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EFFECT OF ROOTSTOCK AND GRAFTING METHODS ON THE GRAFT SUCCESS IN MANDARIN

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Abstract

A trial was carried out to select suitable rootstock and appropriate grafting method for mandarin at the Nursery of Pomology Division, Horticulture Research Centre, Bangladesh Agricultural Research Institute (BARI), Gazipur. Scions of BARI Komala-1 were grafted on four rootstocks (Cleopetra mandarin, Rough lemon, Calamonsi and Rangpur lime) with three grafting methods (cleft, veneer and side grafting).The studies revealed that higher percentage of grafting success was recorded in cleft and veneer method (92.40% and 89.3%, respectively) on Rangpur lime which was at par with cleft and veneer method on Rough lemon (90.50 and 85.2%, respectively) and cleft method on cleopetra mandarin (85.6). Cleft followed by veneer method showed higher survivability when grafted on Rangpur lime (89.80% and 83.20%, respectively) as well as on Rough lemon (87.40% and 85.10%, respectively) at 180 days after grafting. Conclusively, cleft and veneer method showed higher percent of graft success, length of graft and percent of survivability on Rough lemon followed by Rangpur lime.

Key words: Rootstock, grafting methods, graft success, cleopetra mandarin, rough lemon, calamonsi and Rangpur lime.

Introduction

Propagation is an important aspect for commercialization of a fruit crop. The success of fruit production depends in many cases, among them propagation method is vital one. Various citrus species are cultivated through vegetatively. Among the citrus species mandarins are more sensitive to vegetative propagation especially rootstocks and grafting techniques. Khasi mandarins may be grafted on rootstock, like rough lemon or Rangpur lime. These two rootstocks have shown wide acceptance by the mandarin growers in India (Ghosh and Singh, 1993). In India, Kinnow mandarin is being cultivated on commercial scale and Cleopetra is being used as a rootstock. (Josan and Kaur, 2006). Ghose and Narayan (1993) studied the effect of rootstock on Nagpur and Kinnow mandarins, and found that rough lemon rootstock was the most vigorous, while Rangpur lime (*Citrus limonia*) supported a high fruit yield and quality. Waqar *et al.* (2006) reported that rootstocks directly affect the ability of plants to take up water and nutrients and significantly alter the pattern of canopy development and photosynthesis. In another experiment Lima (1993) observed that mandarin trees budded on Rangpur lime and Rough lemon are vigorous in growth.

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Like other citrus, mandarin generally propagated by seeds, cuttings, grafting or budding. Citrus seedling is not usually raised for commercial planting unless it is a poly-embryonic one. Mandarin also shows poly-embryonic in nature. But plants are susceptible in different diseases like gummosis, root rot, cankers etc when grown its own root system. Rough lemon is tristeza tolerant but susceptible to foot rot (Grimm and Hutchison, 1973) and nematodes. For this reason different rootstocks were used in modern citrus cultivation. Schafer *et al.* (2001) studied the propagation of mandarin by cuttings and grafting in Rio Grande do Sul, Brazil, during 1993-98. Cutting was less effective than grafting when Swingle and Troyer were used as rootstocks. Chalise *et al.* (2013) conducted a field experiment at Dhankuta, Nepal to standardize the time and method of grafting and to assess the success and growth of mandarin saplings. The success and growth of sapling was significantly affected by the dates while the methods had no effect. Therefore, techniques of different grafting methods need to be standardized for successful cultivation of mandarin in our country.

Mandarin is a promising fruit crop in Bangladesh, but very little effort has been given to its propagation technique. Considering the above facts, the present investigation was undertaken to select suitable rootstocks and standardize appropriate grafting method(s) for mandarin propagation.

Materials and Methods

Place of study: The experiment was conducted at the Nursery of Pomology Division, Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur from November 2008 to August 2010.

Scion and rootstock preparation

Scions were collected from the plant of BARI Komala-1. Seedlings of Cleopetra mandarin, Rangpur lime, Calamonsi and Rough lemon were used as rootstock. Seeds of Cleopetra mandarin, Rangpur lime, Calamonsi and Rough lemon were sown in polybags previously filled with a mixture of equal amount of sand, silt and clay. The seeds were germinated within 25-30 days. Seedlings of selected rootstock were placed in nursery bed. Proper care was taken for growing the seedlings till grafting. Side branches were carefully removed very close to the stem by means of a sharp pruning knife.

