Evaluation of different grape (Vitis sp.) rootstocks for North Indian conditions

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Abstract: Viticulture in North India is suffering from different problems, of which termite and salinity are the major causes for decline of vineyards. This is mainly due to extensive use of the self-rooted plant materials. Therefore, it is now felt that viticulture in the region should include rootstock based composite plants so that the vineyard life is more and the plants can endure biotic and abiotic stresses more efficiently. Keeping this point in view, an experiment was conducted to evaluate the different grape rootstock genotypes for their suitability as potential rootstocks for the different scion cultivars. The performance of ten rootstocks *viz.*, Dogridge A, Dogridge B, Salt Creek, 1613, 1616, St. George, SO4, 1103 P, Teleki 5A and H-144 were evaluated on the basis of different vegetative growth parameters such as total shoot length, shoot growth rate, total number of leaves/sprout, leaf characters and root characters. The rootstocks, Dogridge A, Salt Creek and 1613 performed better in comparison to others tried for different parameters.. The final survival of different grape rootstocks under nursery conditions was the maximum in Salt Creek followed by 1613 and Dogridge A.

Keywords: Evaluation, grape, rootstocks.

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1. Introduction

Grape (*Vitis vinifera* L.) is one of the commercially most important fruit crops of the world owing to its excellent fruit quality and also being a good source of minerals and vitamins (Creasy, 2018). In India, grape is grown in diverse climatic conditions ranging from tropical, sub-tropical to temperate regions. The major grape growing states are Karnataka, Telangana, Andhra Pradesh and Tamil Nadu in the South, Maharashtra in the West and Punjab, Haryana and Uttar Pradesh in the North (Nimbolkar *et al*., 2016a). In India, commercial grape cultivars are largely grown on their own roots, as they are propagated by rooted hardwood cuttings (Adsule *et al*., 2012). However, with the reports of declining yields in Anab-e-Shahi, Thompson Seedless, Gulabi and Bangalore Blue due to abiotic (soil & water salinity and drought) and biotic (termites and nematodes) stresses in the peninsular Indian states, the need for adopting resistant rootstocks was suggested (Somkumar and Adsule, 2004). Such stresses have been one of the reasons for the decline in area under grape in other parts of the country like Punjab and Haryana as well (Somkuwar *et al.*, 2014). Lately, it has been realized that rootstocks play an important role to overcome biotic as well as abiotic problems of salinity, drought, poor fruiting, nematodes *etc*. (Chadha, 2008). Rootstock Salt Creek has been found tolerant to salinity, while Dogridge has twin advantages of being tolerant to salinity and drought both. Nematode resistant rootstock 1613 has been found to be well compatible with Anab-e-Shahi, while Dogridge is now commercially exploited to raise scions of Thompson Seedless in Maharashtra (Nimbolkar *et al*., 2016a). Due to the prevailing adverse edaphic and biological constraints depending upon the ecological regions, use of rootstock for the establishment of vineyards is gradually becoming imperative and as a result, the use of rootstock has remarkably increased for commercial grape production in India (Adsule *et al*., 2012). However, a rootstock proven to be advantageous for one scion cultivar may not be universally beneficial for others (Sathisha *et al*., 2010). In this perspective, there is a pressing need for identifying an alternative rootstock(s) (Somkuwar *et al*., 2014), especially, for North Indian conditions. Further, to cater the demand of planting materials, the planting material should have the ability for efficient rooting, survival and growth (Somkuwar *et al*., 2017). Therefore, the need for conducting a rootstock trial in grape was felt in view of the problems encountered by the grape industry in India as enumerated already using some of the available rootstocks based on their growth performance. For this consideration, the present investigation was carried out.

