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Effect of rootstocks on growth parameters of red globe grapevines (*Vitis vinifera* L.)

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Abstract

The present investigation was conducted for two years (2018-19 and 2019-20) to study the effect of rootstocks (Dogridge, 110R, 140Ru, Salt Creek and own roots of Red Globe) on growth parameters of Red Globe grapevines. The vigour and growth parameters such as pruning weight was found maximum on vines grafted on Dogridge rootstocks while minimum days to sprout and cane maturity was recorded in own rooted Red Globe vines. Number of canes/vine, shoot length, shoot diameter, leaf area and stock: scion ratio varied significantly among the rootstocks and were found maximum in vines grafted on Dogridge rootstock followed by Salt Creek and 110R rootstocks. The present study revealed that Red Globe grapevines grafted on Dogridge followed by Salt Creek rootstock proved better for growth parameters but in terms of growth period Red Globe own rooted vines was early to sprout and took minimum days for cane maturity over the vines grafted on rootstocks.

Keywords: Rootstocks, growth parameters, red globe, compatibility, vine vigour

Introduction

Grape (*Vitis vinifera* L.) is one of the most important fruit crop of temperate zone, which has acclimatized to sub-tropical and tropical agro climatic conditions prevailing in the Indian Sub-Continent. The production of fresh grapes in India is about 31.25 lakh MT with the cultivation on an area of 1.40 lakh ha and with a productivity of 21.00 MT/ha (Anonymous, 2020) [2]. The major grape growing states in India are Maharashtra (75.94%), Karnataka (19.15%), Mizoram (1.76%), Tamil Nadu (1.55%) Andhra Pradesh (0.58%), Telangana (0.25%) and Punjab (0.21%) amounting to nearly 99 per cent of the total production (Anonymous, 2018) [1]. The total of 1,93,690.54 MT grapes of 2,17,686.82 lakh rupees exported to different countries (APEDA, 2020) [3]. Rootstocks have recently gained great importance in consistently effective and successful strategy in major viticulture countries worldwide (Troncoso *et al.*, 1999 [25] and Omer *et al.*, 1999) [12]. In addition, rootstocks can also be potential tools for manipulating the vine growth and productivity (Chadha and Shikhamany, 1999) [4]. The choice of specific rootstock is becoming increasingly difficult as a result of the availability of numerous new rootstocks (Loreti and Massai, 2006) [9]. Rootstocks perform differently with different soils and climates, thus regional rootstock evaluations are essential in determining which rootstock is best suited to a particular environment (Shaffer, 2002) [17]. The requirement for adoption of rootstock for grape cultivation in India is to sustain profitable production under major abiotic stresses, it also helped for growers to improved quality, ensure uniform and early bud sprout, more fruitfulness and proper vine vigour etc. This all factors leads to more economical for farmers (Jogaiah *et al.*, 2013) [8]. Red Globe is one of the promising Grape variety which have high demand in international and local market but its cultivation in India is very confined due to unavailability of suitable rootstock and low vine vigour. A two year investigation was carried to study the growth performance of Red Globe on different rootstocks. Somkuwar *et al.*, (2015) [21] studied the influence of different rootstocks on growth, photosynthesis, biochemical composition and nutrient contents in Fantasy Seedless grapes and reported that rootstock influences the vegetative growth thereby increasing the photosynthesis of vine. Fantasy Seedless grafted on Dogridge followed by 110R rootstock proved better for growth parameters.

Elaidy *et al.*, (2019)^[5] also reported that rootstock gave better results for vines grafted on rootstocks compared to those grown on their own roots. Ghule *et al.*, (2019)^[7] evaluated the effect of rootstocks on three scion cultivars and found that the growth parameters such as trunk girth, number of canes and leaf area showed significant difference among the cultivars.

