Propagation of Mango by cleft-grafting

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Abstract

Experiments were conducted at the Faculty of Agricultural Sciences, University of Gezira, Wad Medani, Sudan during the period December 2001-December 2002, to investigate the use of cleft grafting technique for mango propagation, where the scion is detached from the parent tree. The treatments were rootstock diameters of 1.5, 1.5 to 0.5 and 0.5 cm; scion hardening methods in which the leaves were either removed or trimmed to half leaves; scion lengths of 8-9 or 15-16 cm; glasshouse and nursery shed conditions and two cultivars, namely Galbeltor and Abusamaka. The most viable scions with the highest number of successful grafts were obtained when scions in which all the leaves were removed were grafted on rootstocks of 0.5 cm in diameter. There were no significant differences between the two mango cultivars, but Galbeltor tended to have higher values. Longer scions resulted in significantly higher percentage of successful grafts than shorter ones. Grafted seedlings kept under glasshouse conditions resulted in 100% successful grafts as compared to those kept in the nursery shed due to the high relative humidity levels maintained in the glasshouse.

Introduction

Mangoes are grown all over the Sudan and are leading the Sudanese horticultural exports. Many cultivars of excellent fruit quality are currently grown such as Abusamaka, Alphonse, Dibsha, Zibda, Galbeltor and Shendi. However, the majority of the mango fruit crop in Sudan is harvested from seedling trees, of which the local cultivar (Kitchener) is leading. Although the quality of fruit of these seedling trees is fairly good, they are usually too fibrous and not suitable for export especially to European markets (Elkashif *et al.* 2003).

The build up of mango export industry in Sudan is dependent on mass propagation and planting of superior cultivars which are acceptable in international markets. The only vegetative method of mango propagation currently employed in Sudan is approach grafting (Sidahmed 1992). It is tedious, slow, expensive and requires parent trees with low branches, because the scion must be attached to the parent tree till the healing of the graft scion. Therefore, there is an urgent need to develop a quick and easy method of mango propagation where the scions are detached from the parent tree.

Grafting methods in which the mango scion is detached from the parent tree include crown grafting, budding and cleft grafting (Hartmann and Kester 1983; Ram 1993, 1997; Sidahmed 1992; Reddy and Melanta 1988). The success of grafting methods depends on season, age of both rootstock and scion and cultivar (Ram and Sirohi 1989).

Cleft grafting is generally used with rootstocks of large diameters and normally more than one scion is inserted. However, a modification has been recently made where younger rootstocks and one scion can be used for large scale mango

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propagation (Kanwar and Bhajwa 1974; Azouz *et al.* 1984; Bajpaj *et al*. 1989; Nunez *et al*. 1996). It has been reported that cleft grafting is easier to use (Kulwal and Tayde 1989) and more successful than other methods of grafting (Amin 1978; Panickar and Deasi 1989; Ram 1997).

Mass propagation of superior cultivars of mango suitable for export can only be achieved by the adoption of a grafting method where the scion is detached from the mother tree. Therefore, the objective of this study was to investigate the effects of rootstock diameter, scion length, presence or absence of leaves and environmental conditions or success and survival of cleft-grafted mango seedlings.

Materials and methods

Experiments were conducted at the Faculty of Agricultural Sciences, University of Gezira, Wad medani, Sudan, between May 2001 and June 2002. Rootstock seedlings from "Baladi" cultivar were grown from seeds and raised in nursery beds. After one month, seedling stocks were transferred to pots filled with river silt and left in the nursery until they attained the suitable size for grafting. Half of the seedling stocks were taken to the glasshouse for grafting and the other half was grafted in the nursery shed. The glasshouse was set at 25^0C during the day and 21^0C during the night and 70% relative humidity.

Scions from "Abusamaka" and "Galbeltor" cultivars were selected from healthy parent trees grown in a private orchard at Hantoub area, east of the Blue Nile. Healthy shoots containing swelling terminal buds were detached from mother plants on the same day of the experiment and kept in polyethylene bags ready for grafting.

