Effect of Rootstocks on Yield, Berry and Wine Quality Parameters in Sauvignon Blanc Vinegrape

ABSTRACT

The influence of rootstocks on yield, berry and wine quality and sensory evaluation of Sauvignon Blanc was examined during 2017-2020 at ICAR-National Research Centre for Grapes, Pune, India. Seven 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. While, higher number of bunches/vine and yield/vine was recorded in 110R rootstock. TSS and acidity content in berries was more in 110R rootstock. Wine composition parameters like glucose, malic acid and total acid found higher in 140Ru rootstock; volatile acid and pH of wine found higher in110R rootstock. The ethanol percentage in wine found higher for vines grafted on SO4 rootstock. The overall acceptability of wine found better for Sauvignon Blanc vines grafted on Fercal.

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 grows 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 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 rank first in world for grape productivity and secured 7th position in the world for table grape export with the quantum of 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.

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 it a prominent cultivar in the production of high quality wines [3, 4]. The grapevine's growth and performance greatly influenced by its rootstock, which acts as the foundation for its development and nutrient uptake [5]. Rootstocks are tolerant of varied abiotic stresses [6] and

resistant to a variety of pests and diseases [7, 8]. 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 agreements have yet been established. In terms of vine vigor, a number of earlier studies found a considerable variation between various grafted vines [9, 10].

Rootstock contributes in the partitioning of biomass between root, shoot, trunk and fruit. Carbohydrates reserves stored in vine canes not only serve as indicators of the 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 [11]. 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 [12]. However, 110-R is another addition which is an alternative to Dogridge, looking into the soil and water problem in grape cultivation [13]. The interaction between scion and rootstock can influence several parameters, such as yield, berry composition and the resulting wine's sensory attributes [14]. 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. MATERIAL AND METHODS

2.1 Vineyard, Experiment Design, and Vine Management

The study was carried out at ICAR-National Research Centre for Grapes, Pune (latitude $18^0$32'N and longitude $73^0$51E) during the year 2017-18, 2018-19 and 2019-20. The cultivar 'Sauvignon Blanc' grapevines grafted onto 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. The plants were seven years old, trained onto a mini Y system of trellises and spacing 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.

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. At the harvesting, soluble solids (Brix), titratable acidity (g L^{-1} tartaric acid) and pH were measured using the juice of pressed berries (100 berries per treatment) collected. 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} [15]. 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 of wine sample was measured by FOSS mashine. Wine sensory evaluation was done by serving the wine samples to 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 [16].

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. RESULT AND DISCUSSION

3.1 Yield parameters

The data recorded on yield attributing parameters are presented in the Table 1. The results obtained 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) rootstock while lowest was noted in SO4 (39.30 and 4.41 kg/vine, respectively) rootstock. The 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 1103P rootstock while lowest in Fercal grafted vines. In a present study, higher number of bunches were recorded in vines grafted on 110R rootstock. The quantity 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/vine 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 [17]. to [18], 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. [19] reported that Red Globe vines grafted on Dogridge followed by Salt Creek rootstock recorded higher yield per vine. [20] found that both, the inherent vigour of the scion that conferred by the rootstock were contributing factors to yield performance.

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Table 1. Effect of various rootstocks on the yield parameters of Sauvignon Blanc grapevines (pooled means for three years)

*: Significant at P < 0.05, **: Significant at P < 0.01, NS: Non significant

3.2 Berry quality parameters

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Rootstocks	Nu TSS (°B) bunches/vine	N Acidity (g/L) berries/bunch	Average b Juice pH weight (gm)	Yield/vine (kg)
Dogridge	47.65	127.43	136.53	6.50
Salt Creek	45.79	133.17	138.23	6.31
Fercal	50.49	105.29	135.32	6.82
140Ru	41.83	118.79	127.77	5.30
SO4	39.30	113.15	111.13	4.41
1103P	44.31	138.81	135.73	6.02
110R	52.73	108.78	135.26	7.11
SEm±	0.53	2.22	3.03	0.10
CD at 5%	1.63	6.85	9.35	0.31
Sig	**	**	**	**

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 data, significant differences were recorded for TSS, acidity and juice pH. Among the, highest TSS was observed in Dogridge (24.24^{0}B) which was at par with the vines grafted on 110R, Dogridge, Fercal and Salt Creek, while the lowest with 140Ru rootstock grafted vines (22.56^{0}B). The highest acidity was recorded in 110R which was at par with 1103P and Salt Creek rootstocks grafted vines while, lowest in Dogridge rootstock. The vines grafted on Fercal rootstock recorded higher juice pH (3.60) 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 [21]. These findings are in accordance with the results obtained by [22, 23] in Sharad Seedless and Manjari Naveen grapevines grafted on Dogridge rootstock, respectively. [24] 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 [25]. The pH value of the grape juice was not significantly affected by the rootstock [26].

