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Grapevine Rootstock Affects Grape Phenology, Yield and Quality of Thompson Seedless Grapes Grown Under Pune Condition

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Authors' contributions

This work was carried out in collaboration among all authors. Author RGS have designed the experiment. Author NG has performed the experiment and organised the data. Author ST written the manuscript. Author PBK helped in writing and editing the manuscript. Author RGS has reviewed the data along with whole manuscript. All authors read and approved the final manuscript.

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ABSTRACT

The performance of Thomson Seedless on Dogridge, 110R, 140RU and 1103P rootstocks along with own rooted vine for growth and yield parameters during 2023-24 was studied. The growth and yield parameters varied significantly among rootstocks. Thomson Seedless on Dogridge rootstock recorded highest pruning weight (1.25 kg/vine) and 34 canes per vine, while, it also exhibited maximum percentage of fruitful canes (96.50%), along with shoot length (129.30 cm) and leaf area (173.60 cm^2). In terms of yield, Dogridge outperformed other rootstocks, with highest number of bunches per vine (35.00), average bunch weight (321.10 g), 50-berry weight (143.80 g) and total yield per vine (11.25 kg). However, for chlorophyll content, 110R rootstock excelled, with highest values of 32.20 mg/ml and 15.50 mg/ml at 45 and 90 days after fruit pruning respectively.

Keywords: Thompson seedless; rootstock; growth; yield; nutrients.

1. INTRODUCTION

Grape (*Vitis vinifera* L.) is temperate crop adopted to the warm tropics and subtropics of India. Varietal adaptability and advancement in cultivation practices made the viticulture successful to larger level. Major grape growing areas of India comprises of tropical regions. It is grown over area of 1.76 lakh ha with production of 38.96 lakh MT and productivity of 22.15 MT/ha (Anonymous, 2024). Table grapes occupy 90% of total grape area in the country. The grape growing states which majorly contributes are Maharashtra (70.67%), Karnataka (24.49%), Tamil Nadu (1.43%), Andhra Pradesh (1.34%), Madhya Pradesh (1.02%) and Mizoram (0.50%) accounting to nearly 99 % of the total production (NHB, 2022). However, the grapes are used for table purpose (78%) of total production, raisins (25-25%) and for juice and wine purpose only 2% of the total production.

Thompson Seedless is grown for both table and raisin purpose. Increase in soil salinity, unpredictable drought incidence and decline in productivity of own rooted plants demands usage of rootstocks in commercial orchard (Sah et al., 1997). Use of rootstock also increases productivity of grape orchards. Selection of rootstocks is based on importance of its character which it contributes (Reynolds et al., 2004). It is proved that rootstocks affect vine growth, fruit yield and quality of the scion. Growth and performance were influenced by rootstocks, results from nutrient uptake and development (Migicovsky et al., 2021). The varied response of rootstocks to scion needs analysis for better rootstocks identification of certain variety and purpose. Interaction among rootstocks and scion influences the vine behaviour than stock or scion alone (Hartmann et al., 1993). Rootstocks influence the grapevine canopy architecture, which affects the microclimate, promoting or hindering disease development. Rootstocks also influences the biochemical composition of grapevine and final yield. 110R and Dogridge rootstocks were used to overcome soil and water problems in grape cultivation (Somkuwar et al., 2006) Considering the problem, the study was conducted to evaluating the performance of Thompson Seedless grafted on four rootstocks and own rooted under semi-arid condition.

2. MATERIALS AND METHODS

The study was carried out at National Research Centre for Grapes, Pune (latitude 18°32′N and longitude 73°51′E) during 2023-24. Five-year-old Thompson Seedless grafted on Dogridge (*Vitis champinii*), 110 Richter (*Vitis berlandieri* × *Vitis rupestris*), 140-Ru (*Vitis berlandieri* × *Vitis rupestris*), SO4 (*Vitis berlandieri* × *Vitis riparia*) and on own rooted vines were evaluated in randomized block design with four replications. The planting was done at a spacing of 2.7 X 1.5 mtr accommodating 968 vines/acre. The soil is heavy black with pH 7.75 and EC 0.46 dS m^{-1}. Double pruning and single cropping pattern are being followed under tropical condition. The foundation pruning and fruit pruning was carried out in April and September respectively.