Cleft grafting technique was used to study the effects of rootstock diameter, scion length and scion hardening method on the success of grafting. Rootstock diameters were 0.5, 0.5-1.5 and 1.5 cm; and scion lengths were 8-9 and 15-16 cm. Two scion hardening methods were used. In the first method, all the leaves were removed before grafting. In the second method, 4-5 leaves surrounding the terminal bud were trimmed to half leaves. The treatments were arranged in a randomized complete block design with five replications.

The rootstock was decapitated 25 cm above the soil surface and then split for subsequent insertion of the scion. The basal end of the scion was wedged by making slanting cuts on both sides. Then, the split of the rootstock was opened and the cleft of the scion was slipped into it in such a way that the cambial layers of both the scion and rootstock were facing each other and met firmly. The graft union was then wrapped with paraffin film, and covered with a thin transparent polyethylene bag to ensure high relative humidity. Polyethylene bags were removed as soon as new leaves were formed and turned to green colour. Data on success of grafting were taken at weekly intervals but results were presented only for the first week. The success of grafting was expressed in terms of scion viability which was rated using a scale of 1 to 5 as follows: 1, scion dry and dead; 2, yellow and severely desiccated; 3, yellowish green and slightly desiccated; 4, fairly green and healthy; 5, green and healthy. Number of survived grafts was recorded after four months and expressed as percentage of total grafts.

Another experiment was carried out, from August to December, 2002, to investigate the effects of the environment, viz nursery shed or glasshouse conditions, on the success of grafting. Rootstock diameters of 0.5 and 0.5-1.5cm and scion lengths of 8-9 and 15-16 cm were used. Grafting was carried out similar to the first experiment and success of grafting was followed in a similar manner. Half the grafted

seedlings were raised in the nursery and the other half in the glasshouse set at the previously mentioned conditions. The treatments were arranged in a randomized complete block design with five replications.

Results and discussion

The main effects of scion diameter and scion hardening methods on scion viability and the number of successful grafts are shown in Table 1. Scion diameter had a significant effect on both scion viability and number of successful grafts. Both parameters increased as scion diameter decreased from 1.5 to 0.5 cm. When a rootstock diameter of 1.5 cm was used, scions were yellow and severely desiccated after one week from grafting, whereas a rootstock diameter of 0.5 cm resulted in fairly green and healthy scions. The high percentage of successful grafts obtained with the smallest rootstock diameter was probably due to the juvenilty of the thin rootstock. Juvenile rootstocks usually have vascular cambiums with active meristematic cells which readily unite with those of the scion and result in a successful graft union. These results are in agreement with those reported by Reddy and Melanta (1988) who recommended that rootstock diameters of more than 2 cm should always be avoided, because they were too mature and resulted in failure of grafting.

The interaction effects of cultivar and rootstock diameter on scion viability and number of successful grafts were significant (Table 2). The effects of rootstock diameter on these parameters followed the same trend as described before within each cultivar. Although there were no significant differences between mango cultivars, Galbeltor tended to have higher values than Abusamaka.

The main effects of scion hardening methods were highly significant (Table 1). The highest values were obtained when all the leaves were removed from the scion as compared to scions in which the terminal 4 to 5 half leaves were retained. The high values of scion viability and the high percentage of successful grafts obtained when all the leaves of the scion were removed were due to the fact that removal of leaves reduced the process of transpiration from the scion. This led to an effective reduction in the amount of water loss from the scion and hence prevented its desiccation and resulted in the formation of a successful graft union.

The interaction effects of rootstock diameter and scion hardening method on scion viability and number of successful grafts were highly significant (Table 3). The best results were obtained when scions from which all the leaves were removed were grafted on rootstocks of diameters ranging from 0.5 to 1.5 cm or 0.5 cm. These results are in agreement with those reported by Panickar and Deasi (1989) and Numez *et al.* (1996) who demonstrated the importance of rootstock age and scion defoliation on the success of the graft union.

