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Comparative performance of different grafting techniques in grape cv. Pusa Urvashi

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ABSTRACT

Rootstocks have become a major component in present day viticulture. Till date, there are several rootstocks evolved of which some have become commercial in many advanced countries. Different types of grafting and budding methods have been tried in grape with varying success rates. Hence, to standardize the same for Pusa Urvashi, different rootstocks (Dogridge A, Salt Creek, 1613 and H-144) involving different grafting methods (wedge, side and bench grafting) were tried. The grafting factors like month (February, March and August) and grafting height (15, 30 and 45 cm) were standardized using one-year-old rootstocks under glasshouse conditions. The highest graft take success was registered in wedge followed by side in all the three months, while for bench grafting, the highest graft take was recoded in the month of February. The graft take was the maximum at the height of 30 cm, while the minimum was noted at 15 cm. Of the three grafting months, February was found the best with respect to percentage graft success and survival. Dogridge A as rootstock was proven most compatible with Pusa Urvashi as compared to other rootstocks.

Key words: Grafting technique, grape, rootstocks, season.

INTRODUCTION

Grape (*Vitis vinifera* L.) is one of the most important fruit crops of the world owing to its fine fruit quality and varied uses. It is also favoured for being a good source of minerals and vitamins. With the global climate change, grape cultivation in newer as well as conventional areas is under the threat of unfavorable growing conditions including soil. Soil-borne diseases and nematodes are the other maladies, which severely hamper the production. In such situations, propagation through conventional means, *i.e.* cuttings needs to be replaced with some other vegetative propagation methods like grafting and budding to produce composite plant (scion on rootstock). In composite plants, stionic influence helps in exploiting the desired /needed vigour and tolerance against different biotic and abiotic stresses, which is turn, enhances the productivity and vitality of the vine. For these considerations, standardization of grafting technique using Pusa Urvashi as a scion cultivar was attempted.

MATERIALS AND METHODS

The studies were conducted at the Division of Fruits and Horticultural Technology, IARI, Pusa, New Delhi. One-year-old cutting derived plants of uniform size and vigour in four rootstocks namely Dogridge A, Salt Creek, 1613 and H-144 were selected for grafting. The scion stick was taken from the Pusa Urvashi vines maintained in the germplasm block. Three grafting methods, namely wedge, side and bench (wedge) and three month of grafting, *i.e.* February, March and August were selected for the study. Grafting was performed at the different heights, *i.e.* 15, 30 and 45 cm. The grafts were maintained under glasshouse conditions. The experiment was laid out in Factorial Block Design with three replications. The data on bud sprouting was recorded and the average time taken for a bud to sprout from the date of grafting was worked out and expressed in days. Data on vegetative growth and success percentage were recorded 120 days after grafting. The internodal length and sprout diameter were measured between fifth and sixth nodes on the selected grafted vines. Leaf area was computed by tracing the leaf boundary on a square paper sheet and expressed in cm^2 per vine. Girth of stock and scion were recorded 5 cm above and below the graft union point, respectively and stock-scion ratio was calculated. The length of sprout was measured from the graft point up to the highest point of growth and the number of leaves was also counted.

RESULTS AND DISCUSSION

The graft take percentage as influenced by different rootstocks was significant, irrespective of grafting heights and techniques during the entire

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experimentation period (Tables 1, 2 & 3). The highest graft take (66.08, 46.02 and 68.06% during February, March and August, respectively) was observed on Dogridge A rootstock, while least (52.76, 35.18 and 52.09% during February, March and August, respectively) was recorded for H-144 followed by Pusa Urvashi on its own roots (60.32, 39.31 and 60.66% during February, March and August, respectively). All the rootstock genotypes showed superiority over control, *i.e.* own rooted Pusa Urvashi except H-144.

From the experimental results, it was evident that grafting was successful during February, irrespective of stionic combination compared to August or March. This specificity in success is expected to be directly associated with growth stage of mother and/or stock plants. Furthermore, the prevailing weather conditions also are known to influence the graft take, irrespective of propagation methods. Unlike rest of the period of experimentation, during August only two grafting techniques, *i.e.* wedge and side were tried. Bench grafting did not perform well during this month because the vines were in active vegetative growth. In the present investigation it was also showed that the percentage success of particular grafting technique was associated with the existing weather factors, i.e. temperature, relative humidity and growth stage of the stock plant. This result is in conformity with that Chandel *et al.* (4) who also observed January and February to be ideal time for grafting grape and kiwifruit. Under sub-tropical conditions, during these months, sprouting takes place and the vine achieve certain degree of maturity to give good graft success. Likewise, several workers found differences in success with regard to grafting success in different geographical regions. Click (5) reported August and September as ideal time for grafting grape in Turkey.