2. Materials and methods

The present investigation was conducted at the Division of Fruits and Horticultural Technology, ICAR-IARI, Pusa, New Delhi. The ten rootstocks *viz.*, Dogridge A, Dogridge B, Salt Creek, 1613, 1616, St. George, SO4, Teleki 5A and H-144 were used for evaluation. These rootstock genotypes were evaluated on the basis of different growth parameters such as days to sprouting time, shoot length, shoot growth rate, number of leaves/shoot, internodal length, shoot diameter, leaf and root characters. Observations on bud and root sprouts were recorded at regular intervals. The data on days to bud and root sprout were noted. Data on vegetative growth and success percentage were recorded at 120 days after shoot sprout and rooting. The shoot length was measured from the bud sprouting point up to highest point of growth and total number of leaves on the same sprout was also counted. The internodal length and diameter of shoot was measured between fifth and sixth nodes of the selected vines and the leaf area was computed by tracing the leaf boundary on a square paper sheet and expressed in cm^2. The leaf length and width ratio was also to determine the leaf shape. The leaf morphology was studied with the help of botanical taxonomic descriptors. The rootstock canopy volume was determined by using Vernier callipers. The shoot growth rate was calculated at 30 day intervals after bud sprout and expressed as percentage increase over the previous reading.

$$\text{Shoot growth rate (\%)} = \frac{\text{Final growth} - \text{Growth at previous interval}}{\text{Duration}} \times 100$$

The experiment was laid out in completely randomized block design with three replications comprising 50 cuttings per genotypes in each replication.

3. Results

Sprouting time: Nature of vegetative growth is the basic characteristics of any plant/groups to identify their growth habit as vigorous, moderately vigorous or slow growth. The rootstocks 1103 P and Teleki 5A gave earlier bud sprout, closely followed by SO4. Dogridge A, Dogridge B and Salt Creek were late in bud sprouting (Table 1). The variation in bud sprouting time might be due to genotypic effect of the rootstocks. Earlier, comparative performance of different rootstock genotypes was also carried out by Satisha *et al.* (2010) and Somkuwar *et al.* (2014).

Bud sprouting percentage: Bud sprouting percentage was observed to be the highest in rootstock Salt Creek followed by 1613 and Dogridge A. The least bud sprouting was noted in rootstock Teleki 5A followed by 1616 and 1103 P (Fig. 1). This result is in agreement with the earlier findings of Eris and Celik (1981). Earlier, Muhammad *et al*. (2003) also found that the number of bud sprouting in peach rootstock may be due to sufficient food material already been stored in the cuttings, which was utilized for early bud sprout. The stored food material available in shoot plays an important role in propagation success in grape (Somkuwar *et al.,* 2017). Liu and Sherif (2019) had reported that in certain species, schlerenchymatous tissues surrounding the vascular tissue prevent the emergence of root/shoot initials. Alternatively, the endogenous level of the hormones might have been sufficient for initiating bud sprout or the endogenous growth inhibitors were at minimum levels to facilitate bud sprouting.

Shoot length: The maximum shoot length was produced by rootstock Dogridge A followed by 1613 (Table 1). This increased shoot length might be due to early bud sprout and also due to high levels of food reserve (Somkuwar *et al.,* 2017). Satisha *et al.* (2012) suggested that the early bud sprout and increased vigour through shoot length in cuttings of the rootstock may be attributed to the increased polyphenol oxidase activity in their buds. Similar, finding was also reported by Bhujbal (1993) who had evaluated performance of five grape rootstocks for vigour and graft success. He reported rootstock SO4 to be more vigorous in nature compared to other rootstocks.

Shoot growth rate: The shoot growth rate varied considerably among the genotypes at different duration post-bud sprouting. The growth rate at 0-30 days after bud sprouting was found to be increasing and thereafter declining from 30-60 days after bud sprouting. The shoot growth rate was the highest during 30-60 days (Fig. 2). Based on this character, the above genotypes could be proved to be vigorous and semi-vigorous types.

Number of leaves per vine and intermodal length: The number of leaves sprouted per vine showed marked variation amongst the rootstock genotypes. The highest number of leaves was recorded for the rootstock Dogridge A followed by 1613 and Dogridge B (Table 1). The variation in leaf number might be due to genotypic effects. Internodal length was also found maximum in rootstock Dogridge A followed by Salt Creek and 1613 (Table 1). The variation in internodal length is also due to genotypic effects and may be directly associated with vigour of the scion variety upon grafting (Reddy, 1987).

