Impact of various rootstocks and grafting techniques on pomegranate (*Punica granatum* L.) growth and survival

ABSTRACT

An experiment was conduct on evaluation of various rootstock of Pomegranate (*Punica granatum* Linn.) was carry out with an analysis to evaluate the Graft compatibility between CV Phule Bhagwa Super and rootstocks of pomegranates (*Punica granatum* L.). The purpose of Phule Bhagwa Super wedge grafting was to evaluate the compatibility of graft in several rootstocks with the hybrid Phule Bhagwa Super. The rootstocks Bedana Suri and Alandi required the shortest amount of time (16.76 days) to sprout buds, according to the data. Bedana Suri had the highest percentage of bud sprouts (79.00%) at 30 days following grafting (DAG).In Bedana Suri, the highest percentage of graft survival (75.66%) at 90 DAG was documented. The Bedana Suri rootstock had the maximum rate of shoot growth. The rootstock Bedana Suri show the most internodes, shoots, and largest shoot length (89.00 cm). Additionally, there was a noticeable increase in shoot and internodal length with regard to time. The maximal girth at graft union (12.05 mm) was measured in bedana suri. The rootstocks with wedge grafting, Ganesh, Bedana Suri, and Kandhari, had the maximum rootstock and scion girth ratio (1.01). Longer shoots and roots, together with the maximum fresh shoot weight (65.40 g) and root weight (38.40 g), were generated with Bedana Suri rootstock. Kandhari has the greatest shoot/root weight ratio (0.77).

KEYWORDS: *Punnica granatum* L., rootstocks, grafting method and budding method, graft and bud success

INTRODOCTION

Pomegranate (*Punica granatum*) is mostly commercially cultivated in India. It is native to Iran (Persia).The pomegranate is belong to the family Lythraceaea. Pomegranate contains high levels of vitamin C .Pomegranate is important fruit crop of arid and semi-arid region. In India it is cultivated in Maharashtra, Karnataka, Gujarat, Rajasthan, Tamil Nadu, Andhra Pradesh, Uttar Pradesh, Punjab and Haryana. Due to its significant economic, nutritional, and medicinal benefits, the pomegranate is the major fruit crops commercially grown on India's Deccan Plateau, has become more well-known globally in recent years (Marathe et al. 2010). In Maharashtra, Karnataka, and Andhra Pradesh, air layering is the primary method of propagation. Pomegranates, in contrast to other perennial fruit crops, frequently use multi-stem training systems (Chandra et al. 2008; Dubey et al., 2021). Wilt has become a significant hazard in India's main pomegranate growing regions recently, and there is currently no acceptable rootstock or conventional grafting/budding strategy to address this issue. According to Reisch et al. (2012), easy of propagation, high graft compatibility with scion types, and soil condition adaptation are important considerations for rootstock selection. Through seedling propagation, tap and secondary root development is possible (Dubey et al., 2022; Das et al., 2024). On the other hand, there is little data on the graft compatibility of various rootstocks with scion kinds in pomegranates through diverse propagation techniques. In order to investigate the most appropriate means of propagation through the use of various rootstocks, the current study on "Evolution of various rootstocks of pomegranate *(Punica granatum* L.)" was carried out (Sunil et al., 2023; Raj et al., 2024) .