Grafting height had a marked effect on graft take success since the tissue age in both partners has to match with each other. Furthermore, it is important that the height should sufficiently be enough so that it may not interfere in the performance of plant in the later stages. In the present study, marked differences in success were noted due to grafting at different heights. Irrespective of grafting techniques, time and genotypes, the maximum graft take percentage was found at 30 cm height, while minimum was recorded at 15 cm (Tables 1, 2 & 3). For better agronomic performance, an ideal height is one, which avoids infection due to soil-borne pathogens and is also easy to perform. The rootstock height of 30 cm was adjudged ideal, irrespective of grafting techniques, compared to 45 and 15 cm height. Blanco (3) in pear cultivars budded at 15 and 50 cm height was successful when planted with graft union at 10 and 50 cm above soil surface showed that the scion trunk cross sectional area was smaller on the high worked trees. Furthermore, stock area at soil level was also smaller on the high budded trees.

The stionic combination had pronounced influence with respect to days to bud sprouting. Earliest bud sprout (19.25 days) was noted in Pusa Urvashi (control) as rootstock, which may be due to early bud union and existing conducive environmental conditions in glasshouse (Table 4). Similar findings have been reported by Prakash and Reddy (16) who also recorded early bud break on Gulabi rootstock but delayed bud break on Dogridge under Maharashtra conditions. In another experiment conducted at NRCG, earliest sprouting time (14.57 days) was recorded on Dogridge A followed by Dogridge B and 110 R (Anon, 1). Dogridge A also gave the highest stock-scion ratio (0.89) and other conducive factors responsible for successful graft union. It is an established fact that optimum temperature regime cause high cell activity at the union point and thus early vascular connection (Hartmann *et al*., 11).

Shoot length was longer in certain stionic combinations and also the growth rate varied considerably. The maximum shoot length was noted on the rootstock Dogridge A, while minimum with H-144 (Table 4). This finding is in agreement with the earlier observation that the total vine length on Dogridge A was more as compared to Dogridge B and 110 R (Anon, 1). The differences could be directly attributed to the early callusing followed by successful vascular connection union and restoration of normal metabolic activities. These differences in growth rates may be attributed to the differences in scion and rootstock genotypes. Hence, graft take was found to vary with different factors, suggesting interaction of all ideal or optimal levels resulting into maximum success. Fouad *et al.* (8) studied the effect of MM 111, MM 106 and M 9 rootstocks on the growth of 'Anna' apple and observed that the shoot length was the highest on MM 111.

Internodal length was found higher on rootstock Dogridge A followed by 1613 and Salt Creek (Table 5). The variation in internodal length can be expected due to the genotypic effects of the rootstocks. Earlier, Reddy (16) reported that the internodal length of the grafted plant is directly associated with vigour of the plant. Recently, Saeleznyova *et al.* (17) reported that apple rootstock M 9 reduced the number of nodes per extension growth unit in different scion cultivars. In most cases, rootstock/inter-stock combination had no effect on the linear relationship between extension growth unit length and node number. Average internode length depends on unit node number with internodes being shorter for units with fewer nodes.

Table 1. Effect of rootstock genotype, grafting height and technique on graft take (%) during February.

Rootstock	Wedge				Side				Bench (Wedge)				Grand mean
GH (cm)	15	30	45	Mean	15	30	45	Mean	15	30	45	Mean	
Dogridge A	92.82	96.76	88.57	92.72	52.50	62.13	57.36	57.33	42.68	59.29	42.63	48.20	66.08
	(74.51)*	(69.67)	(70.28)		(46.46)	(52.05)	(49.26)		(40.81)	(44.62)	(40.70)		
Salt Creek	86.20	90.40	82.85	86.48	49.59	60.63	62.05	57.42	36.68	47.02	42.91	42.20	62.03
	(68.23)	(72.00)	(65.57)		(44.89)	(51.16)	(52.00)		(37.29)	(43.33)	(40.94)		
1613	87.46	92.67	84.33	88.15	59.58	78.55	70.61	69.58	39.37	45.80	34.77	39.98	65.90
	(69.31)	(74.35)	(66.72)		(50.55)	(62.44)	(57.20)		(38.88)	(42.61)	(36.15)		
H-144	76.70	78.76	73.70	76.39	41.56	54.02	54.52	50.03	29.68	33.40	32.53	31.87	52.76
	(61.17)	(62.60)	(59.18)		(40.16)	(47.33)	(47.61)		(33.02)	(35.32)	(34.77)		
Own root	78.83	83.37	78.38	80.19	64.44	70.79	60.18	65.14	25.37	33.96	47.54	35.62	60.32
	(62.64)	(65.96)	(62.31)		(53.42)	(57.32)	(50.90)		(30.26)	(35.66)	(43.61)		
Mean	80.40	88.39	81.57	84.79	53.53	65.22	60.94	59.90	34.76	43.89	40.08	39.58	-