Material and Methods

The investigation was conducted at ICAR-National Research Centre for Grapes, Pune (MS), during the year 2018-19 and 2019-20. The research was conducted on five year old vineyard of cv. Red Globe established on different rootstocks during 2018-19 (Trial-I) and 2019-20 (Trial-II). The vines were trained 'extended Y' system of training with four cordons (H shape – Height = 1.20 m from ground, cross arm width = 0.60 m) developed horizontally with vertical shoot orientation on each cordon. A distance of 0.60 m was maintained from the fruiting wire to the top of foliage support wire. The soil in the region is heavy black with pH 7.75 and EC 0.46 dS m⁻¹. The region falls under a tropical belt, where double pruning and single cropping is being practiced, the foundation pruning was carried out in the month of April and fruit pruning during the month of October. Red Globe grapevines grafted on different rootstocks taken as a treatments (T₁. Red Globe grafted on Dogridge rootstock, T₂. Red Globe grafted on 110R rootstock, T₃. Red Globe grafted on 140Ru rootstock, T₄. Red Globe grafted on Salt Creek rootstock, T₅. Red Globe on own roots). Five vines were selected and tagged under each replication and means of five vines was calculated for each parameter and the growth observations were recorded as given below.

Pruned biomass (kg/vine)

Pruned biomass were collected from each vine immediately after pruning and weight of biomass was recorded using weighing balance and mean was calculated and expressed in kg/vine.

Days to bud sprout

The first sprouted bud with fully expanded leaf was taken as an indicator to measure the days taken to bud sprouting (Satisha *et al.*, 2010)^[16]

Days taken for cane maturity

Days taken for cane maturity was calculated from the date of foundation pruning to the cane maturity for individual vine and mean was calculated.

Number of canes/vine

Number of canes per vine retained after foundation pruning was recorded at 120 DAP (Foundation pruning) and their means were worked out.

Shoot length (cm)

Five shoots per vine were selected randomly tagged for recording observations. The length of each shoot was recorded using measuring tape at 120 DAP (Foundation pruning) from five vines. Their average was calculated and expressed in cm.

Shoot diameter (mm)

Shoot diameter of the matured canes was measured between fifth and sixth node with Vernier Caliper for five canes per vine at 120 DAP (Foundation pruning) from five vines and their mean was expressed in mm.

Leaf area (cm²)

Five shoots were selected randomly from each vines and all leaves were removed and leaf area were calculated using BIOVIS, leaf area meter at 120 DAP (Foundation pruning). Their average was worked out and expressed in cm².

Stock: scion ratio

The girth of rootstock was measured one cm below the graft union while the scion girth was measured one cm above the graft union with the help of digital Vernier calliper.

Statistical analysis

The experiment was conducted in Randomized Block Design (RBD) consisting of five treatments as rootstocks which were replicated four times. Statistical analysis of data collected during the course of studies was carried out by standard method of analysis of variance as described by Panse and Sukhatme (1985)^[13]. The standard error of mean (S.Em±) was worked out and the critical difference at 5 per cent level of significance was calculated wherever the results were found significant.

Results and discussion

Vigour and growth parameters

The data on effect of different rootstocks on vigour and growth of Red Globe grapevines are presented in Table 1. The rootstocks showed significant effect on pruned biomass for the year 2018-19 and 2019-20 and also for pooled data. In 2018-19, the maximum pruned biomass was recorded in Red Globe grapevines grafted on Dogridge rootstock (1.25 kg/vine) which was at par with vines grafted on Salt Creek (1.21 kg/vine) followed by 110R (1.17 kg/vine) and 140Ru (1.11 kg/vine) rootstocks while minimum pruned biomass was recorded in own rooted vines (0.67 kg/vine). In second year of study (2019-20), maximum pruned biomass was recorded in Red Globe grapevines grafted on Dogridge rootstock (1.46 kg/vine) which was at par with Salt Creek (1.38 kg/vine) and 140Ru (1.37 kg/vine) rootstocks followed by 110R (1.33 kg/vine) rootstock, while minimum pruned biomass was noted in own rooted vines (1.08 kg/vine). The pooled data showed that Red Globe grapevines grafted on Dogridge rootstock (1.35 kg/vine) recorded maximum pruning biomass which was at par with the vines grafted on Salt Creek (1.29 kg/vine), 110R (1.25 kg/vine) and 140Ru (1.24 kg/vine) rootstocks while the minimum pruned biomass was noted in own rooted vines (0.88 kg/vine). The amount of pruned biomass depends upon the vigour of the vine, highly vigorous vines produce more pruned biomass than less and medium vigorous varieties. The difference in the pruned biomass among the rootstocks may be due to the difference in the vigour of vine resulting from assimilation of carbohydrates (Somkuwar *et al.*, 2006)^[19]. The higher storage accumulation in vine results into more number of canes, number of leaves produced and other growth parameters results in more dry matter production (Menora *et al.*, 2018)^[10]. Similar results were obtained by Sommer *et al.*, (1993)^[22] who reported that the rootstocks Ramsey and Dogridge conveyed high shoot length and vine vigour to the scions which resulted into higher pruned biomass. Satisha *et al.*, (2010)^[16] reported that Thompson Seedless grapevines grafted on Dogridge rootstock recorded highest pruning weight. Rizk-Alla *et al.*, (2011)^[15] also reported higher pruned biomass in Red Globe grapevines grafted on Dogridge rootstock.