Shoot diameter: Apart from other parameters studied, shoot diameter also showed considerable variation in the ten rootstock genotypes. These variations could be due to genotypic effect (Somkuwar *et al.,* 2017). Earlier, Stafne and Carroll (1994) and Prakash and Shikhamany (1995) also noted genotypic variation for this character in grape rootstocks. The maximum shoot diameter was recorded with rootstock Dogridge A followed by Salt Creek, which was at par with rootstock H-144 (Table 1). Earlier, Prakash and Shikhamany (1995) also reported Dogridge A to be a vigorous rootstock.

Leaf area per shoot and length/width ratio: Leaf area and length/width ratio also showed marked variation in the rootstocks. Increment in leaf area and L/B ratio might be due to genotypic influence of the rootstocks. The maximum values were found for 1613 (Table 1). It is a well established fact that vigorous rootstocks influence leaf area and scion length (Hartmann *et al.,* 2002).

Leaf morphology: The leaf morphology of ten rootstocks was recorded at 120 days after planting of cuttings (Table 2). The lobes were found undivided in some of the rootstocks namely Dogridge A and 1103 P, while in most of the rootstocks three lobes were present. The shape of petiole sinus in almost all the rootstocks was wide open, while in Dogridge B it was deep and U shaped. The rootstock Dogridge A had broad and shallow petiole sinus, while in rootstock H-144 it was closed. Shape of the teeth in most of the rootstocks was noted on both was side concave. On rootstocks SO4 and H-144 both sides were straight, while Dogridge B had no teeth. Pubescence on abaxial surface was absent in rootstocks Dogridge A, St. George, SO4 and 1103 P. The pubescence on petiole was absent in rootstocks St. George and 1103 P. Of the ten rootstocks used in the experiment, the leaf serration was present on all except Dogridge B. The findings of present study corroborates with the studies carried out at NRC on Grapes (Anon., 2004) when two clones of Dogridge with different leaf morphological characters were studied and were reported to be the two variants and were totally different from each other. The leaf shape of Dogridge A was reniform, while it was cordite in Dogridge B. The leaf texture of Dogridge A was smooth, while in Dogridge B it was rough. The leaf pubescence in Dogridge A was glabrous, while it was light in Dogridge B.

Root characters: The mechanism of rootstock species to overcome drought conditions is well understood. Root characters in term of number of primary and secondary roots, root length and diameter help in overcoming drought by absorbing more water from deeper layers of soil. Adequate root development is therefore, very essential for the good health of plants as well as well production of quality produce (Nimbolkar *et al*., 2016b).

Days to rooting: The rootstocks SO4 and 1103 P were earliest to root closely followed by St. George. Dogridge A, Dogridge B and Salt Creek were late in rooting (Table 3). The variation in rooting time might be due to genotypic effect (Satisha *et al.*, 2010). Earlier, Prakash and Shikhamany (1995) studied the comparative performance of some rootstock genotypes. They reported those rootstocks St. George and 1613 graft and root well while, Dogridge and Salt Creek root with difficulty. Earlier, Chapman and Hussey (1980) had also reported that rootstocks Dogridge and Salt Creek (Ramsay) were difficult to root.

Number of primary and secondary roots: The maximum number of primary and secondary roots was recorded in rootstock Salt Creek. The number of primary roots was also high in H-144, while number of secondary roots was in Dogridge A (Table 3). Daulta and Chauhan (1980) recorded the maximum number of roots with Thompson Seedless. Similarly, Bhujbal (1993) recorded the maximum number of main roots on rootstock Dogridge A. Gracia *et al.* (2001) reported that the time for optimum root production July in both own-rooted and grafted apple trees.

Root length and root diameter: The maximum length in root was noted with rootstock H-144 followed by Dogridge A and Salt Creek while; root diameter was recorded the highest with rootstock 1613 followed by Salt Creek (Table 3). Similar, conformity was given by Singh *et al.* (1986). With regard to root length and diameter, Bhullar *et al.* (1977) made similar observations on three-year-old Perlette grapevines. The rootstock 1103 P was significantly superior with respect to root length and root diameter compared to other rootstocks. Bianco *et al.* (2003) reported that apple trees on less vigorous M 9 rootstocks showed less stem and root growth since they produced fewer and/or shorter shoots and fewer and/or shorter and thinner roots.

