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Assessment of Grafting and Budding Success in Different Varieties of Ber under *In-situ* Condition

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ABSTRACT

Ber (*Ziziphus mauritiana*), a valuable indigenous fruit tree of the Rhamnaceae family offers significant nutritional and mineral benefits. However, its cultivation is limited due to the lack of quality planting material, with seed propagation causing variability in plant vigor, delayed fruiting and inconsistent fruit quality. In this context, vegetative propagation, particularly grafting and budding, plays a crucial role in maintaining genetic uniformity and preserving cultivar identity. Successful grafting involves callus formation and vascular union between scion and rootstock. However, graft incompatibility can hinder success when different genotypes or species are involved. This study aimed to identify the best vegetative method and variety for ber propagation under *in situ* conditions. The results showed that grafting the *Dandan* variety onto *Ziziphus mauritiana* var. *rotundifolia* which is resistant to biotic and abiotic stress gave the best results. The *Dandan* variety exhibited the highest graft height (29.83 cm, 33.83 cm, and 39.21 cm), graft diameter (0.68 cm, 0.91 cm, and 1.2 cm), number of leaves (28.00, 33.66, and 38.16), graft success (91.16%, 86.00%, and 87.83%) and graft survival rate (91.16%, 88.83%, and 87.83%) 30, 60 and 90 days after grafting respectively. In contrast, the *Chhuhar* variety grafted onto *Ziziphus mauritiana* var. rotundifolia showed the lowest performance. These findings underlined the importance of selecting the right root stock and variety to enhance graft success, genetic stability of ber.

Keywords: Callus, Grafting, Scion, Root stock.

INTRODUCTION

Ber or Indian jujube (*Ziziphus mauritiana*) is an important minor indigenous fruit tree belonging to family Rhamanaceae. It is called as king of arid fruits, poor man's fruit, Chinese date and Chinese fig *etc.* because of its high nutritive value and comparatively lower market price (Morwal *et al,* 2018). It has recently attained importance as an arid zone horticulture crop, because of its hardy nature and high yield potential (Nath *et al,* 2000). The fruits are rich in minerals like phosphorus, calcium, iron, vitamin C, A and B complex, the composition varies with varieties. The fruit is the most well-known used product from the tree. Its leaves contain 5.6 percent digestible crude protein and 49.70 percent total digestible nutrients, making it a nutritive fodder for animals (Sharif *et al,* 2015). Though the fruit crop is having vast scope, the expansion of area under cultivation is limited due to the non-availability of sufficient genuine planting material. Ber is propagated both by seeds and vegetative methods. The most common and simplest method of raising the ber tree is from seed (Singh, 2022). As the tree do not bear true to type fruits it leads to immense variation in fruit and yield characters. In this regard importance of vegetative propagation in ensuring genetic uniformity and preserving the identity of clones or cultivars is well established in horticultural crops. Hence, identifying an efficient method for the rapid multiplication of superior ber plants is essential. Hence, vegetative methods like grafting, budding are adopted in this crop. The important budding methods followed are approach and softwood grafting. The rootstock generally used for grafting is *Ziziphus mauritiana* var. *rotundifolia* which can withstand long periods of drought, salt and water logging and can therefore be grown on degraded or marginal lands (Verma *et al,* 2000). Hence, the present study aimed to evaluate and identify the most effective vegetative propagation method and suitable ber (*Ziziphus*

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mauritiana) variety under in situ conditions to enhance establishment, growth performance, and overall propagation success.

