Journal of Advances in Biology & Biotechnology

Volume 27, Issue 7, Page 382-389, 2024; Article no.JABB.117743
ISSN: 2394-1081

Rootstock Influences Yield, Berry Composition and Wine Quality in Sauvignon Blanc Grown under Semi-Arid Condition

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/jabb/2024/v27i7999

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/117743

Original Research Article

Received: 08/04/2024
Accepted: 11/06/2024
Published: 13/06/2024

ABSTRACT

The influence of rootstocks on yield, berry and wine quality and sensory evaluation of Sauvignon Blanc was studied during 2017-2020 on 7-year-old vines of Sauvignon Blanc at ICAR-National Research Centre for Grapes, Pune, India. The vines grafted on seven different rootstocks (Dogridge, Salt Creek, Fercal, 140Ru, SO4, 1103P and 110R) were used for study. The yield and berry quality parameters *viz.,* number of bunches/vine and yield per vine varied significantly among the rootstocks. The vines grafted on Salt Creek rootstock recorded maximum average bunch weight

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Cite as: Somkuwar , R. G., A. K. Sharma, Nilima Gobade, and Praveen Kumar Ausari. 2024. "Rootstock Influences Yield, Berry Composition and Wine Quality in Sauvignon Blanc Grown under Semi-Arid Condition". Journal of Advances in Biology & Biotechnology 27 (7):382-89. https://doi.org/10.9734/jabb/2024/v27i7999.

(138.23 gm) while, higher number of bunches/vine (52.73) and yield/vine (7.11 kg) was recorded in 110R grafted vines. TSS content in berries was higher (24.24^{0}B) and lowest acidity (0.56 g/L) in Dogridge rootstock grafted vines. Wine composition parameters like glucose (2.71 g/l), malic acid (3.3 g/l) and total acid (7.30 g/l) was higher in 140Ru rootstock; volatile acid (0.54 g/l) and pH (3.60) of wine was higher in110R rootstock. The ethanol (14.04 %) in wine was higher in vines grafted on SO4 rootstock. The wine sensory attributes were also positively influenced using different rootstocks, wine prepared from Sauvignon Blanc grapes grafted on Fercal rated the highest overall wine quality followed by 110R and Dogridge rootstocks.

Keywords: Sauvignon Blanc; Vitis vinifera L; rootstocks; yield; wine quality.

1. INTRODUCTION

Grape (*Vitis vinifera* L.) is an important fruit crop in the country. It is being grown on an area of 1.62 lakh ha with production of 34.45 lakh MT and productivity 21.00 MT/ha. The major grape growing states with their share in India are Maharashtra (70.67%), Karnataka (24.49%), Tamil Nadu (1.43%), Andhra Pradesh (1.43), Madhya Pradesh (1.02%), and Mizoram (0.50%) amounting to nearly 99 % of the total production [1]. India ranks first in world for grape productivity and 7th for table grape export with exported fresh grapes of 2.67 lakh MT worth 2543.42 crores during 2022-23 [2]. However, only about 2% of the total production of grapes is being used for juice and wine purpose.

Grape berry consist of a skin, pulp, seeds, and pedicel each contributing to their overall benefits. The skin is rich in antioxidants like resveratrol and flavonoids that provides significant health benefits, including anti-inflammatory and anti-cancer properties. The pulp is high in water, sugars, vitamins, and dietary fiber, supports hydration, digestive health, and provides essential nutrients like vitamins C and K. The seeds contain oils and polyphenols, which further enhance their antioxidant profile and offer cardiovascular benefits by lowering cholesterol and blood pressure. Wine holds significant cultural, economic, and social importance, serving as a symbol of celebration and ritual across various civilizations throughout history [3-5]. It enhances culinary experiences, contributes to global economies through wine industry, and supports rural agricultural communities. Wine also offers potential health benefits when consumed in moderation, such as improved heart health due to its antioxidant properties. Additionally, advancements in winemaking techniques and sustainable practices reflect its ongoing influence and adaptation in the modern world, making wine a pivotal element in both heritage and contemporary life.