Pruning weight was measured using weighing balance. The pruned mass was collected from five vines under each treatment and the average was taken and expressed in kg. The shoot length was measured using measuring tape and expressed in cm while the shoot diameter was measured using vernier calliper and expressed in mm. Number of canes, fruitful canes (%), stock and scion ratio, leaf area were measured at 90 days after fruit pruning. Number of canes and fruitful canes were measured by visual observation as previously described by Somkuwar et al., (2024d). The days to bud sprout, berry setting and days to harvest were

recorded on day basis through visual observations. The days taken to achieve each activity was calculated as the days taken from fruit pruning to achieve each stage. From each vine, ten bunches were collected randomly and the bunch weight was recorded and average bunch weight was taken and expressed in g. Fifty berries were plucked from each vine and 50 berry weight was recorded. The grapes were harvested from individual vine and average of five vines was taken using electronic weighing balance and yield/vine was expressed in kg/vine. The grape juice was extracted from the grape berries. TSS was measured using hand refractometer and expressed in ^{o}Brix. The Juice pH was measured using pH meter. From the extracted juice, the total titratable acidity was determined by titrating the berry juice with 0.1 N NaOH (Ranganna, 1986). Leaf samples from the vines grafted on each rootstock were collected from five vines under each replication at 45 and 90 days after fruit pruning. These leaves were subjected to estimation of Chlorophyll a and b using dimethyl sulfoxide (DMSO) method as suggested by Hiscox and Israclstam, (1979).

3. RESULTS AND DISCUSSION

Growth parameters: Thompson Seedless grafted on Dogridge rootstocks recorded highest pruning weight (1.25 kg) and was on par with SO4 (1.21 kg) followed by 110R (1.15 kg) while, lowest pruning weight observed in own rooted vine (0.99 kg). Vine vigour influenced the pruning weight (Table 1). Somkuwar et al., (2024a) reported highest biomass in 1103P followed by Dogridge in Manjari Naveen variety. Similar result was observed by Satisha et al., (2013) on Thompson Seedless while Gautier et al., (2020) reported higher pruning weight in Cabernet Sauvignon grapevine grafted on Dogridge and 420A rootstock.

The number of canes/vine were maximum in the vines grafted on Dogridge rootstock (34.00) followed by 1103P (33.10) as compared to the lowest in own rooted vines (30.80). The vines grafted on Dogridge rootstock were more fruitful (96.50%) followed by 110-R grafted vines (95.10%) compared to least in own rooted vines (80.00%). As above mentioned 110R was on par with Dogridge in percentage of fruitful canes. Sommer et al., (2001) grafted vines were more fruitful than own rooted ones. Performance of Thompson Seedless on Dogridge was best compared to own rooted vines. Highest shoot length was observed in SO4 (130.40 cm) grafted vines followed by Dogridge (129.30 cm) and 110R (125.60 cm) while least value was observed in own rooted vine (114.20 cm).

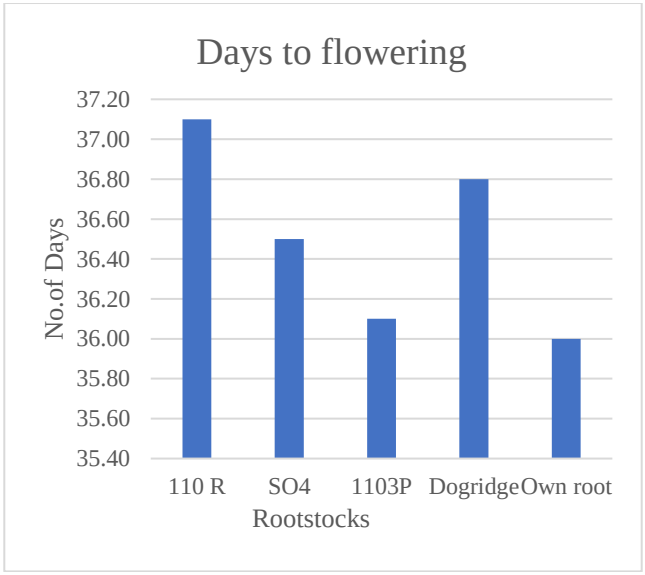
Maximum shoot diameter was recorded in SO4 (8.40 mm) and was on par with 110R (8.30 mm) while minimum in own rooted vine (7.00 mm). Highest leaf area was recorded in Dogridge grafted vines (173.60 cm^2) followed by SO4 (168.30 cm^2) and 110R (158.40 cm^2) while the vines grafted on 1103P recorded minimum leaf area (157.55cm^2). Somkuwar et al., (2014) found highest shoot length, shoot diameter and leaf area of Thompson Seedless grafted on Dogridge rootstock. Vine vigour is directly correlated in terms of shoot length, shoot diameter and leaf area. Kose et al., (2014) reported Merzifon Karasi variety on 110R, 8B and V. rupestris with highest leaf area, shoot diameter and shoot length. Somkuwar et al., (2015) reported better growth parameters in Fantasy Seedless grafted on Dogridge rootstock followed by 110R rootstocks. Hifny et al., (2016) also reported maximum shoot growth in Red Globe grafted on Freedom rootstocks while maximum leaf area was recorded on Salt Creek rootstock. Rootstock with *V. champinii* parentage has higher vigour in increasing shoot growth, leaf area and shoot diameter.