Grafting study

Seedlings of 17 month were used as rootstock for grafting. The uniform and healthy seedlings attaining pencil thickness were selected as rootstock. The scions of BARI Komala-1 were collected from the mature shoots of the past seasons growth having 4 to 5 buds. Three grafting methods viz. cleft, veneer and side were applied during grafting. The grafting operations were done in 2 February 2010. The experiment was laid out in a factorial Randomized Complete Block Design with three replications. Twenty grafts were used in each treatment combination in each replication. The grafting union was tied firmly with budding tape to secure close contact between the cambium layers of scion and rootstock. The graft union was covered by polyethylene tube to check water loss from graft area. Grafting operation was accomplished in the lath house. After one

month, grafted seedlings were transferred in the net house. Irrigation was done frequently to the grafts and all the sprouts below graft union were removed. Plant protection measures were taken against leaf miner. Data were recorded at 30 days after grafting (DAG) on graft success (%) and at 180 DAG on length and diameter of shoot, number of leaves per graft, length and diameter of graft and graft survivability.

Data analysis

The recorded data were analyzed statistically using MSTAT-C program. Means were compared by Duncan Multiple Range Test (DMRT) and Coefficient of Variation (CV) was also estimated as suggested by Gomez and Gomez (1984).

Results and Discussion

Graft success: Effect of rootstock on success of graft is presented in Fig. 1. It had profound influence on success of graft. The highest percentage (87.4%) of graft success was observed in Rangpur lime which was statistically identical with Rough lemon (84.1%). Considerable success of grafting was obtained in Cleopetra mandarin (78.4%), while the least was in Calamonsi (71.5%). Ghosh and Singh (1993) have been identified Cleopatra mandarins for Velencia and Jaffa; and Rangpur lime for Mosambi as promising rootstocks; while Josan and Kaur (2006) reported the Cleopetra as a rootstock for Kinnow mandarin.

The method of grafting had significant influence on success of graft (Fig. 2). The highest success (86.0%) was recorded in cleft grafting which was at par with veneer grafting (81.4%) while it was least in side grafting (73.7%). Gautam *et al.* (2001) was found the highest graft success of mandarin (85.0 to 87.5%) at different times when grafted on trifoliate rootstocks in Nepal. This was in line with the present finding.

Rootstock and method of grafting interacted on the success of graft (Fig. 3). Statistically higher percentage of grafting success (92.4) was recorded in cleft method when grafted on Rangpur lime which was statistically identical with cleft method on Rough lemon (90.5) and veneer method on Rangpur lime (89.3%), as well as cleft on Cleopetra mandarin (85.6%) and veneer on Rough lemon (85.2%), while it was lower in side grafting on Calamonsi (66.0%). Side grafting was resulted satisfactory success when grafted on Rough lemon, Rangpur lime and Cleopetra mandarin. Malik *et al.* (1974) stated Rough lemon (*C. jambhiri* Lush) might be a hybrid in origin and highly polyembryonic in nature, which is Swidely used rootstock in India, South Africa, Florida and Brazil. Grimm and Hutchison (1973) reported Rough lemon is tristeza tolerant but susceptible to foot rot.

Graft diameter, shoot diameter, shoot length and leaves per graft

Influence of rootstock on graft diameter, shoot diameter and leaves per graft were found insignificant (Table 1). The rootstock showed significant influence on shoot length and the longest shoot (40.46 cm) was recorded in Rough lemon as well as in Rangpur lime (39.76) while the shortest shoot (35.02 cm) was in Calamonsi which was at par with Cleopetra mandarin.

Table 1. Effect of rootstock on graft diameter, shoot diameter, shoot length and leaves per mandarin graft at 180 DAG.

Rootstock	Graft diameter (cm)	Shoot diameter (cm)	Shoot length (cm)	Leaves/graft (no.)
Cleopetra mandarin	0.71	0.49	35.18 b	53.2
Rangpur lime	0.77	0.48	39.76 a	55.2
Calamonsi	0.79	0.49	35.02 b	53.1
Rough lemon	0.78	0.51	40.46 a	56.7
CV (%)	3.71	3.90	6.84	7.19
Level of significance	NS	NS	**	NS

Means in a column followed by the same letters are not significantly different at 1% level of significance**Significant at 1% level of significance.