The rootstocks showed significant effect on days to bud sprout for both the years (2018-19 and 2019-20) and for

pooled analysis. In 2018-19 minimum days taken for bud sprouting were recorded in own rooted Red Globe vines (12.83) while maximum days taken for sprout was recorded in vines grafted on Dogridge rootstock (18.10) which was at par with 140Ru (17.55) and Salt Creek (16.88) rootstocks followed by vines grafted on 110R rootstock (16.05). In 2019-20, own rooted vines recorded minimum days for sprouting (13.63) after foundation pruning which was at par with the vines grafted on 110R (15.03) and Salt Creek (15.08) rootstocks while maximum days taken for bud sprouting was noted in vines grafted on Dogridge rootstock (16.95) which was at par with 140Ru rootstock (16.20). The pooled data of two years also showed significant effect for days to bud sprout. Own rooted vines noted the minimum days for sprouting (13.23) while Red Globe grapevines grafted on Dogridge rootstock (17.53) recorded maximum days for days to bud sprout which was at par with 140Ru (16.88) and Salt Creek (15.98) followed by 110R rootstocks (15.54). The early and increased percentage of bud burst on own roots might be attributed to the increased activity of peroxidase activity (POD) and fewer growth inhibitors in their buds. The least Polyphenol oxidase activity in vines on Dogridge rootstock might have resulted in late and uneven bud sprouting (Jogaiah *et al.*, 2013)^[8]. The changes in peroxidase and polyphenol oxidase (PPO) activity could be an indicator of when endogenous changes occur, as the enzymes might lead to the scavenging of the accumulation of H₂O₂ in the buds and thus release dormancy, resulting in early bud sprouting (Tripathi *et al.*, 2006)^[24]. These results are in close conformity with the results of Prakash and Reddy (1990) who reported a significant effect of rootstocks on bud burst of Anab-e-shahi cultivar. Satisha *et al.*, (2010)^[16] and Somkuwar *et al.*, (2014)^[20] also reported that Thompson Seedless own rooted vines recorded less days for bud sprout than vines grafted on rootstocks.

The results over two years elucidated that the days taken for cane maturity significantly influenced by use of rootstocks. For the first year of study 2018-19, the minimum days taken for cane maturity was recorded in own rooted vine (135.08) which was significantly superior over the rootstocks. The maximum days for cane maturity was recorded in vines grafted on Dogridge rootstock (146.73) which was at par with vines grafted on Salt Creek rootstock (144.70) followed by 140Ru (141.35) and 110R (140.88) rootstocks respectively. In second year of study (2019-20) the minimum days for cane maturity were taken in own rooted vine (132.13) which was at par with Red globe grapevines grafted on 140Ru rootstock (134.93). It was followed by 110R rootstock (138.35) while maximum days for cane maturity was recorded on vines grafted on Dogridge rootstock (144.53) which was followed by Salt Creek rootstock (140.04). The results obtained from pooled analysis also revealed the same trend. The own rooted vines recorded minimum days (133.60) for cane maturity which was significantly superior over the rootstocks and was followed by 140Ru (138.14) and 110R (139.41) rootstocks while maximum days for cane maturity was recorded in vines grafted on Dogridge rootstock (145.63) which was at par with vines grafted on Salt Creek rootstock (142.37). The days taken for cane maturity varied among the rootstock genotype. Own rooted vines recorded minimum days for cane maturity. Own rooted vines were early to sprout than grafted vines which also results into the early cane maturity. The cane maturity is an important aspect in grapevine, proper and timely cane maturity secures maximum fruitfulness by storing maximum food material into the canes. The present finding is

in accordance with the Somkuwar *et al.*, (2014)^[20] who reported minimum cane maturity in Thompson Seedless own rooted vines than grafted one. The number of canes/vine significantly influenced by use of rootstocks.