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Table 2. Effect of various rootstocks on berry quality parameters of Sauvignon Blanc grapevines (pooled means for three years)

Dogridge	24.24	0.56	3.32
Salt Creek	23.70	0.62	3.45
Fercal	23.75	0.61	3.56
140Ru	22.56	0.61	3.51
SO4	23.68	0.61	3.51
1103P	23.03	0.62	3.53
110R	24.04	0.64	3.50
SEm±	0.28	0.01	0.02
CD at 5%	0.86	0.02	0.05
Sig	**	**	**

*: Significant at P < 0.05, **: Significant at P < 0.01, NS: Non significant

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3.3 Wine quality parameters

The data recorded on wine quality parameters in the vines grafted on different rootstocks are presented in Table 3. In pooled data, which found significant differences between values. Glucose content, malic acid and total acid found significantly higher in wine made from 140Ru grafted vines. While, volatile acid and pH recorded higher in wine prepared from 110R grafted on Sauvignon Blanc vines. Ethanol percentage found higher in wine prepared from SO4 and found 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 [26]. But rootstocks significantly affected accumulation of malic acid in fruits of grafted scions as reported by several workers [27]. [28] conducted that pH value regulate the degradation of glucose and fructose as lower the pH value, show will be the degradation. It is also playing a modulating role in wine haze formation, which diminishes or overthrows the commercial value of wine [29]. Volatile acid plays an important role in fermentation process as its improper fermentation processes occurring during winemaking [30] while acid, ethanol and tannins are the primary factor determine the wine aroma, taste and mouth feel in red wine [31]. 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 [32]. However, it decreases astringency and increases the bitterness of wine [33].

Table 3. Effect of various rootstocks on the wine quality parameters of Sauvignon Blanc grapevines (pooled means for three years)

Rootstocks	Glucose content in wine	pH of wine	Ethanol in wine (%)	Malic acid in wine (g/l)	Volatile acid in wine (g/l)	Total acid in wine (g/l)
Dogridge	1.58	3.56	13.71	2.0	0.46	6.86
Salt Creek	2.07	3.60	12.83	2.8	0.52	7.06
Fercal	1.07	3.54	12.99	1.9	0.40	6.93
140Ru	2.71	3.43	12.81	3.3	0.38	7.30
SO4	2.59	3.58	14.04	1.9	0.37	6.76
1103P	1.76	3.59	13.04	1.9	0.34	5.86
110R	1.92	3.60	13.88	1.2	0.54	6.57
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	**	**	**	**	**	**

*: Significant at P < 0.05, **: Significant at P < 0.01, NS: Non significant

3.4 Wine sensory parameters

The sensory evaluation is an important parameter in wine quality analysis. The prepared wine form 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, basis wine prepared from Sauvignon Blanc grapes grafted on Fercal rootstocks recorded highest (3.61) overall wine quality which was followed by 110 R (3.50) and Dogridge (3.35) rootstocks. Whereas, lowest overall wine quality was found 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 [34]. According to [9] 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. [35] 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 [36]. Cabernet Sauvignon wine had recorded the highest rating scores when grafted on 161-49 C and 420A MGT rootstocks [37]. [38] 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.

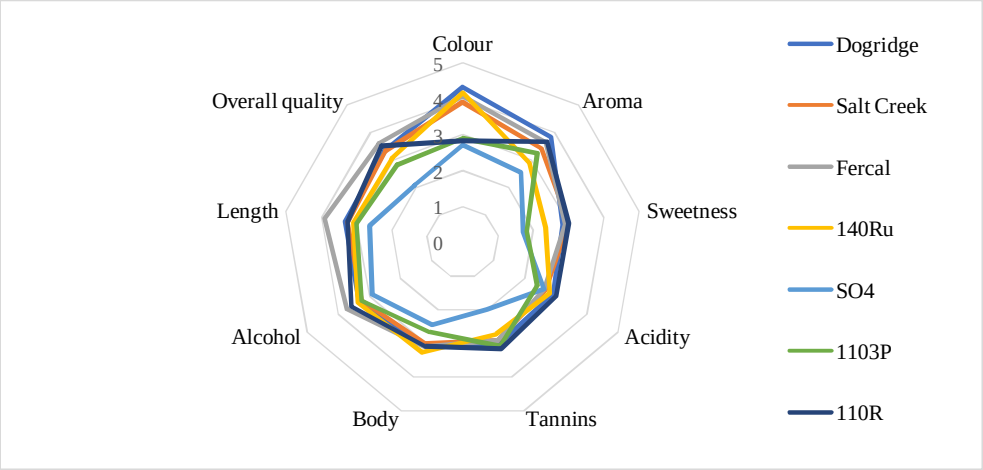

Fig. 1. Sensory attributes of Sauvignon Blanc grafted on different rootstocks

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 found higher in berries of Dogridge rootstock. While, acidity and juice pH recorded higher with 110R and Fercal rootstocks. Wine composition parameters like glucose, malic acid, total acids found higher with 140Ru rootstock; volatile acids found higher with 110R rootstock and pH of wine found higher with 110R and Salt Creek rootstock. Organoleptic test done for wine; overall acceptability of wine found better for Fercal grafted vines.