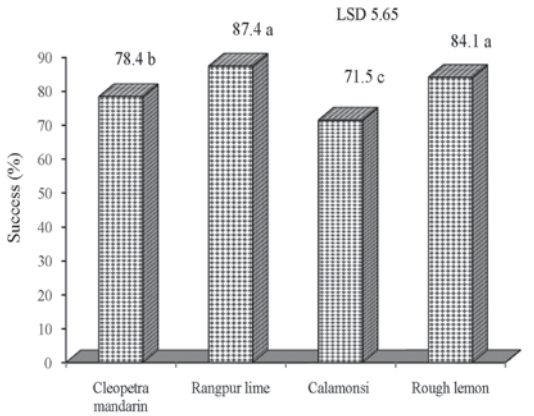

Fig. 1. Effect of rootstock on graft success in mandarin.

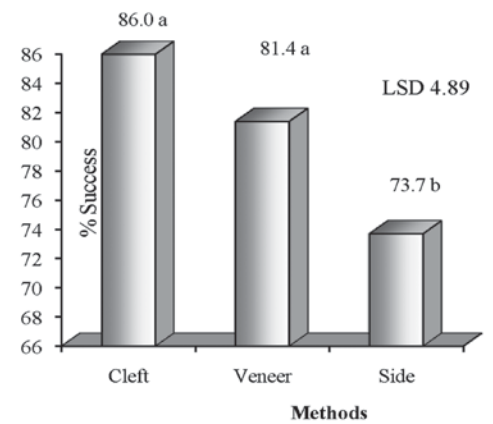

Fig. 2. Effect of grafting method on graft success in mandarin.

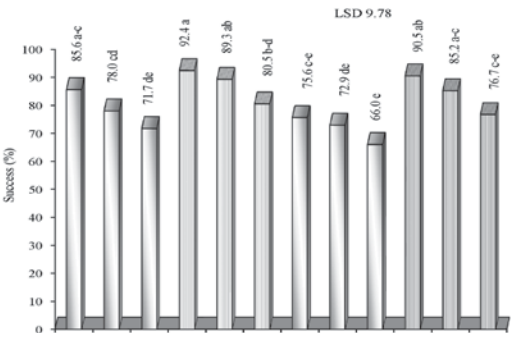

Fig. 3. Combined effect of rootstock and grafting method on graft success in mandarin.

Effect of grafting method on graft diameter, shoot diameter, shoot length and leaves per graft are presented in (Table 2). No significant difference was found in graft diameter and shoot diameter. Significant effect of grafting methods was observed in length of shoot. The longest shoot was obtained by cleft method (40.79 cm) and the shortest shoot (33.86 cm) was obtained by side grafting. Significant effect of grafting methods was also observed in leaves per graft. Maximum number of leaves (58.4) was obtained by cleft grafting followed by veneer grafting (56.4) and minimum number of leaves (48.8) obtained by side grafting.

Table 2. Effect of grafting method on graft diameter, shoot diameter, shoot length and leaves per mandarin graft at 180 DAG.

Method	Graft diameter (cm)	Shoot diameter (cm)	Shoot length (cm)	Leaves/graft
Cleft	0.76	0.49	40.79 a	58.4 a
Veneer	0.79	0.50	38.16 b	56.4 a
Side	0.75	0.49	33.86 c	48.8 b
CV (%)	3.71	3.90	6.84	7.19
Level of significance	NS	NS	**	**

Means in a column followed by the same letters are not significantly different at 1% level of significance**Significant at 1% level of significance.

NS = Not Significant, DAG = Days After Grafting

There was no statistical difference in graft diameter and shoot diameter was observed as influenced by rootstocks and grafting methods (Table 3). The rootstock and grafting method interacted significantly on shoot length and leaves per graft. The longer shoot was recorded in cleft (43.70 cm) grafted on Rangpur lime which was statistically similar with cleft (42.17 cm) and veneer (41.13 cm) on Rough lemon, veneer (40.60 cm) with Rangpur lime and cleft on Cleopetra mandarin (39.47 cm). The shortest shoot (30.43 cm) was obtained from side grafting when grafted on Cleopetra mandarin. The rootstocks and methods of grafting interacted significantly on number of leaves per graft (Table 3). The cleft grafting produced maximum number of leaves when grafted on Rough lemon (62.30) followed by Rangpur lime (59.10), Cleopetra mandarin (57.30) and Calamonsi (55.00) at 180 days after grafting. While side grafting was done on Cleopetra mandarin produced

Table 3. Combined effect of rootstock and grafting method on graft diameter, shoot diameter, shoot length and leaves per mandarin graft at 180 DAG.