MATERIALS AND METHODS

The present investigation was carried out at Department of Fruit Science, Kittur Rani Channamma College of Horticulture, Arabhavi to study the grafting and budding success under *in-situ* condition using six varieties of ber as scion on local rootstock (*Z. rotundifolia*). Softwood grafting was carried out using rootstocks that were five months old. The terminal portion of the rootstock was removed using a sharp knife and secateurs. A vertical slit, approximately 5 cm in length, was then made on the cut surface of the rootstock. A scion of similar diameter was selected, and its basal end was trimmed with two gentle, slanting cuts on opposite sides to form a wedge by removing both bark and a small portion of wood. This wedge-shaped scion was carefully inserted into the slit on the rootstock, ensuring proper alignment. It was then tightly secured using a 150-gauge transparent white polythene strip, measuring 1.5 cm in width and 30 to 45 cm in length, to maintain close contact between scion and stock. Finally, the grafted scions were enclosed in small transparent plastic tubes for protection. In chip budding the first step is to make a cut about 2-2.5 cm long with a depth of 25 percent of the stock diameter with a horizontal cut made at the bottom of first cut and remove the cut portion from the stock. Then prepare a scion of same size containing active bud such that it exactly fits the cut portion made in the stock portion. After fitting the scion bud into the rootstock hold the bud tightly to stock and wrap the graft tape such (leaving bud to sprout) that there should not be any space for movement of air and water at the union portion.

RESULTS AND DISCUSSION

Graft height

In the present investigation, softwood wedge grafting showed significantly highest graft height (22.27 cm) at 30 DAG, compared to chip budding while at 60 and 90 DAG chip budding showed significantly highest graft height (29.33 and 40.27 cm), respectively (Table 1). While comparing various methods of grafting and budding Kim *et al* (1988) and Chandel *et al* (1998) also obtained the maximum growth of plants with chip budding because formation of quick and strong union, higher uptake of water and nutrients and longer growing period may account for the higher growth of chip-budded plants. Dandan variety showed highest graft height (23.83 and 31.08 cm) at 30 and 60 DAG respectively, which was on par with Sannaur-2 and Meharun (22.00 and 21.43 cm) at 30 DAG respectively, Sannaur-2 and Gola (30.83 and 29.66 cm) at 60 DAG respectively, while at 90 DAG Gola showed highest graft height (39.16 cm) followed by Dandan (38.83 cm) and Sannaur-2 (38.50 cm). Significantly minimum graft height was found in Chhuhara at different stages of growth (19.83, 25.33 and 31.78 cm) at 30, 60 and 90 DAG respectively. This increase in graft height was mainly because of better graft success of improved varieties with the local rootstock. The reports were similar to findings of Patil *et al* (2008). The interaction of propagation and varieties showed non-significant difference with respect to graft height at 30 and 60 DAG, while at 90 DAG chip budding of Dandan showed the highest graft height (45.66 cm), followed by chip budding of Gola and Sannaur-2 (43.00 and 42.33 cm) at 90 DAG, respectively. Significantly minimum graft height was in softwood wedge grafting of Meharun variety (29.00 cm) at 90 DAG. This difference in height may be due to the better nutrient uptake by grafts at different stages of their growth. This might be also due to the vigour and genetic makeup of individual varieties.

Graft girth

The softwood wedge grafting showed significantly high graft girth (0.64 cm) at 30 DAG, while at 60 and 90 DAG the highest graft height was noticed in chip budding 0.92 and 1.36 cm ,respectively. Initially the minimum graft girth was observed in chip budding (0.55 cm) at 30 DAG, while at 60 and 90 DAG minimum graft girth was seen in softwood wedge grafting (0.78 and 0.87 cm, respectively). This was mainly due less damage to the stock which get fast recovery compared to grafting methods and they form strong union formation in short period of time, higher uptake of water and nutrients and longer growing period may account for the higher growth of chip-budded plants (Kim *et al*, 1988: Chandel *et al*, 1998). Meharun variety showed highest graft girth (0.80, 0.99 cm) at 30 and 60 DAG respectively, which was on par with Dandan (0.98 cm) at 60 DAG, while at 90 DAG, Dandan showed high graft girth (1.28 cm), followed by Meharun (1.16 cm). Significantly minimum graft girth was found in Chhuhara (0.44, 0.66 and 1.00 cm) at 30, 60 and 90 DAG respectively. The increase in graft girth is mainly because of better compatibility of local rootstock and better uptake of nutrients and water from deep layers of soil. The interaction of propagation and varieties also showed highest graft girth in softwood wedge grafting of Meharun (0.86 cm) at 30 DAG

followed by softwood wedge grafting of Dandan (0.80 cm) and chip budding of Meharun (0.73 cm) however, at 90 DAG highest graft girth was observed in chip budding of Dandan (1.60 cm), which was on par with chip budding of Meharun, Sannaur-2 (1.22 and 1.26 cm) at 90 DAG respectively. Minimum graft girth was observed in chip budding of Chhuhara (0.40 cm) at 30 DAG, while at 90 DAG minimum graft girth was observed in softwood wedge grafting of Chhuhara (0.70 cm). The reason is early healing of graft union due to presence of congenial climate for graft union and growth under *in-situ* conditions as reported by Sharif *et al* (2015).