MATERIALS AND METHODS

The experiment was conducted between 2023 and 2024 in a 50% green shade net house at Department of Agriculture of Shridhar University, Pilani, Rajasthan. In this experiment randomized block design (Factorial) was used. In this experiment two methods of propagation Wedge grafting method (M_1) and Patch budding method (M_2) and 11 rootstocks Ganesh (R_1), Bedana Suri (R_2), Alandi (R_3), Kandhari (R_4), Jallore Seedless (R_5), Jodhpur Red (R_6), Patna-5 (R_7), Muscat (R_8), Yercaud (R_9), Bedana Sedana (R_{10}) and Daru (R_{11}). Using around 15 cm long, leafless scions of Phule bhagwa super that were 6–9 months old, a total of twenty grafts were used in each of the three replications, which involved 22 treatments. Black polythene (30 x 18") bags containing a 1:1:1:1 mixture of soil, sand, vermicompost, and FYM were used to grow the rootstock. Using a sharp budding knife, a long, smooth vertical cut measuring 4 to 5 cm downward was made. Without causing any harm to the cambium layer, a wedge-shaped scion was put into a vertical slit in the rootstock and secured with a polythene strip. About 3 to 4 cm of similar-sized and shaped bark was cut from the top in order to facilitate budding on the chosen rootstock. The patch was securely fastened into the notch, revealing the bud when a polythene strip was wound around it. Both techniques employed a 3 cm by 15 cm polythene covering with a gauge thickness of 100 to cover the graft scions. The time it took for grafts to sprout from the date of grafting or budding was recorded for each plant, treatment by treatment, and average values were reported. Grafts that demonstrated the development of the scion stick were considered successful. After 30 days of grafting or budding, the percentage of grafted scion that had sprouted was calculated. This was deemed the initial success of the process. The prepared grafts were observed for 60 and 90 days after the grafting/budding process in order to determine the ultimate survival percentage. Following the grafting process, After 180 days, sprouting branches was count up treatment-wise in each replication, and the average number of shoots per plant was noted. The average number of internodes for each treatment and replication 180 days after grafting, shoot length, and internode length per shoot were tallied separately. The information was statistically examined utilizing recognized methods according to Panse and Sukhatme's (1985) guidelines.

RESULT AND DISCUSSION

Days required for sprouting

Table 1 displays the mean number of days needed for graft sprouting. It is evident that propagation techniques (M) and rootstock types (R) have a considerable impact on this data. After taking into account the two-way interaction shown in Table 2, the minimal number of days needed for graft sprouting was found in M1R2 and M1R3 (14.52), then in M1R1 and M1R5 (14.70). Second extra days could have been needed to ensure compatibility and provide the scion with food material for sprouting. The shortest amount of time required for sprouting is correlated with the scion's greater availability of feeding material—that is, the wedge rather than the patch. The shorter time it took for the wedge graft to spout may have been caused by improved cambial layer contact between the scion and stock, which led to early callus development and the start of early subsequent growth. These findings concur with those of Singh and Chaudhari (1984) for grapes and Visen et al. (2010) for guava.

Sprouting and survival percentage

The results in (Table 1) shows that different rootstocks (R) and propagation methods (M) had a substantial impact on the sprouting percentage up to 30 days after grafting. Thirty days after grafting/budding, the interaction effects of different rootstocks and propagation strategies on sprouting showed statistically negligible differences in the grafts' success and survival. Nonetheless, M1R2 showed the highest rate of sprouting (79.00%), followed by M1R1 and M1R5 (75.66%). Days 60 and 90 after grafting and budding, individually were when wedge grafting on Bedana Suri showed the best survival rates (79.00%) and (75.66%). This may be because the longer scion has good callusing ability and the ideal nutritional and hormonal condition. Better graft union healing may be linked to high success of wedge graft rates on 60 and 90 DAG and DAB. Because the wedge graft fully balances the stock and scion, it delivers very high graft success and more stability than conventional grafting procedures in fruit crops (Tabora and Atienza 2006, Selvi et al. 2008, Somkuwar et al. 2009).This outcome is consistent with the findings of Chandra and Jadhav (2012), who said that the highest survival rate of 90.00% was achieved using wedge grafting in pomegranates during the month of January.

Average number of branches that germinate 180 days following budding or grafting

Table 3 shows that the average number of sprouted shoots 180 days after grafting was statistically important for both the propagation method and different types of rootstocks individually, and non-significant differences were observed for the interaction between the propagation method and different rootstocks. Nevertheless, M1R3 had the highest number of shoots (3.59%) numerically (Table 4).