*Transformed values; GH = Grafting height

CD at 5%

Genotype (G)	= 1.40
Method (M)	= 1.81
G × M	= 3.13
Grafting height (H)	= 1.40
G × H	= 2.42
M × H	= 3.13
G × M × H	= 5.42

There were marked variations in the leaf number and leaf area due to the influence of rootstock used for grafting. Slight increment in leaf number and area may be due to the genotypic influence of the rootstocks. The highest number of leaves was recorded on rootstock Dogridge A, while maximum leaf area was on 1613 (Table 4). It is a well proven fact that vigorous rootstocks influence scion length, inter-stock length and leaf area of the composite plants (Hartmann *et al.*, 11). Chandel (4) did not find much difference in the leaf area of apple trees grafted on different rootstocks, except the plants on M 25, which showed larger leaved rootstock on M 9. Sharma (18) studied the rootstock effect on Red Delicious and Royal Delicious varieties due to M 7 or MM 106. Very meagre differences were observed with regard to leaf area. Gangwar *et al.* (9) studied the compatibility behavior of a plum rootstock with peach scions. They reported that vegetative characters, *viz*., total number of leaves and leaf area were highest in the stionic combination Flordasun/ Kala Amritsari.

Apart from other growth factors, girth of scion and rootstock also showed considerable variation, which varied with stionic combination. The scion and rootstock diameter both were found maximum with rootstock 1613 followed by Salt Creek. The minimum scion diameter was recorded for the rootstock Pusa Urvashi on its own roots while, with respect to rootstock diameter, the least value was registered with Dogridge A (Table 4). These variations in rootstocks could be due to the their genotypic constitution. Fouad *et al.* (8) studied the effect of MM 111, MM 106 and M 9 rootstocks on the growth of 'Anna' apple observed that scion diameter was highest on MM 111 and the least on M 9. Later, Corino *et al.* (7) evaluated trunk diameter of grape cv. Pinot Noir grafted onto 41 B and SO4 rootstocks. They also observed that stock diameter of 41 B was superior as compared to SO4.

Another important parameter with regard to longevity of composite plants is ratio of stock and scion diameter as wide variation from unit ratio leads to bottleneck symptoms owing to differences in growth of scion and rootstock. An extreme may even lead to delayed incompatibility; hence, it is important to calculate the ratio for any stionic combination. In the present study, the maximum stock/scion ratio was recorded with rootstock Dogridge A followed by Salt Creek. The minimum value was noted for the rootstock Pusa Urvashi on its own roots (Table 4). The variation in stock/scion ratio may be due to genotypic differences and stionic combination. Tamble and Gawade (20) studied the influence of rootstock on vigour of the grapes and reported that the interaction effects between rootstocks and varieties had significant influence on girth of scion and stock. Earlier, highest scion : rootstock ratio was obtained when grape cv. Tas-e-Ganesh was grafted on Dogridge A while, on 1613 showed inverted neck symptoms registering lower ratio (Anon, 1). Similar findings were also reported by Tamble and Gawade (20) in grape when Tas-e-Ganesh was grafted on to Dogridge A. While, Harish *et al.* (10) studied the compatibility of citrus cvs. Lahore Local and Nagpur mandarin on different rootstocks and found that the stock/scion ratio in all stionic combinations revealed incompatibility symptoms. This may be due to lack of graft union crease formation at grafting point or due to wide variation in growth ratio of the two graft partners.

The grafting success was recorded maximum with rootstock Dogridge A followed by 1613 and Salt Creek. Khilli *et al.* (12) reported that callusing followed by vascular connectivity is absolutely necessary for any graft success, thus helping in higher success percentage. The findings of present study corroborates with the studies carried out at NRC for Grapes (Anon, 2) as Dogridge A gave the maximum success with Thompson Seedless. Likewise, Nissar *et al.* (14) studied the performance of different stone fruits (peach, plum, apricot and almond) on different peach rootstocks. They observed maximum success percentage when plum was budded on peach rootstocks while, least with apricot on peach.

From the present work, it can be concluded that of the different grafting methods and other factors studied, wedge grafting performed at the height of 30 cm during the month of February exhibited better performance compared to side and bench grafting in terms of graft take percentage and other vegetative growth parameters.