Rootstock	Method	Graft diameter (cm)	Shoot diameter (cm)	Shoot length (cm)	Leaves/ graft
	Cleft	0.72	0.51	39.47 a-e	57.3 ab
Cleopetra mandarin	Veneer	0.74	0.48	35.63 ef	54.5 b-d
	Side	0.67	0.47	30.43 g	47.7 e
	Cleft	0.74	0.49	43.70 a	59.10 ab
Rangpur lime	Veneer	0.82	0.49	40.60 a-d	56.00 a-c
	Side	0.76	0.48	37.07 c-e	50.5 c-e
	Cleft	0.79	0.48	37.83 b-e	55.00 b-d
Calamonsi	Veneer	0.78	0.51	35.27 ef	56.40 a-c
	Side	0.80	0.49	31.97 fg	47.8 e
	Cleft	0.78	0.49	42.17 ab	62.30 a
Rough lemon	Veneer	0.81	0.53	41.13 a-c	58.50 ab
	Side	0.76	0.52	35.97 d-f	49.2 de
CV (%)		3.71	3.90	6.84	7.19
Level of significance		NS	NS	**	**

Means in a column followed by the same letters are not significantly different at 1% level of significance **Significant at 1% level of significance

NS = Not Significant, DAG = Days After Grafting

minimum number of leaves (47.7) which was at par with side grafting on Calamonsi (47.8), Rough lemon (49.2) and Rangpur lime (50.5). Mandarin grafted on Rough lemon was proved the best vigorous in Pakistan (Nasir *et al.,* 2011).

Graft length

The rootstock had significant influence on graft length (Fig 4). The rootstock Rough lemon (55.94 cm) produced the highest length of graft followed by Rangpur lime (54.77 cm) which was statistically at par. Minimum length of graft (49.95 cm) was obtained in Cleopetra mandarin, which was at par with Calamonsi (51.69 cm)**.**

The method of grafting had significant influence on length of graft (Fig. 5). The Cleft method produced the highest length of graft (56.37 cm) as well as Veneer (53.38 cm). While minimum length of graft (49.51 cm) was obtained from side grafting.

The interaction effect of rootstock and grafting method had significant influence on length of graft (Fig. 6). Cleft method produced the highest length of graft (59.35 cm) when grafted on Rough lemon which was at par with veneer (55.27 cm) and side method (53.20) on same rootstock. Again it was statistically identical with cleft and veneer methods when grafted on Rangpur lime (57.34 cm and 56.56 cm respectively), Calamonsi (55.00 cm and 52.27 cm, respectively) and cleft method on Cleopetra mandarin (53.80 cm). Whereas, the lowest length of graft produced by the side grafting (46.61 cm) when grafted on Cleopetra mandarin which was followed by veneer on same rootstock, side on Rangpur lime, veneer and side on Calamonsi and side on Rough lemon.

Graft survivability

Rootstock had significant effect on survivability of graft at 180 DAG (Fig. 7). Percent survivability was recorded maximum in Rough lemon (82.90%) as well as in Rangpur lime (81.17%), while it was recorded the minimum in Calamonsi (65.63%).

In the study grafting methods had significant influence on survivability of graft at 180 DAG (Fig. 8). It was recorded the highest in cleft grafting (81.93%) and the lowest in side grafting (68.80%).

Rootstock and method of grafting interacted significantly on survivability of graft at 180 DAG (Fig. 9). Percent survivability was recorded maximum in cleft method followed by veneer when grafted on Rangpur lime (89.8% and 83.2%) as well as on Rough lemon (87.4% and 85.1% respectively). The least survivability was recorded from side grafting (60.0%) when grafted on Calamonsi rootstock. Ghosh and Singh (1993) suggested Rough lemon is the common rootstock for mandarin, and Rangpur lime followed by Cleopatra mandarin has emerged as a most promising rootstock for Coorg mandarin and Nagpur mandarin in Karnataka and Maharashtra. Harish-Kumar *et al.* (2001) reported trees of local mandarin budded on Jatti Khatti, Kharna Khatta, Pectinifera and Karun Jamir rootstocks showed higher survival (83.3-100.0%) than trees on Cleopetra and Troyer (50.0%). Vijaya *et al.* (2000) recommended the Rangpur lime and Rough lemon as rootstocks for Shevroy hills of India.

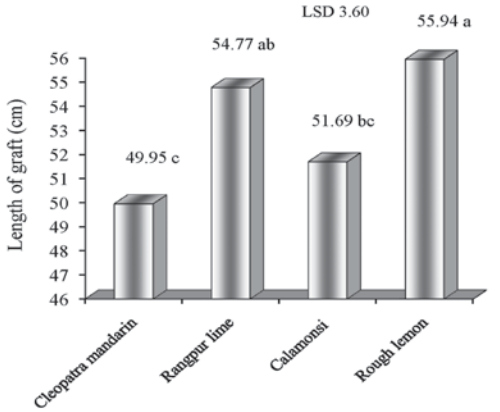

Fig. 4. Effect of rootstock on graft length in mandarin.