Highest root stock: scion ratio was observed in 1103P grafted vines (0.95) followed by Dogridge and 110R (0.93 each) while minimum ratio in SO4 (0.83). Satisha et al., (2013) reported significant influence of rootstock on biomass accumulation on Dogridge grafted vines. Similar result was also reported by Verma et al., (2010) in Pusa Urvashi grafted with Dogridge rootstocks. However, Satisha et al., (2010) reported stock: scion ratio's influence on the yield of Thompson Seedless grapes grafted on different rootstocks.

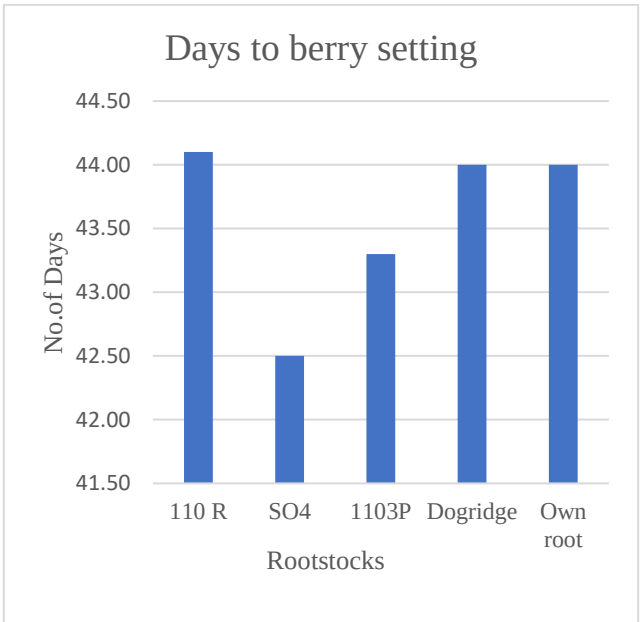
Own rooted Thompson Seedless was early to flower in 36.00 days (Fig 1.a). The number of days required for flowering was in order of 1103P < SO4 < Dogridge < 110R. Thompson Seedless grafted on SO4 rootstock achieved early berry set (42.50 days) followed by 1103P (43.30 days). Dogridge and own rooted cuttings were on par (44.0 days) while 110R was late to set the berries (Fig. 1b). The early harvest was observed in the own rooted vines (133.90 days) followed by 110R (134.10), SO4 (135.80), Dogridge (136.50) and 1103 P (137.60) (Fig. 1.c.).

