted with 2-year-old seedling rootstock might be due to the good compatibility of the 2-year-old rootstock with the mother stock. The rootstock was in full growth and active condition within two years, which was more compatible with the selected mother stock, enhanced the graft union process and resulted the earlier graft success and highest percent survival of the grafts. The result is in agreement with the findings of Asadullah and Khan[6], Maijhail and Singh[13,14] and Talukder and Ahmed[15] and Giri[3]. They elucidated that the larger seedling rootstock yielded better success in approach grafting. The result differed with the observations of Ahmad[8], Singh[5], Naik[1] and Garg[2]. They recommended 1-year-old seedling rootstock for approach grafting in mango.

That grafting with 2-year-old seedling rootstock on 16 May was better might be due to the good environmental conditions prevailing during May with adequate temperature and relative humidity, the active growth conditions of both the rootstock and the mother stock with the most compatible conditions with 2-year-old seedling rootstock. This enhanced better cell division, promoted callus formation with the optimum supply of auxin, accelerated the intermingling of vascular bundles and resulted in early success and a higher percent survival. The two favourable factors (age of rootstock and time of grafting) interacted positively thus enhancing the early success and higher percentage of survival[16].

From the above experiments, it is concluded that due to low survival rate in comparison with other grafting methods, (like cleft or modified cleft where the average survival is 87-92%) grafting in mango[17], long time required for success of the graft (some times more than 172 days), damage of the mother plant through removing big branches (Fig. 1), and high incompatibility of the grafts (Fig. 2) high costly, labour consuming and laborious method from grafting to marketing (Fig. 3) the method should be avoided in commercial scale mango grafts production and as well as in mango garden establishment under Bangladesh condition. This observation was also supported by the findings of

Patwardhan and Deshmukh[18] and Singh[5]. They elucidated that grafts with large and old scions (incompatibility) having several branches become top heavy and fail to thrive.

REFERENCES

1. Naik, K.C., 1947. South Indian Fruit and Their Culture. P. Varadachary, Madras Cited from, the Mango: Botany, Production and Uses, by Litz, pp: 363-400.
2. Garg, M.L., 1954. Mango grafting made easy and cheap. Indian J. Hort., 11: 145-146.
3. Giri, A., 1966. Transplanting success with varying stem girths of mango seedling. Agril. Pakistan, 17: 195-200.
4. Gaur, N.V.S., 1984. Comparative evaluation of selected methods of mango propagation. Punjab Hort. J., 24: 1-6.
5. Singh, L.B., 1960. The Mango. Leonard Hill, London.
6. Asadullah, M. and M.D. Khan, 1960. Studies of various factors affecting success in grafting by approach (inarching in mangoes). Punjab Fruit J., 23: 59-70.
7. Kumar, V.S. and S.K. Mittra, 1994. Standardization of time and propagation techniques in mango cv. Himsagar. Hort. J., 7: 71-73.
8. Ahmed, S., 1960. Propagation of mangoes. Punjab Fruit J., 23: 49-53.
9. Oliver, G.W., 1911. Seedling inarch and nurse plant method of mango propagation. United State Department of Agriculture Plant Industry Bulletin no. 202.
10. Gomez, K.A. and A.A. Gomez, 1984. Statistical Procedure for Agricultural Research. 2nd Edn. A Wiley Interscience Production. John Wiley and Sons, New York, pp: 139-140.
11. Rao, V.N.M., 1967. Propagation Practices. The Mango Hand Book. Indian Council of Agricultural Research, New Delhi, pp: 32-69.
12. Whilley, A.W., 1993. Environmental effects on phonology and physiology of mango. A review. Acta. Hort., 541: 168-176.
13. Maijhail, H.S. and K.K. Singh, 1962a. Inarching in mango. 1. The effect of Alkathene wrapper, time of inarching and size of rootstock seedling. Punjab Hort. J., 2: 33-43.
14. Maijhail, H.S. and K.K. Singh, 1962b. Inarching in mango. 1. The optimum period of grafting and age of stock seedling. Punjab Hort. J., 2: 109-113.
15. Talukder, M.R. and S. Ahmed, 1965. Success of inarching done on the three varieties of mango on young stocks at Lyallpur. Pak. J. Sci., 17: 72-74.
16. Hartmann, H.T., D.E. Kester, Jr.F.T. Davies and R.L. Geneve, 1997. Plant Propagation: Principles and Practices. 6th Edn., Prentice-Hall of India Private Limited, New Delhi – 110001.
17. Islam, M.N., M.A. Rahim and A.M. Farooque, 2004. Standardization of time and grafting techniques in mango under Bangladesh condition. Asian J. Plant Sci., 3: 378-386.
18. Partwardhan, G.B. and G.B. Deshmikh, 1931. A Hand Book of Horticultural Practices. Partwardhan, Poona, pp: 103-115.