Number of leaves

The chip budding showed significantly highest number of leaves at different stages of growth (13.30, 30.50 and 41.50) at 30, 60 and 90 DAG respectively, compared to soft wood wedge grafting (11.26, 13.63 and 20.33) at 30, 60 and 90 DAG respectively, which showed minimum number of leaves/graft (Table 3). Ghosh (2009) reported that budding of plants in open sunlight condition showed maximum leaf number. The reason might be explained from the fact that *in-situ* grown-seedlings have good tap root system that help to supply better nutrients and moisture to the stock plant and thereby improve physiological condition of the plants. Better physiological status of stock plants of *in situ* grown-seedlings, would result better cambium activity and help to show good success and survival after budding (Nath *et al,* 2000). Dandan variety showed significantly higher number of leaves/grafts at all stages of growth (14.33, 24.25 and 33.83) at 30, 60 and 90 DAG, respectively, which was on par with Meharun (12.95) at 30 DAG, Meharun and Sannaur-2 (23.66 and 22.83) at 60 DAG respectively and Meharun (31.66) at 90 DAG. Significantly the minimum number of leaves/grafts was found in Chhuhara (10.83, 20.25 and 29.66) at 30, 60 and 90 DAG respectively. The difference in number of leaves/grafts might be because of variation in the formation of callus and the vascular connectivity at the graft union. The higher number of leaves in chip budding of Dandan variety (16.33) at 30 DAG, which was on par with chip budding of Sannaur-2 (14.66) and at 60 DAG highest number of leaves were noticed in chip budding of Sannaur-2 (33.50) at 60 DAG, which was on par with chip budding of Meharun and Dandan (32.33 and 31.33) at 60 DAG respectively. Significantly minimum number of leaves was observed in softwood wedge grafting of Chhuhara (9.66) at 30 DAG, while at 60 DAG least number of leaves were observed in soft wood wedge grafting of Sannaur-2 (12.16) at 60 DAG. This increase in number of leaves is mainly due to better compatibility of rootstock with the improved varieties which was reported by Singh and Srivastava (1980).

Graft success

The softwood wedge grafting showed significantly highest graft success percent (87.05 and 85.55 %) at 30 and 60 DAG respectively. The minimum success percent was found with chip budding method (78.16 and 75.88 %) at 30 and 60 DAG respectively. These findings are in line with Reddy and Melenta (1988) who reported successful *in situ* soft wood grafting on seven- and eight-month-old rootstocks and the highest graft- take under Bangalore conditions was 90 percent. Dandan variety showed significantly highest percent graft success, at all stages of growth (91.1 and 88.83 %) at 30 and 60 DAG respectively. While the minimum percent graft success was found in Gola (75.50 and 73.33 %) at 30 and 60 DAG respectively. Differential budding success of ber cultivars on rootstock/rootstocks was also observed by Verma *et al* 2000. According to them different budding success of ber cultivars on various rootstocks was due to incompatible graft combination and explained that this graft incompatibility was either due to cellular disturbances at the bud junction or lack of callus formation which resulted no vascular connection between stock and scion. They also opined that failure of success might have been due to excessive callus formation at the budded portion which inhibits the movement of water from stock to scion. The interaction of propagation and varieties was also showed high percent graft success in softwood wedge grafting of Umran variety at all stages of growth (100 and 98.33 %) at 30 and 60 DAG respectively, which was on par with chip budding of Dandan (89.00 and 86.00 %) at 30 and 60 DAG respectively, softwood wedge grafting of Sannaur-2 (96.66 and 95.00 %) at 30 and 60 DAG respectively, softwood wedge grafting of Dandan (93.33 and 91.66 %) at 30 and 60 DAG respectively. Minimum percent graft success was observed in softwood grafting of Gola (74.00 and 72.00 %) at 30 and 60 DAG respectively. This variation might be due to the compatibility of the different varieties with the rootstocks that is affected by the grafting method. The histological studies by Abd El-Zaher 2008 illustrated that graft anatomical features of jackfruit were correlates the grafting success percentage.

