Grapevine rootstocks affect grape phenology, yield and quality of Thompson Seedless under semi-arid condition

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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 growth parameters, including 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 cm²). 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, Quality

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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 under cultivation 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.

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Thompson Seedless is being grown for both table and raisin purpose. Increase in soil salinity, unpredictable drought incidence and decline in productivity of own rooted cuttings demands usage of rootstocks in commercial orchard. 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). Itis 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

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varied response of rootstocks to scion needs analysis for better rootstocks identification of certain variety and purpose. Interaction among stock 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 for evaluating the performance of Thompson Seedless grafted on various rootstock under semi-arid condition.

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 champini*), 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 three replications. The planting was done spacing used is 9 X 5 feet accommodating 968 vines/acre. The climate in this region is slightly dry and the soil is heavy black with pH 7.75 and EC 0.46 dS m^{-1}. Double pruning and single cropping system are being followed under tropical condition. The foundation pruning and fruit pruning was carried out in April and September respectively.

Growth parameters like pruning weight was measured using weighing scale, shoot length was measured using measuring tape, shoot diameter using vernier calliper. 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-by day basis through visual observations. Average fruit weight, 50 berry weight, yield/vine was measured using electronic balance while berry length, berry diameter using vernier calliper. TSS, acidity and Juice pH was calculated from selected grape berries taken for juice extraction. Berries were selected randomly. Total soluble solids in the juice was determined using hand refractometer and expressed in degree brix (°Brix). Total titratable acidity was determined by titrating the berry juice with 0.1 N NaOH (Ranganna, 1986). Chlorophyll a and b was analysed at 45 and 90 days after pruning and estimated using dimethyl sulfoxide (DMSO) method (Hiscox and Israclstam, 1979).

Result and Discussion

Growth parameters

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Thompson Seedless grafted on Dogridge rootstocks recorded highest biomass (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 grafted on Dogridge and 420A rootstocks.

The Number of canes and percent fruitful canes were maximum in the vine grafted on Dogridge rootstock (34.00 and 96.50 % respectively) followed by 1103P (33.20 %). The vines grafted on 110R was on par with Dogridge in percentage of fruitful canes (95.10 %) while least values were recorded in own rooted vines (30.80 and 80.00 % respectively). Grafted cuttings were more fruitful than own rooted cuttings (Sommer *et al.,* 2001). 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). Sommer *et al.,* (2001) reported grafted cutting has increased shoot length.

Maximum shoot diameter was observed in SO4 (8.40 mm) and was on par with 110R (8.30 mm) while minimum shoot length and shoot diameter was observed on own rooted vine (114 cm and 7.00 mm). Highest leaf area was observed 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) found Merzifon Karasi on 110R, 8B and Rupestris has highest leaf area, shoot diameter and shoot length of Thompson Seedless grafted Dogridge rootstocks. Somkuwar *et al.,* (2015) reported better growth parameters in Fantasy Seedless grafted on Dogridge 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 rootstocks.

Highest 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) found 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 and Somkuwar *et al.,* (2006) in Flame Seedless grafted with 110R. However, Satisha *et al.,* (2010) reported stock: scion ratio's influence on the yield of Thompson Seedless grafts on different rootstocks.

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

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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

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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) (Fig 1.b.). Dogridge and own rooted cuttings were on par (44.0 days) while 110R was late to set the berries. The earlier harvest 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.).

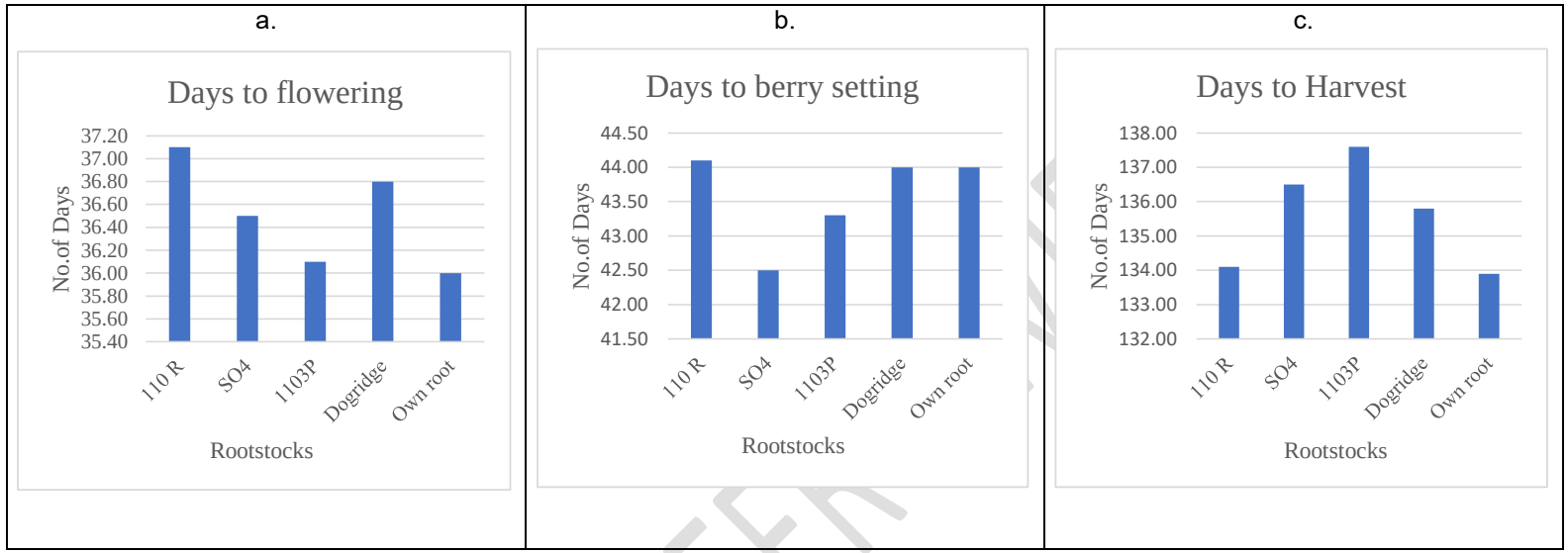

Fig 1. Influence of rootstock on days required for flowering, berry set and harvest in Thompson Seedless grapes

Yield Parameters

The maximum number of bunches recorded in Dogridge grafted vine (35.00) while, there was no significant difference between other rootstocks (Table 2). 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 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 and 1103P rootstocks under semi-arid climate. Ghule et al. (2019) reported higher fruitfulness in Sauvignon Blanc grafted on 110R compared to other rootstocks. 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). Highest berry diameter 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). Similar results were obtained by Satisha *et al.,* (2010) in Thompson Seedless.

TSS was maximum in Dogridge grafted vines (19.80^{o} Brix) and was on par with 1103P (19.70^{o} Brix) further followed by SO4 > 110R > Own rooted vines. Rootstock has significant effect on the total soluble solids (Berdeja *et al*. 2014; Miele and Rizzon, 2019). Somkuwar *et al.,* (2024b) reported high TSS in Cabernet Sauvignon grafted on Gravesac (25^{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).

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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

Chlorophyll content

At 45 days after pruning, chlorophyll a and 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 proceeds in the 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 their own rooted vines in Flame seedless.

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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

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.

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