Growth parameters at 120 DAP

The data on effect of different rootstocks on growth parameters of Red Globe grapevines at 120 DAP are presented in Table 2. During the first year (2018-19), highest number of canes/vine was noted in Red Globe grapevines grafted on Dogridge rootstock (32.13) which was at par with vines grafted on 110R (30.52) followed by 140Ru (28.93) rootstock while lowest number of canes/vine was noted on own rooted vines (25.63) which were par with vines grafted on Salt Creek rootstock (27.83). In second year of study (2019-20), the highest number of canes/vine were recorded in Red Globe grapevines grafted on Dogridge rootstock (34.68) which was at par with vines grafted on 110R rootstock (32.44) while lowest number of canes/vine were recorded on own rooted vines (27.68) which were at par with vines grafted on 140Ru (29.10) and Salt Creek (30.28) rootstocks respectively. The pooled analysis of results over two years also showed that highest number of canes/vine were recorded on Dogridge rootstock (33.40) which was at par with vines grafted on 110R rootstock (31.48) followed by 140Ru (29.01) and Salt Creek (29.05) rootstocks while lowest number of canes/vine was recorded on own rooted vines (26.80). The higher vigour and growth might have contributed to higher number of canes/vine in Red Globe grapevines grafted on Dogridge rootstock. The production of canes depends upon vigour of the vine, which in turn depends upon the extent of stored food material in the vine (Menora, 2014)^[11]. Similar results were reported by Menora (2014)^[11] who reported maximum number of canes in Kishnmish Chorni, Thompson Seedless and Flame Seedless grafted vines. Satisha *et al.*, (2010)^[16] reported higher number of canes in Thompson Seedless grapevines grafted on Dogridge rootstock. Shelake *et al.*, (2019)^[18] also reported that Thompson Seedless and its clone grafted on Dogridge rootstocks performed better for number of canes/vine.

The maximum shoot length in 2018-19, was recorded on Dogridge rootstock (86.72 cm) which was significantly superior over vines grafted on other rootstocks. This was followed by vine grafted on 110R (76.86 cm), Salt Creek (79.35 cm) and 140Ru (76.38 cm) rootstocks while minimum shoot length was found in own rooted vines (70.99 cm). In 2019-20, maximum shoot length was recorded on Dogridge rootstock (82.48 cm) which was at par with vines grafted on Salt Creek (79.98 cm) and 110R rootstocks (79.43 cm) followed by 140Ru (77.53 cm) rootstock while minimum shoot length was noted in own rooted vines (68.19 cm). The pooled analysis of two years revealed that maximum shoot length was recorded on Dogridge rootstock (81.60 cm) which was at par with vines grafted on Salt Creek (79.66 cm) and 110R (78.14 cm) rootstocks respectively followed by 140Ru rootstock (77.05 cm) while minimum shoot length was noted in own rooted vines (69.59 cm). The use of rootstocks has positively affected vine vigour. It might be due to rootstock imparts more vigour in vine which directly results maximum growth of vine indicated through the maximum shoot length. The differences in vigour suggest a stionic influence caused by rootstock genotypes (Verma *et al.*, 2010)^[27]. This finding are in accordance with the Reddy (1987)^[14] who recorded maximum shoot length in Anab-e-Shahi on the Dogridge rootstock. Venugopal (2007) and Satisha *et al.*, (2010)^[16]

reported that Thompson Seedless vines grafted on Dogridge and Salt Creek rootstock had higher shoot length. Rizk-Alla *et al.*, (2011) [15] also reported that Red Globe grapevines grafted on Dogridge followed by Salt Creek rootstock had maximum shoot length.