Length of sprouting shoots on average (cm) 180 days following budding or grafting

Table 3 shows that the average length of sprouted shoots 180 days after grafting was significantly affected by both the propagation method and different rootstocks individually, and that the interaction between the two factors resulted in statistically non-significant alterations. Nevertheless, M1R2 recorded the hieghest length of shoots, measuring 89.00 cm. (Table 4). Superior stock and scion union as well as healthier graft union may be the cause of this. The present study's results were at odds with those of Karibasappa (1999), who found that grape shoot length was maximum in chip/patch budding grafts done on September 15.

Internodes on average per plant 180 days following grafting or budding

Table 3 shows the average number of internodes per plant as a function of the propagation method, various rootstocks, and their interactions. Table 4 shows that the largest number of internodes (22.62) per plant was reported in M1R2 180 days after grafting, a statistically significant result. With contrast to patch budding, the heighest number of internodes each plant was seen with wedge grafting method. This might be because wedge grafting produces longer shoots than patch budding method.

180 days after grafting or budding, girth at bud union or graft (mm)

The propagation strategy and several rootstocks' interaction effects were found to be statistically non-significant. M1R2 had the greatest girths at graft or bud union (13.04 mm) (Table 4).

Average weight of new roots 180 days after grafting or budding in grams

Table 5 shows that, on average fresh root weight. While the interactions between the propagation technique and various rootstocks produced statistically non-significant differences, the individual impacts of the propagation method and various rootstocks revealed statistically significant variations. On the other hand, M1R2 (Table 6) recorded the greatest fresh root weight (38.40 g) numerically. Wedge grafting yielded higher fresh root weight records for grafts than patch budding. In Bedana Suri, the highest fresh root weight was measured.

Weight (grams) of average fresh shoot 180 days after grafting or budding

Table 5 shows that the average fresh shoot weight. On the other hand, M1R2 recorded the greatest fresh shoot weight of 65.40 g in numerical terms (Table 6). Wedge grafting yielded higher fresh shoot weight records for grafts than patch budding. In wedge grafting, the increased fresh shoot weight may be related to earlier bud take, which may improve the link between the scion and stock and, as a result, improve water and nutrient uptake. These findings are comparable to those on other fruit crops published by Kayane et al. (1981) and Hamdi et al. (2007).

Ratio of shoot to root weight 180 days following grafting or budding

Table 5 shows that the propagation method and various rootstocks had statistically significant individual effects on the shoot/root weight ratio 180 days after grafting, while the interaction effects of the propagation method and various rootstocks showed statistically non-significant differences. Nevertheless, M1R4 had the maximum shoot/root weight ratio (0.76) recorded numerically (Table 6).

Based on the previously described experiment, it can be inferred that pomegranate has greater graft compatibility. CV Phule Bhagwa Super was discovered using patch budding or wedge grafting techniques on the rootstocks Bedana Suri, Ganesh, Kandhari, Jallore Seedless, and Alandi in order to improve the stionic development and success rate of the grafts.

CONCLUSION

It was discovered that the rootstocks Daru, Jodhpur Red, Jallore Seedless, and Bedana Suri have a moderate resistance to wilt disease and the root-knot nematode. In order to achieve a greater success rate and better stionic development of pomegranate grafts, Phule Bhagwa Super was discovered to have superior graft compatibility with the rootstocks Bedana Suri, Ganesh, Kandhari, Jallore Seedless, and Alandi by wedge grafting or patch budding methods. Therefore, long-term pomegranate wilt control should benefit from the use of wedge grafting/patch budding and moderately resistant rootstocks.

Table 1. Influence of root stocks and grafting techniques on graft survival and sprouting

Treatments	**The number of days needed for sprouting**	**Sprouting % up to 30DAG/DAB**	**Percentage of survival graft**	
			60th day	**90th day**
M1 : Wedge grafting	16.31	72.02	69.29	68.08
M2 : Patch budding	20.64	67.78	65.96	65.96
SEm (±)	**0.24**	**0.72**	**0.55**	**0.69**
CD at 5%	**0.72**	**1.10**	**1.63**	**1.03**
R1 : Ganesh	17.01	74.00	74.00	74.00
R2 : Bedana Suri	16.76	79.00	77.33	75.66
R3 : Alandi	16.76	70.66	69.00	69.00
R4 : Kandhari	17.16	70.66	69.00	69.00
R5 : Jallore Seedless	16.87	74.00	62.33	62.33
R6 : Jodhpur Red	17.24	70.66	67.33	67.33
R7 : Patna	20.62	65.66	62.33	62.33