Rooting percentage: The highest rooting per cent was recorded for the rootstock Salt Creek followed by 1613 (Table 3). Similar, findings were also proposed by Saroj and Prakash (1997) who also found 1613 to give high rooting as compared to other rootstocks. This finding suggested that grape cuttings contain some inhibitors, which are also responsible for variation in rooting. Further, rooting ability of cuttings differs with the species, Indole-3-butyric acid concentration, C:N ratio and biochemical composition of the mother vines (Satisha *et al*., 2007; Somkuwar *et al.*, 2017). Bhujbal (1993) recorded the maximum rooting for rootstock 1103 P. Kracke *et al.* (1981) reported that the rooting percentage of cuttings after 45 days was the highest in Kober 5 BB than 140 Ruggeri. They suggested that in rootstock 140 R cuttings (hard-to-root), little IAA was detected, but relatively high amount of GA- and ABA-like compounds, which are considered to be root inhibitors. A contrasting situation was noted in Kober 5BB rootstock (easy-to-root). The cuttings have shown very high IAA activity and low acid GA- and ABA-like inhibitors.

Final survival percentage: The final survival of different grape rootstocks under nursery conditions was the maximum in Salt Creek followed by 1613 and Dogridge A (Graph 3). The variation in final survival may be due to genotype effects of the rootstocks. Earlier, Baghel and Sarawat (1999) also got the maximum survival for hard-wood cuttings in pomegranate and attributed it to higher reserve status. It is a known fact that because of ontogenic maturity and thickness, hard-wood cuttings contain higher amount of food reserves compared to semi-hard wood cuttings. Similar, finding was also reported by Singh *et al.* (1986) in grape. Carbohydrates stored in cane indicates health and vigour of vine during growth period (Somkuwar *et al*., 2011).

The vegetative growth plays an important role in securing higher vigour of rootstock genotypes, which ultimately decides their fate during propagation through cuttings. Higher vigour leads to high food reserve in cuttings, which attains a pivotal position while rooting and survival (Somkuwar *et al*., 2011; 2017). This holds significance for this investigation as well as the results of the present study suggest that the rootstock Dogridge A followed by Salt Creek and 1613 were superior in terms of growth and root characters under North Indian conditions.

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Table 1. Vegetative growth characters of some grape rootstocks

Rootstock	Sprouting time (days)	Shoot length (cm)	Internodal length (cm)	Shoot diameter (cm)	Number of leaves/vine	Leaf area/shoot (cm^2)	Leaf L/B ratio
Dogridge A	29.39	96.22	3.80	0.39	53.00	106.04	0.95
Dogridge B	28.25	82.61	3.68	0.39	48.50	110.04	0.98
Salt Creek	28.00	71.54	3.72	0.38	43.46	112.51	0.92
1613	24.36	86.58	3.73	0.32	50.31	126.65	0.98
1616	26.45	68.84	3.50	0.34	38.93	90.33	0.85
St George	22.60	78.82	3.41	0.31	40.80	85.47	0.87
SO4	21.25	75.00	3.53	0.32	40.13	81.59	0.75
1103 P	20.46	63.47	3.70	0.34	32.14	72.06	0.81
Teleki 5A	20.50	67.60	3.61	0.33	35.26	122.63	0.80
H-144	24.76	81.03	3.09	0.39	40.57	110.37	0.90
Mean	24.60	77.17	3.58	0.35	42.31	101.77	0.88
CD at 5%	0.77	1.22	NS	NS	1.84	7.70	NS