The shoot diameter significantly influenced by use of different rootstocks for same scion cultivar. In first year of study (2018-19), the maximum shoot diameter was noted in Red Globe grapevines grafted on Dogridge rootstock (9.15 mm) which was at par with Salt Creek rootstock (8.84 mm) followed by 110R (8.11 mm) and 140Ru (8.16 mm) rootstocks while the minimum shoot diameter was recorded in own rooted vine (8.02 mm). In 2019-20, the maximum shoot diameter was noted in Red Globe grapevines grafted on Dogridge rootstock (9.69 mm) which was at par with Salt Creek rootstock (9.16 mm) followed by 110R (8.68 mm) while minimum shoot diameter was recorded on own rooted vine (7.91 mm) which was at par with vines grafted on 140Ru rootstock (8.60 mm). The results obtained from pooled analysis also revealed that higher shoot diameter was recorded in Red Globe grapevines grafted on Dogridge rootstock (9.42 mm) which was at par with Salt Creek rootstock (9.00 mm) while lower shoot diameter was observed in own rooted vines (7.96 mm) which was at par with vines grafted on 110R (8.39 mm) and 140Ru (8.38 mm) rootstocks respectively. The increased cane diameter is the indication of availability of ample reserve food in canes (Venugopal, 2007). Besides pruning weight, the vine vigour can be judged by the cane diameter. The production of canes depends upon vigour of the vine and their dimensions, which in turn depends upon the extent of stored food material in the vine (Fawzi *et al.*, 1984). These results are in close conformity with the results of Venugopal (2007), Satisha *et al.*, (2010) [16], Menora (2014) [11] and Somkuwar *et al.*, (2014) [20] who reported highest shoot diameter in Thompson Seedless vines grafted on Dogridge rootstock. Rizk-Alla *et al.*, (2011) [15] reported that Red Globe grapevines grafted on Dogridge followed by Salt Creek rootstock recorded highest shoot diameter and Shelake *et al.*, (2019) [18] also reported that Thompson Seedless and its clone grafted on Dogridge rootstocks had positive effect on shoot diameter.

The highest leaf area during 2018-19 was recorded in Red Globe grapevines grafted on Dogridge rootstock (123.83 cm²) which was at par with Salt Creek rootstock (117.75 cm²) while lowest leaf area was observed in own rooted vines (102.53 cm²) which was at par with vines grafted on 140Ru (105.29 cm²) and 110R (108.26 cm²) rootstocks. In second year of study (2019-20), highest leaf area was recorded in vines grafted on Dogridge rootstock (121.34 cm²) which was

significantly superior among the rootstocks followed by Salt Creek (118.10 cm²) while the lowest leaf area was observed in own rooted vines (103.97 cm²) which was at par with vines grafted on 140Ru (104.20 cm²) and 110R (106.05 cm²) rootstocks respectively. The pooled analysis over two years also showed that highest leaf area was recorded in Red Globe grapevines grafted on Dogridge rootstock (122.58 cm²) which was significantly superior over all other rootstocks. It was followed by Salt Creek (117.93 cm²) and 110R rootstock (107.15 cm²). The lowest leaf area was recorded in own rooted vines (103.25 cm²) which was at par with vines grafted on 140Ru (104.75 cm²) rootstocks. The leaf area is a main element in source-sink relationship. The vigorous rootstock impart more growth to vines which enhanced higher shoot length and shoot diameter which results in accumulation of more carbohydrate and other food material in vines which gives maximum leaf area. The higher pruned biomass converted more stored food material for leaf area development (Ghule *et al.*, 2019) [7]. Similar results were reported by Reddy (1987) [14] who reported higher leaf area in Anab-e-Shahi grafted on Dogridge rootstock. Tambe (1999), Venugopal (2007) and Somkuwar *et al.*, (2014) [20] reported highest leaf area in Thompson Seedless vines grafted on Dogridge rootstock. Rizk-Alla *et al.*, (2011) [15] also reported that Red Globe grapevines grafted on Dogridge followed by Salt Creek rootstock recorded highest leaf area.