REFERENCES

1. NHB. Annual report. https://nhb.gov.in/annual_report.aspx?. 2022.
2. APEDA. Ministry of Commerce and Industry. Government of India. https://apeda.gov.in/apedawebsite. 2022
3. Louw L, Roux K, Tredoux A, Tomic O, Naes T, Nieuwoudt HH, Van Rensburg P. Characterization of selected South African young cultivar wines using FTMIR spectroscopy, gas chromatography and multivariate data analysis. J. Agric. Food Chem. 2009;57:2623-2632.
4. Coetzee C, du Toit WJ. A comprehensive review on Sauvignon Blanc aroma with a focus on certain positive volatile thiols. Food Res. Int. 2012;45:287-298.
5. Migicovsky Z, Cousins P, Jordan LM, Myles S, Striegler RK, Verdegaal P Chitwood DH. Grapevine rootstocks affect growth-related scion phenotypes. Plant Direct. 2021;5(5): e00324.
6. Serra I, Strever A, Myburgh PA, Deloire A. Review: The interaction between rootstocks and cultivars (*Vitis vinifera* L.) to enhance drought tolerance in grapevine. Aust. J. Grape Wine Res. 2014;20(1):1-14.
7. Hwang, CF, Xu K, Hu R, Zhou R, Riaz S Walker MA. Cloning and characterization of XiR1, a locus responsible for dagger nematode resistance in grape. Theoret. Appl. Gen. 2010;121(4):789-799.
8. Ferris H, Zheng L, Walker M. Resistance of grape rootstocks to plant parasitic nematodes. J. Nematol. 2012;44(4):377-386.

9. Wooldridge J, Louw PJE, Conradie WJ. Effects of rootstock on grapevine performance, petiole and must composition, and overall wine score of Vitis vinifera cv. Chardonnay and Pinot Noir. South African Journal of Enology and Viticulture. 2010;31:45-48.
10. Chitarra W, Perrone I, Avanzato CG, Minio A, Boccacci P, Santini D, Gilardi G. Siciliano I, Gullino ML, Delledonne M, Mannini F, Gambino G. Grapevine grafting: Scion transcript profiling and defense-related metabolites induced by rootstocks. Front Plant Sci. 2017;8:654(1-15).
11. Loescher WH, Mccamant T, Keller JD. Carbohydrate reserves, translocation, and storage in woody plant roots. HortSci. 1990;25(3):274-281.
12. Mijowska K, Ochmian I, Oszmianski J. Rootstock effects on polyphenol content in grapes of 'Regent' cultivated under cool climate condition. Journal of Applied Botany and Food Quality. 2017;90:159-164. DOI:10.5073/JABFQ.2017.090.020
13. Somkuwar RG, Satisha J, Ramteke SD. Effect of different rootstocks on fruitfulness in Thompson Seedless grapes (*Vitis vinifera* L.). Asian J. Plant Sci. 2006;5(1):150:152.
14. Olarte Mantilla SM, Collins C, Iland PG, Kidman CM, Ristic R, Boss PK, Jordans C, Bastian SEP. Shiraz (*Vitis Vinifera* L.) berry and wine sensory profiles and composition are modulated by rootstocks. Am. J. Enol. Viticult. 2017;69(1):32-44.
15. Ryan JJ, Dupont JA. Identification and analysis of major acids from fruit juices and wines. J. Agr. Food Chem. 1973;21(1):45-49.
16. Cuarto PM, Magsino RF. Development of Young Coconut (*Cocos nucifera*) Wine. Asia Pacific Journal of Multidisciplinary Research. 2017;5(2):89-93.
17. Somkuwar RG, Kad S, Naik S, Sharma AK, Bhange MA, Bhongale AK. Study on quality parameters of grape (*Vitis Vinifera*) and raisins affected by grape type. Indian Journal of Agricultural Sciences. 2020;90(6):1072-1075. https://doi.org/10.56093/ijas.v90i6.104765
18. Bascunan-Godoy L, Franck N, Zamorano D, Sanhueza C, Carvajal DE, Ibacache A. Rootstock effect on irrigated grapevine yield under arid climate conditions are explained by changes in traits related to light absorption of the scion. Scientia Horticulturae. 2017; 218:284-292. https://doi.org/10.1016/j.scienta.2017.02.034
19. Rizk-Alla MS, Sabry GH, Abd El-Wahab MA. Influence of some rootstocks on the performance of Red Globe grape cultivar. J. American Sci. 2011;7(4):71-81.
20. Rives M. Statistical analysis of rootstock experiments as providing a definition of the terms vigour and affinity in grapes. Vitis. 1971;9:280-290.