Table 2. Leaf morphology of some grape rootstocks

Rootstock	Number of lobes/leaf	Shape of petiole sinus	Shape of teeth	Pubescence on abaxial surface	Pubescence on petiole	Serration on leaf margin
Dogridge A	Undivided	Broad and shallow	Both side concave	Absent	Present	Present
Dogridge B	Three	U shape and deep	No teeth	Present	Present	Absent
Salt Creek	Three	Wide open	Both side concave	Present	Present	Present
1613	Three	Wide open	Both side concave	Present	Present	Present
1616	Three	Wide open	Both side concave	Present	Present	Present
St. George	Three	Wide open	Both side concave	Absent	Absent	Present
SO4	Three	Wide open	Both side straight	Absent	Present	Present
1103 P	Undivided	Wide open	Both side concave	Absent	Absent	Present
Teleki 5A	Three	Wide open	Both side concave	Present	Present	Present
H-144	Three	Closed	Both side straight	Present	Present	Present

Table 3. Root characters of some grape rootstocks

Rootstock	Days to rooting	Number of primary roots	Number of secondary roots	Root length (cm)	Root diameter (cm)	Rooting (%)
Dogridge A	44.83	18.78	70.00	37.4	0.48	85.32 (67.50)*
Dogridge B	44.12	18.18	68.56	29.30	0.55	88.52 (70.23)
Salt Creek	42.12	19.27	72.58	36.75	0.52	91.24 (72.99)
1613	36.05	17.83	65.17	32.17	0.56	90.48 (72.03)
1616	38.06	12.50	57.67	30.17	0.45	82.5 (65.30)
St. George	31.83	11.42	61.40	28.29	0.46	78.5 (62.41)
SO4	30.83	13.18	63.33	26.70	0.41	72.67 (58.51)
1103 P	31.61	10.00	53.44	35.31	0.43	71.33 (57.66)
Teleki 5A	32.42	11.47	51.39	26.95	0.42	75.17 (60.14)
H-144	38.26	18.32	67.70	39.20	0.52	85.45 (67.58)
Mean	37.01	15.10	63.12	32.22	0.48	82.12
CD at 5%	2.87	1.82	1.45	1.66	0.03	6.57