Table 1. Influence of rootstock in growth parameters of Thompson Seedless grapes

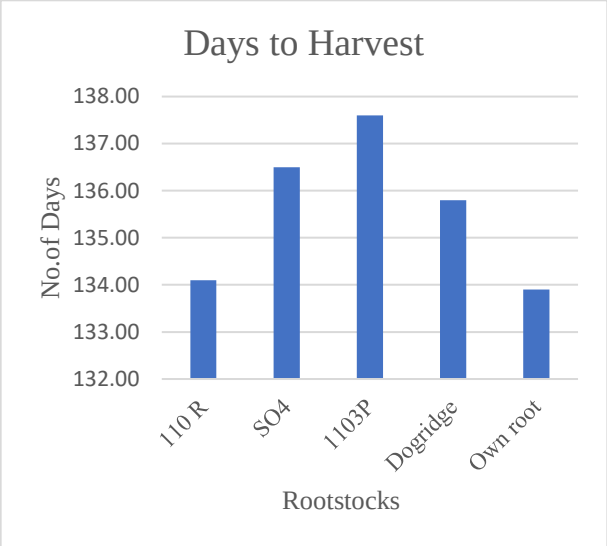
Rootstocks	Pruning weight (Kg/ vine)	Number of canes (No)	Fruitful canes (%)	Shoot length (cm)	Shoot dia. (mm)	Stock: scion ratio	Leaf area (cm^2)
110 R	1.15	32.00	95.10	125.60	8.30	0.93	158.40
SO4	1.21	31.20	91.45	130.40	8.40	0.83	168.30
1103P	1.03	33.10	83.20	115.30	8.00	0.95	157.55
Dogridge	1.25	34.00	96.50	129.30	7.30	0.93	173.60
Own root	0.99	30.80	80.00	114.20	7.00	--	158.30
S Em±	0.01	0.35	0.49	0.73	0.06	0.01	1.12
CD at 5%	0.02	1.06	1.48	2.20	0.17	0.02	3.36



(A)



(B)



(C)

Fig. 1. Influence of rootstock on days required for flowering, berry set and harvest in Thompson Seedless grapes

Table 2. Influence of rootstock on yield parameters of Thompson Seedless.

Rootstock	Bunches/ vine	Avg. bunch weight (g)	50 berry wt. (g)	Yield (kg/ vine)	Berry length (mm)	Berry diameter (mm)	TSS (°Brix)	Acidity (%)	Juice pH
110R	30.20	291.00	127.50	8.80	21.78	15.40	19.00	0.55	3.35
SO4	31.80	295.60	121.40	9.42	21.22	15.86	19.30	0.53	3.37
1103P	30.60	289.40	124.50	8.89	21.22	16.16	19.70	0.51	3.37
Dogridge	35.00	321.10	143.80	11.25	22.48	15.18	19.80	0.54	3.36
Own root	31.00	280.10	120.60	8.71	21.10	14.84	18.50	0.50	3.34
S Em±	0.20	1.88	0.78	0.11	0.57	0.34	0.88	0.004	0.03
CD at 5%	0.61	5.63	2.34	0.32	1.71	1.01	2.63	0.012	0.10

Table 3. Rootstock's influence in the chlorophyll content of the Thompson Seedless

	45 days after fruit pruning			90 days after fruit pruning		
Rootstocks	Chl. a (mg/ ml)	Chl. b (mg/ ml)	Total chl. (mg/ml)	Chl. a (mg/ ml)	Chl. b (mg/ ml)	Total chl. (mg/ml)
110 R	25.00	7.20	32.20	12.50	3.00	15.50
SO4	19.50	5.35	24.65	6.25	2.10	8.35
1103P	20.30	6.00	26.30	9.15	2.40	11.55
Dogridge	19.00	5.70	24.70	10.20	4.30	14.50
Own root	18.60	5.00	23.60	9.00	2.00	11.00
SEm±	0.14	0.04	0.38	0.07	0.01	0.07
CD at 5%	0.41	0.12	1.14	0.20	0.03	0.22

Yield Parameters: The data presented in Table 2 revealed maximum number of bunches in Dogridge grafted vine (35.00). Average bunch weight was higher in Dogridge grafted vine (321.10 g) followed by SO4 (295.60 g) and 110R (291.00 g) as compared to minimum in own rooted vines (280.00 g). Fifty berries weight was higher in Dogridge grafted vines (143.80) followed by 110R and 1103P (127.50 g and 124.50 g respectively). Maximum yield was also reported in vines grafted on Dogridge (11.25 kg/ vine) followed by SO4 (9.42 kg) while low in own rooted vines (8.71 kg). Ausari et al., (2024) noticed good performance of Dogridge rootstock in yield, average bunch weight, 50 berry weight and number of berries per bunch under semi-arid