Under Indian condition, white wine is being preferred more. Sauvignon Blanc, a renowned white wine variety is famous for its distinct aromatic profile and crisp acidity, making a high quality wines [6,7]. The grapevine's growth and performance greatly influenced by its rootstock, which acts as the foundation for its development and nutrient uptake [8]. Rootstocks are tolerant of varied abiotic stresses [9] and resistant to a variety of pests and diseases [10,11]. As a result, grafting is a method that is frequently utilized in viticulture. Numerous studies have examined how rootstocks affect the development of vines and the makeup of fruits. However, given to the intricate interactions between rootstocks, scion cultivars, soil and climatic factors, no correlation have yet been established. In terms of vine vigour, a number of earlier studies found a considerable variation between various grafted vines [12,13].

Rootstock contributes in the partitioning of biomass between root, shoot, trunk and fruit. Carbohydrates reserves stored in canes not only serve as indicators of health and vitality of the previous season's growth but also play a crucial role in various aspects of plant development. In many plant species, these root carbohydrates contribute to shoot development, the expansion of stem and root diameters, the generation of new root length, initiation and growth of flower buds, and fruit set [14]. Rootstocks should be selected both in terms of the characteristics of a given variety and the clone (growth rate, yield, nutrient requirements), as well as the soil and water conditions (soil moisture, soil fertility, active calcium content, etc.). Rootstocks affect the nutrient uptake from the soil, and thus the plant growth, length of the growing season and yield [15]. However, 110-R is another addition which is an alternative to Dogridge, looking into the soil and water problem in grape cultivation [16]. The interaction between scion and rootstock can influence several parameters, such as yield, berry composition and the resulting wine's sensory attributes [17]. Rootstocks vary in their abilities to modulate vine vigor, water uptake, nutrient assimilation, and stress tolerance all of which play pivotal roles in shaping the grapevine and the resulting wine. Considering the potential of rootstocks, the present research was carried out to study the influence of rootstocks on yield, berry and wine quality parameters in Sauvignon Blanc grapevines.

2. MATERIALS AND METHODS

2.1 Vineyard, Experiment Design, and Vine Management

The study was carried out at ICAR-National Research Centre for Grapes, Pune ($18^0$32'N and $73^0$51E) during 2017- 2020. The wine cultivar 'Sauvignon Blanc' grafted on Dogridge (*Vitis champinii*), Salt Creek (*Vitis champinii*), Fercal (*V. berlandieri* × *V. vinifera*), 140Ru (*V. berlandieri* × *V. rupestris*), SO4 (*V. berlandieri* × *V. riparia*), 1103P (*Vitis berlandieri* × *Vitis rupestris)* and 110R (*V. berlandieri* × *V. rupestris*) were evaluated in a randomized block design with four replicates represented by five vines per treatment. Seven years old vines trained to mini-Y system of trellises spaced at 2.4×1.2 m accommodating about 3400 vines per hectare. The vines were pruned twice in a year: once in the summer (known as back pruning) to develop canes for fruit bud differentiation and second pruning on the mature canes after five to six months later (called forward pruning) to encourage bunch development (fruit pruning).

2.2 Yield parameters

The total number of bunches were counted from selected five vines in each treatment and mean number of bunches per wine was calculated after berry set (after fruit pruning). The weight of the bunch was recorded by averaging the weight of 3 bunches borne on the five vines selected randomly at harvest. The total number of berries were counted from selected five bunches in each treatment and mean number of berries per bunch was calculated. The grapes were harvested after attaining the maturity (TSS and acidity). The yield was recorded at the time of harvest.

2.3 Berry Quality Parameters

Harvesting was done about 145 days after forward pruning during the month of March. Total soluble solids (ºBrix) were determined using a handheld refractometer (ERMA, Japan) with temperature compensated to 20ºC. The pH of pure juice of every sample was determined using a pH meter. Titratable acidity was determined by titration with 0.1 N NaOH to a phenolphthalein end point and expressed as g L^{-1} [18]. Also, five vines were selected randomly from each rootstock.