21. Pulko B, Vrsic S, Valdhuber J. Influence of various rootstocks on the yield and grape composition of Sauvignon Blanc. Czech J. Food Sci. 2012;30:467-473.
22. Somkuwar RG, Satisha J, Bondge DD, Itroutwar P. Effect of bunch load on yield, quality and biochemical changes in Sharad Seedless grapes grafted on Dogridge rootstock. International Journal of Biology Pharmacy and Allied Science. 2013;2(6):1226-1236.
23. Somkuwar RG, Samarth R, Ghule VS, Sharma AK. Crop load regulation to improve yield and quality of Manjari Naveen grape. Indian Journal of Horticulture. 2020;77(2):381-383. http://dx.doi.org/10.5958/0974-0112.2020.00053.5
24. Jin ZX, Sun TY, Sun H, Yue QY, Yao YX. Modifications of 'Summer Black' grape berry quality as affected by the different rootstocks. Scientia Horticulturae. 2016;210:130-137. https://doi.org/10.1016/j.scienta.2016.07.023
25. Chou MY, Li KT. Rootstock and seasonal variations affect anthocyanin accumulation and quality traits of 'Kyoho' grape berries in subtropical double cropping system. Vitis. 2014;53(4):193-199.
26. Kodur S, Tisdall JM, Clingeleffer PR, Walker RR. Regulation of berry quality parameters in 'Shiraz' grapevines through rootstocks (*Vitis*). Vitis. 2013;52(3):125-128.
27. Kodur S. Effects of juice pH and potassium on juice and wine quality, and regulation of potassium in grapevines through rootstocks (Vitis): A short review. Vitis. 2011;50:1-6.
28. Pan W, Jussier D, Terrade N, Yada RY, deOrduna RM. Kinetics of sugars, organic acids and acetaldehyde during simultaneous yeast-bacterial fermentations of white wine at different pH values. Food Research International. 2011;44:660-66.
29. Lambri M, Dordoni R, Giribaldi M, Violetta MR, Giruffrida MG. Effect of pH on the protein profile and heat stability of an Italian white wine. Food Research International. 2013;54:1781-1786. http://dx.doi.org/10.1016/j.foodres.2013.09.038
30. Mateo E, Torija MJ, Mas A, Bartowsky EJ. Acetic acid bacteria isolated from grapes of South Australian vineyards. International Journal of Food Microbiology. 2014;178:98-106. http://dx.doi.org/10.1016/j.ijfoodmicro.2014.03.010
31. Scott CF, Harbertsonb JF, Heymanna H. A full factorial study on the effect of tannins, acidity, and ethanol on the temporal perception of taste and mouthfeel in red wine. Food quality and Preference. 2017;62:1-7.
32. Meillon S, Urbano C, Guillot G, Schlich P. Acceptability of partially dealcoholized wines measuring the impact of sensory and information cues on overall liking in real life settings. Food Qual Prefer. 2010;21(7):763-73. https://doi.org/10.1016/j.foodqual.2010.07.013

33. Fontoin H, Saucier C, Teissedre PL, Glories Y. Effect of pH, ethanol and acidity on astringency and bitterness of grape seed tannin oligomers in model wine solution. Food Qual. Prefer. 2008;19(3):286-91. doi:10.1016/j.foodqual.2007.08.004
34. Jogaiah S, Kitture AR, Sharma AK, Sharma J, Upadhyay AK, Somkuwar RG. Regulation of fruit and wine quality parameters of Cabernet Sauvignon grapevines (*Vitis vinifera* L.) by rootstocks in semiarid regions of India. Vitis. 2015;54:65-72.
35. Bravdo B, Hepner Y, Loinger C, Cohen S, Tabacman H. Effect of crop level on growth, yield and wine quality of a high yielding Carignane vineyard. Am J Enol Vitic. 1985;35: 247-252.
36. Bravdo B, Shoseyov O. Aroma studies on fruits and wine in Israel. Acta Hort. 2000;526: 399-405. https://doi.org/10.17660/ActaHortic.2000.526.44
37. Silvilotti P, Zulini L, Peterlunger E, Petrussi C. Sensory properties of Cabernet Sauvignon wines as affected by rootstock and season. Acta Horticulturae. 2007;654:443-448. https://doi.org/10.17660/ActaHortic.2007.754.58
38. Teixeira A, Eiras-Dias J, Castellarin SD, Geros H. Berry Phenolics of Grapevine under Challenging Environments. International Journal of Molecular Sciences. 2013;14:18711-18739. doi:10.3390/ijms140918711