condition. Satisha et al. (2010) reported maximum yield per vine, yield per acre and average bunch weight in Thompson Seedless grafted on Dogridge and 110R compared to other rootstocks studied. Ausari et al., (2024) reported maximum bunch weight on Dogridge (205.33) followed by Fercal (191.67) while minimum bunch weight was reported in 110R. Berry length was higher in Dogridge grafted vines (22.48 mm) followed by 110R (21.78 mm) while lowest in own rooted vines (21.10 mm). Result of the present study confirms the earlier work of Somkuwar et al., (2024d) who reported average higher berry length in Dogridge grafted vines followed by 110R. Highest berry diameter was reported in vines grafted on 1103P rootstocks (16.16 mm) followed by SO4 (15.86 mm) and 110R (15.40 mm) while minimum berry size was observed in berries of own rooted vines (14.84 mm). Satisha et al., (2010) reported higher berry diameters in Thompson Seedless grafted on 110 R and 1103P.

TSS was maximum in Dogridge grafted vines (19.80^{o} Brix) and was on par with 1103P (19.70^{o} Brix) which was further followed by SO4 > 110R > own rooted vines. Rootstock has influence on the total soluble solids of grape berries (Berdeja et al. 2014; Miele and Rizzon, 2019). Somkuwar et al., (2024b) reported high TSS in Cabernet Sauvignon grafted on Gravesac (25° Brix) and 1103P (24.4^{o} Brix). Maximum acidity was reported in 110R (0.55%) followed by Dogridge (0.54%). Remaining rootstock were in the order of SO4 > 1103P > own rooted vines. Similar result was reported by Somkuwar et al., (2024c). Titratable acidity was higher in 110R (0.64 g/L) followed by 1103P (0.61 g/L) and Fercal (0.61 g/L) and lower in the juice of grapes from Dogridge grafted vines (0.56 g/L). Highest juice pH was recorded in the grape juice of vines grafted on SO4 and1103 P (3.37 each) while the least juice pH was recorded in own rooted vines (3.34).

Chlorophyll content: At 45 days after pruning, chlorophyll a and Chlorophyll b were higher in 110R (25.00 mg/ml and 7.20 mg/ml) followed by 1103P (20.30 and 6.00 mg/ml) with total chlorophyll of 26.30 mg/ml (Table 3). After 90 days of pruning, maximum chlorophyll a was observed in 110 R (12.50 mg/ml) with total chlorophyll 15.50 mg/ml. However, chlorophyll b was higher in Dogridge grafted vines.

At 45 days after the pruning, the chlorophyll a content proceeded in the order SO4 > Dogridge > own rooted while chlorophyll b in the order of Dogridge > SO4 > own rooted. Total chlorophyll recorded in the order of Dogridge > SO4 > own rooted. After 90 days of pruning, second highest chlorophyll a and b was recorded in Dogridge (10.20 mg/ml and 4.30 mg/ml) and total chlorophyll of 14.50 mg/ml. At 90 days after pruning, chlorophyll a followed an order of 1103P > own rooted > SO4 while chlorophyll b was in the order of 1103P> SO4 > own rooted. Total chlorophyll recorded in the order of 1103P > own rooted > SO4.

Somkuwar et al., (2011) reported Fantasy Seedless grafted on Freedom rootstock has highest concentration of chlorophyll content, while lowest on SO4 grafted vines. Rafaat and El-Gendy (2013) also reported higher concentration of leaf chlorophyll content in Salt Creek and Freedom than own rooted vines in Flame Seedless. Rootstocks with tolerance to soil salinity and water stress has higher level of total chlorophyll accumulation in the leaves and better in later stages of growth.

4. CONCLUSIONS

From the above experiment, it is concluded that each rootstock has a varied response to the scion grafted. The rootstock Dogridge has highest biomass accumulation, shoot length, number of canes, leaf area, maximum number of bunches, average bunch weight, highest berry yield/vine and weight, with maximum TSS. The rootstock 110R recorded maximum acidity with high chlorophyll activity of a and b with total chlorophyll. Dogridge produced higher grape yield and biomass that has resulted into high vigour. For better economic yield of quality produce, Thompson Seedless grafted on Dogridge rootstock is considered an ideal.

HIGHLIGHTS:

Rootstock helps to overcome biotic and abiotic stresses.

Thompson Seedless and its clone’s occupied 90% area for table and raisin purpose grapes.

Rootstocks also enhances growth, yield and quality of the crop.

Rootstocks particularly Dogridge and 110R are mostly used in India.

Dogridge has salinity and drought tolerant properties.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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