The data presented in Table 1 revealed that in both the years (2018-19, 2019-20) and in pooled analysis highest stock:scion ratio was recorded in Red Globe grapevines grafted on Dogridge rootstock (0.86, 0.88 and 0.87) which was followed by Salt Creek (0.85, 0.87 and 0.86) and 110R rootstock (0.82, 0.83 and 0.82) while lowest stock:scion ratio was recorded in vines grafted on 140Ru rootstock (0.78, 0.80 and 0.79) respectively. This is an important parameter with regard to longevity of any composite plant combinations. An extreme stock:scion ratio can cause delayed incompatibility. Therefore, it is important to estimate it for predicting the long-term success of any graft union (Verma *et al.*, 2010) [27]. The variation in stock: scion ratio of same cultivar grafted on different rootstocks might be due to differences in genetic constituent of the rootstock (Ghule *et al.*, 2019) [7]. Similar results were reported by Somkuwar *et al.*, (2006) [19] for higher stock: scion ratio in Thompson Seedless grafted on different rootstocks. Verma *et al.*, (2010) [27] reported that Pusa Urvashi grafted on Dogridge rootstock recorded highest stock: scion ratio. In contrast Satisha *et al.*, (2010) [16] found that there is no adverse effects of different rootstocks on stock: scion ratio in Thompson Seedless grapes in initial years of vineyard and also long duration evaluations.

Table 1: Effect of different rootstocks on vigour and growth of Red Globe grapevines

Rootstock	Pruned biomass (kg/vine)			Days to bud sprout			Days for cane maturity		
	2018-19	2019-20	Pooled	2018-19	2018-19	Pooled	2018-19	2019-20	Pooled
Dogridge	1.25	1.46	1.35	146.73	146.73	17.53	146.73	144.53	145.63
110R	1.17	1.33	1.25	140.88	140.88	15.54	140.88	138.35	139.61
140Ru	1.11	1.37	1.24	141.35	141.35	16.88	141.35	134.93	138.14
Salt Creek	1.21	1.38	1.29	144.70	144.70	15.98	144.70	140.04	142.37
Own root	0.67	1.08	0.88	135.08	135.08	13.23	135.08	132.13	133.60
S.Em±	0.02	0.04	0.05	0.82	0.82	0.50	0.82	1.26	0.88
CD at 5%	0.07	0.11	0.20	2.52	2.52	1.96	2.52	3.87	3.47

Table 2: Effect of different rootstocks on growth of Red Globe grapevines at 120 Days after foundation pruning

Rootstock	Number of canes/vine			Shoot length (cm)			Shoot diameter (mm)			Leaf area (cm ²)			Stock: Scion ratio		
	2018-19	2019-20	Pooled	2018-19	2018-19	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
Dogridge	32.13	34.68	33.40	86.72	82.48	81.60	9.15	9.69	9.42	123.83	121.34	122.58	0.86	0.88	0.87

110R	30.52	32.44	31.48	76.86	79.43	78.14	8.11	8.68	8.39	108.26	106.05	107.15	0.82	0.83	0.82
140Ru	28.93	29.10	29.01	76.38	77.53	77.05	8.16	8.60	8.38	105.29	104.20	104.75	0.78	0.80	0.79
Salt Creek	27.83	30.28	29.05	79.35	79.98	79.66	8.84	9.16	9.00	117.75	118.10	117.93	0.85	0.87	0.86
Own root	25.63	27.98	26.80	70.99	68.19	69.59	8.02	7.91	7.96	102.53	103.97	103.25	NR	NR	NR
S.Em±	0.77	1.27	0.49	1.30	1.11	1.03	0.12	0.22	0.20	2.53	0.96	0.84	-	-	-
CD at 5%	2.39	3.93	1.94	4.01	3.44	4.03	0.39	0.71	0.77	7.81	2.97	3.30	-	-	-

Conclusion

From the above investigation it was concluded that rootstocks showed significant effect for pruning weight, number of canes/vine, shoot length, shoot diameter, leaf area and stock: scion ratio in Red Globe grapevines. The own rooted Red Globe grapevines was early in sprouting and attaining proper cane maturity as compared to vines grafted on rootstocks. Hence, considering all above parameters Red Globe grapevines grafted on Dogridge followed by Salt Creek rootstock proved better for growth parameters.

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