R8 : Muscat	20.29	70.66	67.33	67.33
R9 : Yercaud	20.32	65.66	62.33	60.66
R10 : Bedana Sedana	20.27	65.66	62.33	60.66
R11 : Daru	20.00	62.32	60.66	59.00
SEm (±)	**0.23**	**0.69**	**0.54**	**0.67**
CD at 5%	**0.69**	**2.01**	**1.56**	**1.94**

DAG-Days after grafting   DAB-Days after budding

Table 2. Influence of root stocks and grafting techniques on graft survival and sprouting

Treatments	**The number of days needed for sprouting**	**Sprouting % up to 30DAG/DAB**	**Percentage of survival graft**	
			60th day	**90th day**
M1R1	14.69	75.66	75.66	75.66
M1R2	14.52	79.00	79.00	75.66
M1R3	14.52	72.32	69.00	69.00
M1R4	14.79	72.32	69.00	69.00
M1R5	14.69	75.66	72.32	72.32
M1R6	14.89	72.32	69.00	69.00
M1R7	18.59	69.00	65.66	65.66
M1R8	18.29	72.32	69.00	69.00
M1R9	18.29	69.00	65.66	62.32
M1R10	18.19	69.00	65.66	62.32
M1R11	19.00	65.66	62.32	59.00
M2R1	19.32	72.32	72.32	72.32
M2R2	19.00	79.00	75.66	75.66

M2R3	19.00	69.00	69.00	69.00
M2R4	19.52	69.00	69.00	69.00
M2R5	19.06	72.32	72.32	72.32
M2R6	19.59	69.00	65.66	65.66
M2R7	22.64	62.32	59.00	59.00
M2R8	22.29	69.00	65.66	65.66
M2R9	22.34	62.32	59.00	59.00
M2R10	22.34	62.32	59.00	59.00
M2R11	22.00	59.00	59.00	59.00
SEm (±)	**0.84**	**2.44**	**1.89**	**2.36**
CD at 5%	**NS**	**NS**	**NS**	**NS**

Table 3. Impact of root stocks and grafting techniques on the average growth characteristics of grafts

Treatments	**Average number of sprouted shoots 180 DAG/DAB**	**Average length of sprouted shoots (cm) 180 DAG/DAB**	**Average number of internodes per plant 180 DAG/DAB**	**Girth at graft/bud union 180 DAG/DAB**
M1 : Wedge grafting	2.95	77.65	2.97	11.07
M2 : Patch budding	0.98	65.17	2.59	10.93
SEm (±)	**0.06**	**1.17**	**0.04**	**0.9**
CD at 5%	**0.20**	**3.37**	**0.14**	**NS**
R1 : Ganesh	2.46	80.00	2.77	11.18
R2 : Bedana Suri	2.29	84.24	3.33	11.95
R3 : Alandi	2.42	76.62	2.92	11.16
R4 : Kandhari	1.89	78.79	3.03	11.27

R5 : Jallore Seedless	1.79	70.74	2.98	11.33
R6 : Jodhpur Red	1.89	67.69	2.69	11.02
R7 : Patna	1.76	63.57	2.59	10.75
R8 : Muscat	1.92	66.69	2.66	10.54
R9 : Yercaud	1.96	66.57	2.52	10.55
R10 : Bedana Sedana	1.89	66.00	2.58	10.71
R11 : Daru	1.49	64.49	2.48	10.56
SEm (±)	**0.06**	**2.77**	**0.11**	**0.08**
CD at 5%	**0.20**	**7.93**	**0.34**	**0.26**

Table 4. Influence of root stocks and grafting techniques on graft growth characteristics