* Transformed values

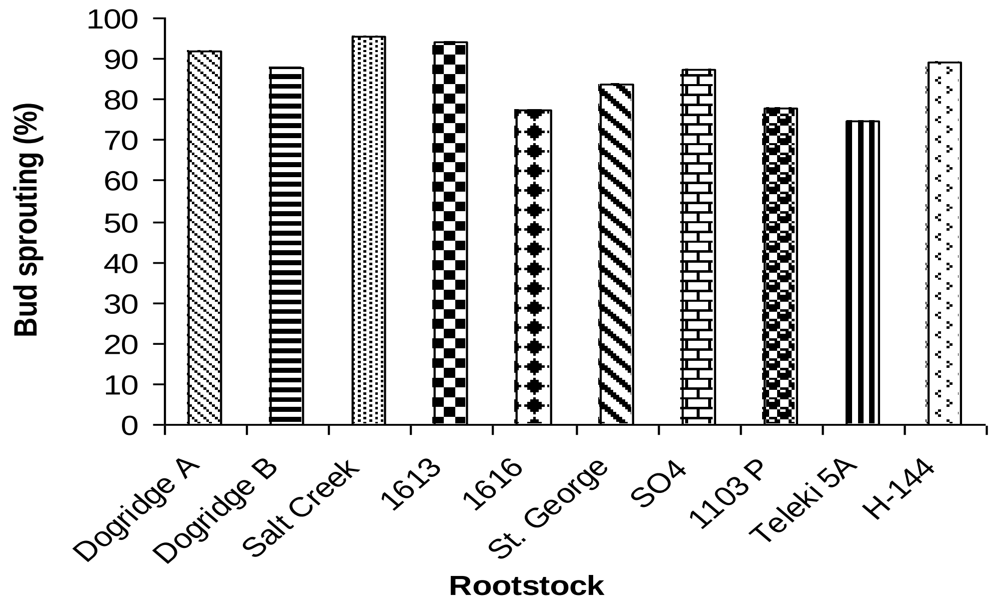

Fig. 1. Bud sprouting percentage of different grape rootstocks

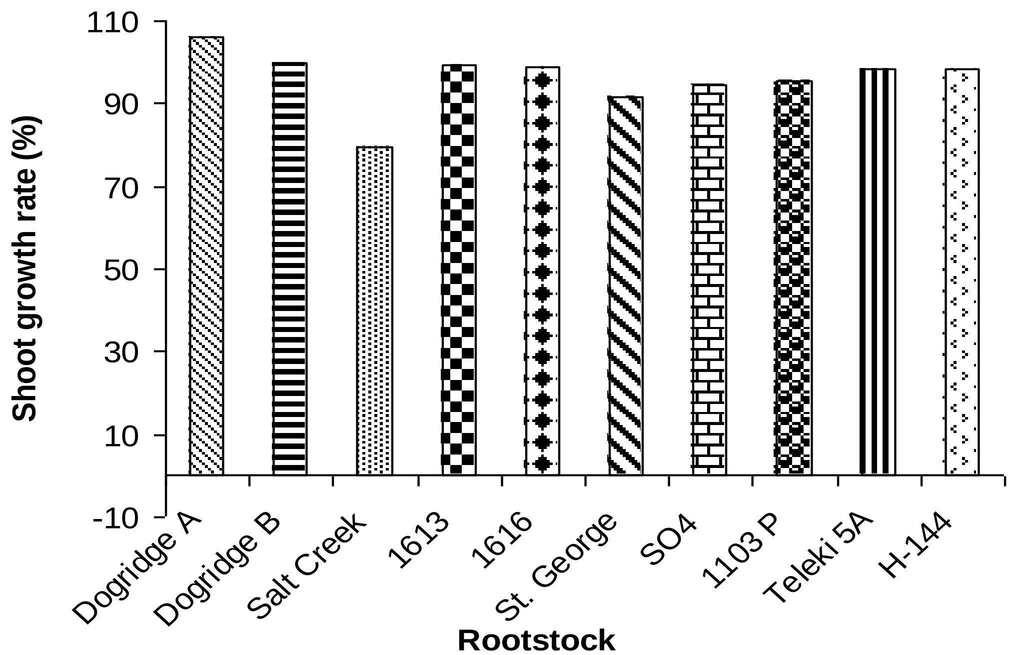

Fig. 2. Shoot growth rate of different grape rootstocks

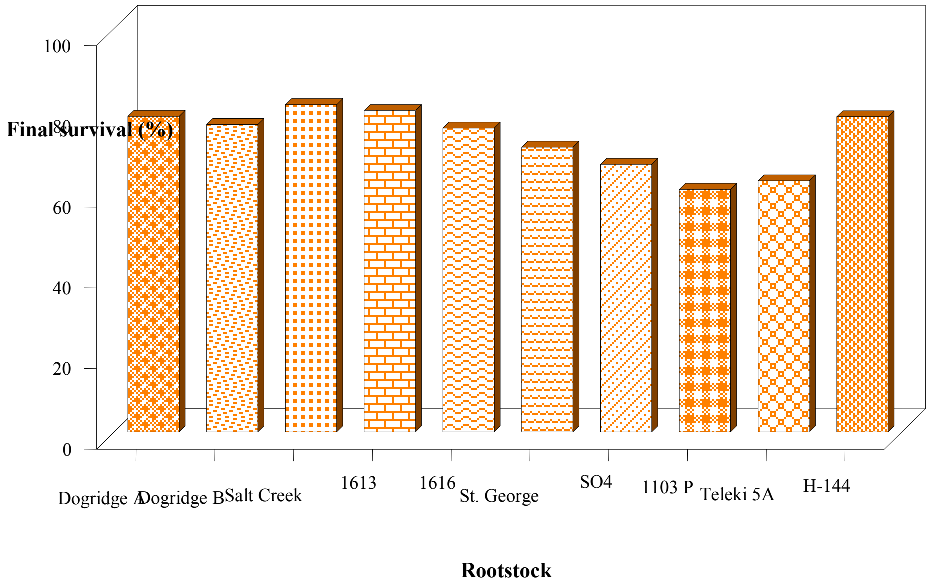

Fig. 3. Final survival percentage of different grape rootstocks