The main effects of environment and scion length on the number of successful grafts were significant. The glasshouse environment had significantly higher successful grafts (100%) than nursery shed environment (85%). This is due to the high level of relative humidity maintained in the glasshouse which reduced water loss from the scion and hence resulted in a successful graft union. Longer scions (15-16 cm) resulted in a significantly ($P \leq 0.05$) higher percentage of successful grafts than shorter ones (8-9 cm). Ram and Sirohi (1989) and Sihahmed (1992) reported similar findings and suggested the use of relatively longer scions.

Neither rootstock diameter nor scion length had any significant effect on number of successful grafts under glasshouse conditions. This was due to the favourable environmental conditions prevailing in the glasshouse where relative

humidity was very high, thus encouraging quick healing of the graft union. However, under nursery shed conditions, longer scions grafted on thinner rootstocks resulted in significantly higher percentages of successful grafts. Generally, the percentage of successful grafts obtained under nursery shed conditions was less than that obtained under glasshouse conditions. This was because the environmental conditions in the nursery shed, manifested in the level of relative humidity, was less than optimum for maximum success of graft union formation. These results suggest that the maintenance of high levels of relative humidity is of utmost importance for successful cleft grafting in mango and that nursery shed conditions can be used only during the rainy season.

Recommendations

Based on the results of this study, we recommend the use of cleft grafting technique for mango propagation using rootstock diameters of 0.5 to 1.0 cm and scions 15 cm long with all the leaves removed. Grafted seedlings should be kept in controlled conditions of relative humidity levels not less than 85% to ensure high success of graft union.

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Table 1. Main effects of rootstock diameter and scion hardening method on scion viability and number of successful grafts.

Treatment	Scion viability one week after grafting	Number of Successful grafts (%)
Rootstock diameter (cm)		
1.5	1.92 c	37.5 c
0.5-1.5	3.3 b	64.0 b
0.5	3.8 a	76.5 a
Level of significance	*	**
Scion hardening method		
All leaves removed	4.1	82.0
4-5 half leaves retained	1.8	36.7
Level of significance	**	**

* and ** indicate significance at P≤ 0.05 and 0.01, respectively.
Means followed by the same letter within each column are not significantly different, according to Duncan's Multiple Range Test.

Table 2. Interaction effects of mango cultivar and rootstock diameter on the success of grafting.

Cultivar	ootstock diameter (cm)	Scion viability one week after grafting	Number of successful grafts (%)
Galbeltor	1.5	2.0 c	61.6 c
	0.5-1.5	3.5 ab	70.0 ab
	0.5	4.0 a	80.0 a
Abusamaka	1.5	1.7 c	43.4 c
	0.5-1.5	3.2 b	65.0 b
	0.5	3.4 ab	77.0 ab
Level of significance		*	**

* and ** indicate significance at P≤ 0.05 and 0.01, respectively.
Means followed by the same letter within each column are not significantly different, according to Duncan's Multiple Range Test.

Table 3. Interaction effects of rootstock diameter and scion hardening method on scion viability and number of successful grafts.

Rootstock diameter (cm)	ion hardening ethod	Scion viability one week after grafting	Number of successful grafts (%)
1.5	All leaves removed	2.8 b	55.0 b
	4-5 half leaves retained	1.0 c	20.0 c
0.5-1.5	All leaves removed	4.9 a	93 a
	4-5 half leaves retained	1.7 c	35 bc
0.5	All leaves removed	4.7 a	98 a
	4-5 half leaves retained	2.8 b	55 b
Level of significance		**	**

** indicates significance at P≤ 0.01.
Means followed by the same letter within each column are not significantly different, according to Duncan's Multiple Range Test.