The graft survival over a period of time showed that softwood wedge grafting showed significantly high percent graft survival (85.05 %) at

Table 1: Effect of propagation methods on graft height of ber varieties under *in-situ* condition.

Graft height (cm)									
	30 DAG			60 DAG			90 DAG		
Variety	Grafting	Budding	Mean	Grafting	Budding	Mean	Grafting	Budding	Mean
Chhuhura	20.66	19.00	19.83	24.33	26.33	25.33	29.23	34.33	31.78
Dandan	24.66	23.00	23.83	28.16	34.00	31.08	32.00	45.66	38.83
Gola	22.30	20.33	21.31	30.33	29.00	29.66	35.33	43.00	39.16
Meharun	22.87	20.00	21.43	24.66	29.33	27.00	29.00	41.00	35.00
Sannaur-2	22.00	22.00	22.00	29.66	32.00	30.83	34.33	42.66	38.50
Umran	21.16	18.66	19.91	26.00	25.33	25.66	30.33	35.00	32.66
Mean	22.27	20.50		27.19	29.33		31.70	40.27	
	P	V	P*V	P	V	P*V	P	V	P*V
S.Em±	0.47	0.83	1.17	0.71	1.24	1.76	0.54	0.95	1.34
C.D. at 5%	1.40	2.43	NS	2.11	3.65	NS	1.61	2.79	3.94

Table 2: Effect of propagation methods on graft girth of ber varieties under *in-situ* condition.

Variety	Graft girth (cm)								
	30 DAG			60 DAG			90 DAG		
	Grafting	Budding	Mean	Grafting	Budding	Mean	Grafting	Budding	Mean
Chhuhura	0.48	0.40	0.44	0.60	0.73	0.66	0.70	1.30	1.00
Dandan	0.80	0.51	0.65	0.90	1.06	0.98	0.96	1.60	1.28
Gola	0.61	0.48	0.55	0.83	0.80	0.81	0.90	1.20	1.05
Meharun	0.86	0.73	0.80	1.03	0.96	0.99	1.10	1.22	1.16
Sannaur-2	0.59	0.66	0.63	0.73	0.93	0.83	0.80	1.26	1.03
Umran	0.53	0.53	0.53	0.63	0.83	0.83	0.76	1.30	1.03
Mean	0.64	0.55		0.78	0.88		0.87	1.31	
	P	V	P*V	P	V	P*V	P	V	P*V
S.Em±	0.02	0.03	0.05	0.02	0.04	0.05	0.03	0.06	0.08
C.D. at 5%	0.06	0.11	0.15	0.07	0.12	NS	0.10	0.17	0.25

90 DAG compared to chip budding (81.33 %) at 90 DAG. This difference in propagation methods under *in-situ* conditions may be due to better union in grafts, because of large surface of cambium cells come in contact with stock and scion in grafting method compare to other method. Dandan variety showed significantly highest percent graft survival (87.83 %), which was on par with Umran (87.16 %), Sannuar-2 (84.83 %) and Meharun (81.83 %) at 90 DAG respectively. Significantly the minimum percent graft survival was found in Chhuhara (76.50 %) at 90 DAG. The difference in percent survival may be due the varietal response to different propagation methods under different environmental conditions. The interaction of propagation and varieties also showed highest percent graft survival in softwood wedge grafting of Umran (93.66 %), which was on par with softwood wedge grafting of Dandan (89.00 %), Sannaur-2 (88.66 %), softwood wedge grafting of Meharun (85.00 %) and chip budding of Dandan (88.66 %) at 90 DAG, respectively, Chhuhara (71.66 %) at 90 DAG. This high percent graft survival may be due to the varietal character in response to congenial environment favoring high graft survival. Similar reports were observed in survival of softwood grafts was minimum in 'Local-3' with 61.18 percent and maximum for 'Kesar' with 76.29 percent (Prajapati *et al,* 2014).