2.4 Wine Quality Parameters

The wine quality parameters like glucose, pH, ethanol, malic acid, volatile acid and total acids in wine sample were measured by FOSS machine. Wine sensory evaluation was done by serving the wine to a panel comprises 6 individuals. For organoleptic test, 5 point hedonic scale score card contains various wine quality parameters like colour, aroma, sweetness, acidity, tannin, body, alcohol, length, and overall quality was used [19].

2.5 Statistical Analysis

The data was subjected to the analysis of variance (ANOVA) using randomized block design by t-test to check the variations in rootstock influence on Sauvignon Blanc scions. The data was analysed using Statistical Analysis System (SAS) software version 9.3. The standard error of mean (SEm±) was measured and the critical difference at 5% level of significance was calculated for all the treatments.

3. RESULTS AND DISCUSSION

3.1 Yield Parameters

The data recorded on yield attributing parameters are presented in the Table 1. The results obtained through pooled mean clearly indicated that, number of bunches/vine, average bunch weight and yield significantly influenced by use of rootstocks for same scion cultivar. The higher number of bunches per vine and yield were recorded on 110R rootstock (52.73 and 7.11 kg/vine, respectively) while lowest was noted in SO4 (39.30 and 4.41 kg/vine, respectively) rootstock. The highest average bunch weight was recorded in Salt Creek (138.23 gm) while lowest in SO4 (111.13 gm) rootstock whereas, the highest number of berries per bunch was on 1103P rootstock while the lowest was in Fercal grafted vines. In the present study, higher number of bunches were recorded in vines grafted on 110R rootstock. The number of bunches/vine shows significant variation based on the variety, vine nutrition, and the potential growing site. The productivity of bunches, bunch weight and length appear to be a genetic phenomenon, but the climate and soil nutrient status also contribute to certain extent. This difference in the number of bunches/vines may be attributed to varietal character due to a greater number of canes or immaturity of canes in different varieties. Similar line of work in grapes was reported by Somkuwar et al. [20] and [21], yield is mainly correlated to the number of grape clusters, but also the traits of grape clusters and berries, as well as the number of grape berries per cluster [22] reported that Red Globe vines grafted on Dogridge followed by Salt Creek rootstock recorded higher yield per vine. [23] found that both the inherent vigour of the scion that conferred by the rootstock were contributing factors to yield performance.

3.2 Berry Quality Parameters

The data collected on various berry quality parameters (TSS, acidity and juice pH) of Sauvignon Blanc grafted on different rootstocks are presented in Table 2. In pooled mean, significant differences were recorded for TSS, acidity and juice pH. The vine grafted on Dogridge rootstock recorded highest TSS (24.24^{0}B) which was at par with 110R, Dogridge, Fercal and Salt Creek rootstocks, while the lowest TSS was recorded in 140Ru (22.56^{0}B) grafted vines. In term of acidity, Dogridge grafted vines had lowest value (0.56 g/L) which was followed by Fercal, 140Ru and SO4 (0.61 g/L) whereas, the highest acidity was recorded in 110R (0.64 g/L) rootstock. The vines grafted on Fercal rootstock recorded higher juice pH (3.56) followed by 1103P (3.53) rootstock whereas, the lowest pH was noticed with Dogridge grafted vines (3.32). The total soluble solids and acidity were negatively correlated to each other. As TSS increased, the acidity was decreased. Total acidity content in the grape juice was moderately correlated with the yield [24]. These findings are in accordance with the results obtained by Somkuwar et al. [25,26] in Sharad Seedless and Manjari Naveen grapevines grafted on Dogridge rootstock, respectively. [27] found low sugar content and high acidity in the berries from the grafted Sauvignon Blanc vines on SO4 might result in an unbalanced sugar to acid ratio, and thus less attractive to consumers; similar results were reported in the berries of ‘Kyoho’/1202C [28].