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Table 2. Effect of rootstock genotype, grafting height and technique on graft take (%) during March.

Rootstock	Wedge				Side				Bench				Grand mean
GH (cm)	15	30	45	Mean	15	30	45	Mean	15	30	45	Mean	
Dogridge A	56.58	66.72	58.94	60.75	38.69	49.75	42.17	43.54	32.74	34.93	33.60	33.76	46.02
	(48.81)*	(54.80)	(51.14)		(38.48)	(44.83)	(40.51)		(34.91)*	(36.25)	(35.44)		
Salt Creek	50.98	51.16	49.46	50.53	36.15	44.53	48.81	43.16	24.10	29.43	29.07	27.53	40.41
	(45.59)	(45.69)	(46.61)		(36.98)	(41.84)	(47.26)		(29.41)	(32.87)	(32.65)		
1613	54.58	58.82	55.38	56.26	46.06	47.02	43.83	45.64	30.29	33.08	32.78	32.05	44.65
	(47.66)	(50.11)	(50.44)		(42.75)	(43.31)	(41.47)		(33.51)	(35.12)	(36.28)		
H-144	43.92	45.43	40.58	43.31	31.53	38.45	39.45	36.48	24.45	27.37	25.46	25.76	35.18
	(41.53)	(42.40)	(40.78)		(34.17)	(38.34)	(38.93)		(29.65)	(31.56)	(30.32)		
Own root	47.60	47.82	42.42	45.95	32.89	35.96	36.84	35.23	33.88	37.71	38.65	36.75	39.31
	(43.65)	(43.77)	(41.95)		(35.010	(36.86)	(37.39)		(35.62)	(37.90)	(38.46)		
Mean	49.36	53.99	50.73	51.36	37.06	43.14	42.22	40.81	29.09	32.50	31.91	31.17	_

* Transformed values; GH = Grafting height

CD at 5%

Genotype (G)	= 1.50
Method (M)	= 1.16
G × M	= 2.60
Grafting height (H)	= 1.16
G × H	= 2.01
M × H	= 2.60
G × M × H	= 4.51

Table 3. Effect of rootstock genotype, grafting height and technique on graft take (%) during August.

Rootstock	Wedge				Side				Grand mean
GH (cm)	15	30	45	Mean	15	30	45	Mean	
Dogridge A	72.36	80.62	76.40	76.46	53.39	63.29	62.28	59.65	68.06
	(58.31)*	(63.91)	(60.97)		(46.97)	(52.74)	(52.14)		
Salt Creek	58.67	67.64	67.48	64.60	63.10	71.50	68.85	67.82	66.21
	(50.02)	(55.36)	(55.26)		(52.62)	(57.76)	(56.10)		
1613	65.21	73.83	70.71	69.92	49.52	57.32	54.40	53.75	61.84
	(53.88)	(59.26)	(57.27)		(44.34)	(49.24)	(47.55)		
H-144	50.44	56.57	58.60	55.20	44.87	54.25	47.81	48.98	52.09
	(45.27)	(48.80)	(49.98)		(42.07)	(47.46)	(43.77)		
Own root	70.46	77.43	68.56	72.15	44.80	52.24	50.48	49.17	60.66
	(57.11)	(61.67)	(55.92)		(42.04)	(46.31)	(45.00)		
Mean	63.43	71.22	68.35	67.67	51.14	59.72	56.76	55.87	_

*Transformed values; GH = Grafting height

CD at 5%

Genotype (G)	= 2.32
Method (M)	= 1.47
Grafting height (H)	= 1.80
G × M	= 3.29
G × H	= 2.55
M × H	= 4.03
G × M × H	= 5.69

Table 4. Effect of stionic combinations on vegetative growth characters of cv. Pusa Urvashi.

Rootstock	Sprouting time (days)	Shoot length (cm)	Internodal length (cm)	No. of leaves/shoot	Leaf area/ shoot (cm^2)	Scion dia. (cm)	Stock dia. (cm)	Stock/scion ratio
Dogridge A	23.50	100.35	4.02	59.00	105.70	0.48	0.55	0.89
Salt Creek	21.61	88.03	3.69	55.00	114.00	0.54	0.63	0.86
1613	22.54	79.34	3.90	43.00	125.74	0.58	0.69	0.85
H-144	24.51	72.35	3.02	38.33	100.55	0.46	0.57	0.80
Own root	19.25	90.34	3.50	41.00	82.24	0.42	0.55	0.76
Mean	22.88	86.08	3.63	47.27	105.65	0.50	0.60	0.83
CD at 5%	2.20	6.17	NS	2.13	8.06	0.07	0.09	0.07

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