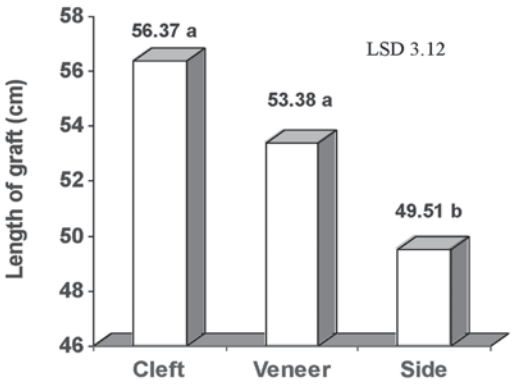

Fig. 5. Effect of grafting method on graft length in mandarin.

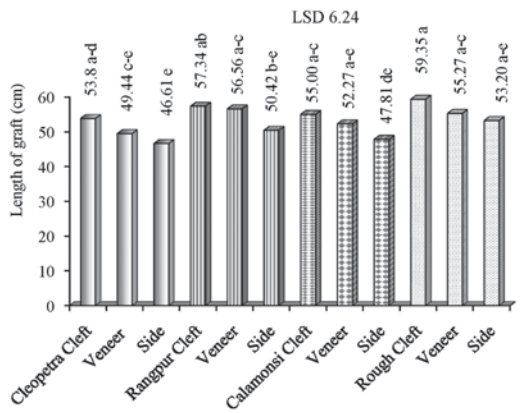

Fig. 6. Combined effect of rootstock and grafting method on graft length in mandarin.

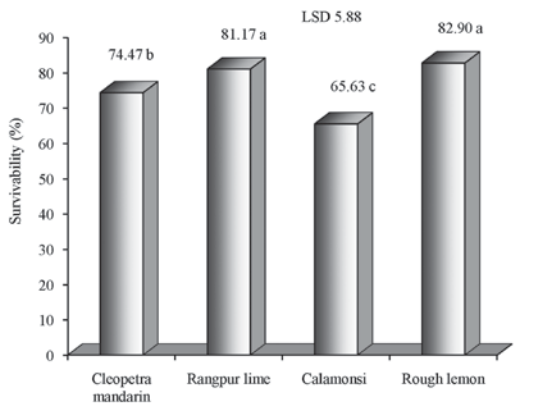

Fig. 7. Effect of rootstock on graft survivability in mandarin.

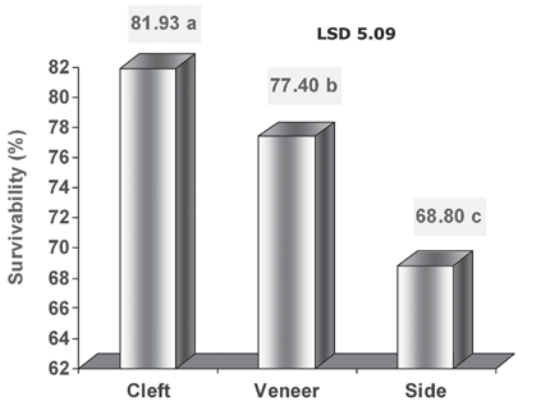

Fig. 8. Effect of grafting method on graft survivability in mandarin.

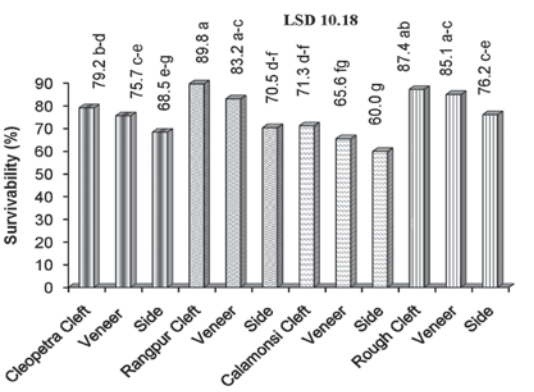

Fig. 9. Combined effect of rootstock and grafting method on graft survivability in mandarin.

In this study, it can be concluded that cleft and veneer method showed higher percent of graft success, length of graft and percent of survivability on Rough lemon followed by Rangpur lime.

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