3.3 Wine Quality Parameters

The data recorded on wine quality parameters in the vines grafted on different rootstocks are presented in Table 3. The pooled data indicated significant differences between values for the studied parameters. Glucose content, malic acid and total acid was significantly higher in wine made from 140Ru grafted vines while, volatile acid and pH was higher in wine prepared from 110R grafted on Sauvignon Blanc vines. Ethanol percentage was higher in wine prepared from SO4 and statistically similar with wine prepared from 110R grafted vines. The non-significant contribution of tartaric acid in influencing juice pH is in accordance to findings of Kodur et al. [29]. But rootstocks significantly affected accumulation of malic acid in fruits of grafted scions as reported by several workers [30]. Pan et al. [31] conducted that pH value regulate the degradation of glucose and fructose as lower the pH value, slow will be the degradation. It is also playing a modulating role in wine haze formation,

Table 1. Effect of different rootstocks on yield of Sauvignon Blanc grape (pooled means for three years)

Rootstocks	Number of bunches/Vine	Number of berries /Bunch	Average bunch weight (gm)	Yield/ vine (kg)
Dogridge	47.65^c	127.43^b	136.53^{ab}	6.50^b
Salt Creek	45.79^d	133.17^{ab}	138.23^a	6.31^{bc}
Fercal	50.49^b	105.29^e	135.32^{ab}	6.82^a
140Ru	41.83^e	118.79^c	127.77^b	5.30^d
SO4	39.30^f	113.15^{cd}	111.13^c	4.41^e
1103P	44.31^d	138.81^a	135.73^{ab}	6.02^c
110R	52.73^a	108.78^{de}	135.26^{ab}	7.11^a
S Em±	0.53	2.22	3.03	0.10
CD at 5%	1.63	6.85	9.35	0.31
Sig	**	**	**	**

**, ** Indicates significances against pooled deviation at P = 0.05 and P = 0.01 levels, respectively* which diminishes or overthrows the commercial value of wine [32]. Volatile acid plays an important role in fermentation process as its improper fermentation processes occurring during winemaking [33] while acid, ethanol and tannins are the primary factor determine the wine aroma, taste and mouth feel in red wine [34]. The concentration of ethanol (14-16 %) was a fundamental requirement for the wine quality as it is linked to sugar content of grape berries, which affect the overall flavour of wine [35]. However, it decreases astringency and increases the bitterness of wine [36].

Table 2. Effect of different rootstocks on berry quality of sauvignon blanc grape (pooled means for three years)

Rootstocks	TSS (°B)	Acidity (g/L)	Juice pH
Dogridge	24.24^{a}	0.56^{c}	3.32^{d}
Salt Creek	23.70^{ab}	0.62^{ab}	3.45^{c}
Fercal	23.75^{ab}	0.61^{a}	3.56^{a}
140Ru	22.56^{c}	0.61^{a}	3.51^{ab}
SO4	23.68^{ab}	0.61^{a}	3.51^{ab}
1103P	23.03^{ab}	0.62^{ab}	3.53^{ab}
110R	24.04^{a}	0.64^{a}	3.50^{bc}
S Em±	0.28	0.01	0.02
CD at 5%	0.86	0.02	0.05
Sig	**	**	**

**, ** Indicates significances against pooled deviation at P = 0.05 and P = 0.01 levels, respectively*

Table 3. Effect of different rootstocks on wine quality of Sauvignon Blanc grape (pooled means for three years)

Rootstocks	Glucose (g/l)	pH	Ethanol (%)	Malic acid (g/l)	Volatile acid (g/l)	Total acid (g/l)
Dogridge	1.58^{f}	3.56^{c}	13.71^{c}	2.0^{c}	0.46^{c}	6.86^{d}
Salt Creek	2.07^{c}	3.60^{a}	12.83^{e}	2.8^{b}	0.52^{b}	7.06^{b}
Fercal	1.07^{g}	3.54^{d}	12.99^{d}	1.9^{c}	0.40^{d}	6.93^{c}
140Ru	2.71^{a}	3.43^{e}	12.81^{e}	3.3^{a}	0.38^{e}	7.30^{a}
SO4	2.59^{b}	3.58^{b}	14.04^{a}	1.9^{c}	0.37^{f}	6.76^{e}
1103P	1.76^{e}	3.59^{b}	13.04^{d}	1.9^{c}	0.34^{g}	5.86^{g}
110R	1.92^{d}	3.60^{a}	13.88^{b}	1.2^{d}	0.54^{a}	6.57^{f}
SEm±	0.001	0.003	0.04	0.05	0.002	0.010
CD at 5%	0.005	0.009	0.11	0.15	0.006	0.030
Sig	**	**	**	**	**	**