Treatments	**Average number of sprouted shoots 180 DAG/DAB**	**Average length of sprouted shoots (cm) 180 DAG/DAB**	**Average number of internodes per plant 180 DAG/DAB**	**Girth at graft/bud union 180 DAG/DAB**
M1R1	3.52	87.49	2.94	11.23
M1R2	3.06	89.00	3.69	12.04
M1R3	3.59	81.64	3.11	11.24
M1R4	2.72	83.59	3.14	11.35
M1R5	2.59	79.00	3.16	11.38
M1R6	2.72	74.00	2.94	11.03
M1R7	2.72	69.49	2.67	10.87
M1R8	3.06	73.49	2.81	10.62
M1R9	3.19	73.49	2.82	10.57
M1R10	2.92	73.00	2.74	10.77

M1R11	2.39	71.00	2.64	10.63
M2R1	1.39	72.49	2.61	11.13
M2R2	1.52	79.49	2.97	11.85
M2R3	1.00	71.59	2.74	11.08
M2R4	1.06	74.00	2.92	11.18
M2R5	1.00	63.49	2.81	11.27
M2R6	1.06	61.64	2.44	11.01
M2R7	0.79	57.64	2.51	10.62
M2R8	0.79	59.89	2.51	10.46
M2R9	0.72	59.64	2.32	10.52
M2R10	0.86	59.00	2.42	10.64
M2R11	0.59	58.00	2.32	10.49
SEm (±)	**0.24**	**3.92**	**0.16**	**0.32**
CD at 5%	**NS**	**NS**	**NS**	**NS**

Table 5. Effects of grafting techniques and root stocks on shoot weight (g), shoot/root weight ratio, and fresh root

Treatments	**Average fresh root weight (g) 180 DAG/DAB**	**Average fresh shoot weight (g) 180 DAG/DAB**	**Shoot/root fresh weight ratio 180 DAG/DAB**
M_1 : Wedge grafting	57.79	34.78	0.63
M_2 : Patch budding	39.30	30.89	0.25
SEm (±)	**0.62**	**0.34**	**0.01**
CD at 5%	**1.79**	**1.00**	**0.03**
R_1 : Ganesh	53.02	34.05	0.51
R_2 : Bedana Suri	55.9	35.49	0.51
R_3 : Alandi	52.32	33.87	0.51
R_4 : Kandhari	53.02	33.37	0.56

R_5 : Jallore Seedless	51.36	33.67	0.49
R_6 : Jodhpur Red	53.37	33.72	0.54
R_7 : Patna	41.24	30.24	0.33
R_8 : Muscat	43.96	32.19	0.33
R_9 : Yercaud	45.59	31.38	0.42
R_{10} : Bedana Sedana	43.51	32.12	0.33
R_{11} : Daru	41.49	31.9	0.30
SEm (±)	**0.59**	**0.32**	**0.01**
CD at 5%	**1.71**	**0.95**	**0.03**

Table 6. The impact of grafting techniques and root stocks on the weight of new roots and shoots

Treatments	**Average fresh root weight (g) 180 DAG/DAB**	**Average fresh shoot weight (g) 180 DAG/DAB**	**Shoot/root fresh weight ratio 180 DAG/DAB**
M1R1	62.86	36.66	0.69
M1R2	65.39	38.39	0.68
M1R3	60.00	35.76	0.65
M1R4	61.52	34.26	0.76
M1R5	59.52	35.59	0.64
M1R6	62.59	36.12	0.70
M1R7	51.00	32.69	0.53
M1R8	54.32	34.39	0.55
M1R9	54.00	33.44	0.59
M1R10	53.49	32.66	0.61
M1R11	51.00	32.66	0.53
M2R1	43.19	31.44	0.35

M2R2	44.79	32.59	0.35
M2R3	44.66	32.00	0.37
M2R4	44.52	32.49	0.35
M2R5	43.19	31.74	0.34
M2R6	44.14	31.32	0.39
M2R7	31.49	27.79	0.12
M2R8	33.59	30.00	0.11
M2R9	37.19	29.32	0.25
M2R10	33.52	31.59	0.05
M2R11	32.00	29.52	0.07
SEm (±)	**2.08**	**1.16**	**0.04**
CD at 5%	**NS**	**NS**	**NS**

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