CONCLUSION

In-situ chip budding of Dandan variety grafted onto *Ziziphus mauritiana* var. *rotundifolia* gives highest graft height, graft girth, number of leaves and

Table 3: Effect of propagation methods on number of leaves/graft of ber varieties under *in-situ* condition

Variety	Number of leaves								
	30 DAG			60 DAG			90 DAG		
	Grafting	Budding	Mean	Grafting	Budding	Mean	Grafting	Budding	Mean
Chhuhura	09.66	12.00	10.83	14.00	26.50	20.25	19.00	40.33	29.66
Dandan	12.33	16.33	14.33	17.16	31.33	24.25	23.00	44.66	33.83
Gola	10.33	12.50	11.41	14.16	30.00	22.08	18.33	40.00	29.16
Meharun	12.90	13.00	12.95	15.00	32.33	23.66	22.33	41.00	31.66
Sannaur-2	10.26	14.66	12.46	12.16	33.50	22.83	18.00	43.33	30.66
Umran	11.00	11.33	11.16	13.50	29.33	21.41	21.33	39.66	30.50
Mean	11.26	13.30		13.63	30.50		20.33	41.50	
	P	V	P*V	P	V	P*V	P	V	P*V
S.Em±	0.31	0.55	0.77	0.30	0.52	0.73	0.470	0.81	1.15
C.D. at 5%	0.93	1.61	2.28	0.88	1.53	2.16	1.37	2.38	**NS**

Table 4: Effect of propagation methods on percent graft success and percent survival of ber varieties under *in-situ* condition.

Variety	Percent graft success						Percent graft survival		
	30 DAG			60 DAG			90 DAG		
	Grafting	Budding	Mean	Grafting	Budding	Mean	Grafting	Budding	Mean
Chhuhura	80.00 (63.47)	77.00 (61.35)	78.50 (62.41)	78.00 (62.06)	74.66 (59.78)	76.33 (60.92)	71.66 (57.98)	81.33 (64.54)	76.50 (61.26)
Dandan	93.33 (77.61)	89.00 (70.64)	91.16 (74.12)	91.66 (73.40)	86.00 (68.05)	88.83 (70.72)	89.00 (71.67)	86.66 (69.21)	87.83 (70.44)
Gola	74.00 (59.34)	77.00 (61.57)	75.50 (60.45)	72.00 (58.05)	74.66 (60.05)	73.33 (59.05)	82.33 (65.26)	79.66 (63.37)	81.00 (64.31)
Meharun	78.33 (66.74)	75.00 (60.02)	76.66 (63.38)	78.33 (66.74)	72.33 (58.28)	75.33 (62.51)	85.00 (67.46)	78.66 (62.72)	81.83 (65.09)
Sannaur-2	96.66 (83.66)	76.66 (61.33)	86.66 (72.49)	95.00 (79.45)	75.00 (60.26)	85.00 (69.85)	88.66 (70.34)	81.00 (64.43)	84.83 (67.38)
Umran	100 (89.71)	74.33 (59.95)	87.16 (74.83)	98.33 (85.50)	72.66 (58.80)	85.50 (72.15)	93.66 (75.56)	80.66 (63.94)	87.16 (69.75)
Mean	87.05 (73.42)	78.16 (62.48)		85.55 (70.86)	75.88 (60.87)		85.05 (68.04)	81.33 (64.70)	
	P	V	P*V	P	V	P*V	P	V	P*V
S.Em±	1.70	2.95	04.18	1.78	3.09	04.37	1.23	2.14	3.03
C.D. at 5%	5.01	8.67	12.27	5.23	9.06	12.82	3.63	6.29	8.90

percent graft success. Hence, in-situ establishment of orchards using Dandan variety can be followed under North Dry Zone of Karnataka for successful production of ber plants. This method not only ensured better field establishment and uniform plant growth but also reduced the cost and effort involved in nursery raising and transplanting. The findings can be effectively utilized by farmers and horticulturists aiming for large-scale ber cultivation in arid and semi-arid regions.

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