**, ** Indicates significances against pooled deviation at P = 0.05 and P = 0.01 levels, respectively*

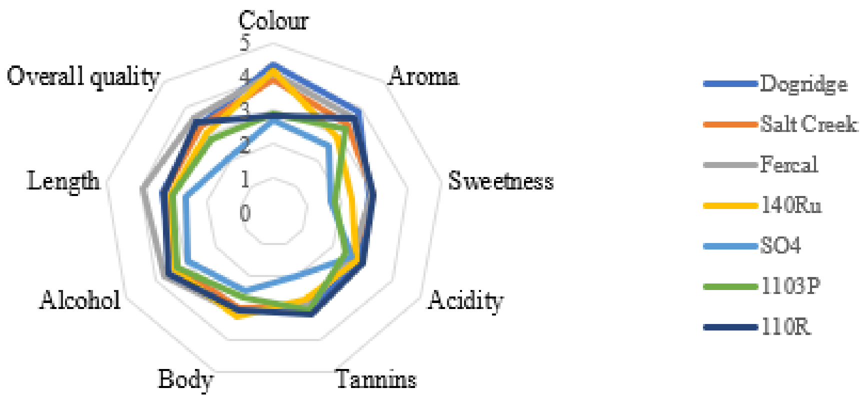

Fig. 1. Sensory attributes of Sauvignon Blanc grafted on different rootstocks

3.4 Wine Sensory Parameters

The sensory evaluation is an important parameter in wine quality analysis. The prepared wine in the present investigation was subjected to sensory evaluation and the results were collected in 1 to 5 rating scale (Fig. 1). The wine prepared from Sauvignon Blanc grapes were significantly influenced by the use different rootstocks. In terms of overall quality, wine prepared from Sauvignon Blanc grapes grafted on Fercal rootstocks recorded highest (3.61) overall wine quality followed by 110 R (3.50) and Dogridge (3.35) rootstocks, while lowest overall wine quality was recorded in wine prepared from Sauvignon Blanc grapes grafted on SO4 (2.08) rootstock. Rootstocks significantly influenced the phenolic, biochemical, and sensory parameters of the prepared wine [37]. There was very less research carried out which showed the rootstock had a positive effect on the wine sensory attributes. According to Wooldridge et al. [12], aroma did not differ between rootstocks. Overall quality was similar in Chardonnay and Pinot noir, but decreased for rootstocks in the sequence: 110R > SO4 > 140Ru. [38] found inverse relationship between vigour and wine quality. The aroma of Cabernet Sauvignon wine was improved when grafted on Ruggeri rootstock, compared to those of Salt Creek [39]. Cabernet Sauvignon wine had recorded the highest rating scores when grafted on 161-49 C and 420A MGT rootstocks [40]. Teixeira et al. [41] found that molecules of phenolic compounds are responsible for the colour, aromas, and flavour of the grapes; consequently, they have a significant impact on the structural properties and sensorial properties of grapes and, in particular, astringency in wines. The sensory analysis of wine prepared form 5C rootstock grafted vines presented more color intensity, more astringency and more meaty aromas compared with wine made from Gravesac grafted vines in Syrah grapes [42]. On the other hand, studies showing difference between rootstocks have also been reported [43].

4. CONCLUSION

The results of the present study indicated that the yield, quality of fruit and quality of wine prepared from Sauvignon Blanc grapevine varied with the rootstock used. 110R rootstock recorded significantly higher yield than other rootstocks. Berry quality *i.e*. TSS was higher and lowest acidity in berries of Dogridge rootstock grafted vines while, juice pH was higher in Fercal rootstock. Wine composition parameters like glucose, malic acid, total acids was higher in 140Ru rootstock; volatile acids was higher in 110R rootstock and pH of wine was higher with 110R and Salt Creek rootstock. Organoleptic test done for wine; overall acceptability of wine found better for Fercal grafted vines.

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 manuscripts.

ACKNOWLEDGEMENTS

The authors are thankful to the Director, ICAR-National Research Centre for Grapes, Pune for providing experimental field and his kind support during the period of study.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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