Evaluation of Wine Purpose Varieties of Grapes under the Environmental Condition of Malwa Plateau

S. R. Anjanawe[1*], I. S. Naruka[2], Asheesh Sharma[1] and Pradeep Mishra[1]

[1]*College of Agriculture, Powarkheda, J.N.K.V.V. (M.P.), India.*
[2]*KNK College of Horticulture, Mandsaur, R.V.S.K.V.V. (M.P.), India.*

Authors' contributions

This work was carried out in collaboration among all authors. Author SRA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors ISN and AS managed the analyses of the study. Author PM managed the literature searches. All authors read and approved the final manuscript.

Original Research Article

ABSTRACT

The quality of wine totally depends on the variety of grape. Grapes are unique among fruits. Ripe, they contain sufficient sugar and an appropriate amount of acid so that when they ferment enough alcohol is produced to make a palatable wine that is protected against imminent spoilage. In present investigation experiment was carried during 2014 to 2016 for 3 year. Treatment performance was observed using Tukey's mean separation method in 95% percent confidence interval. Under this experiment grape ten variety tested under different characteristics. From the result it is found that number of mature and fruitful cane maximum found in Shiraz variety 39.61 and 22.05. Total soluble Solid (TSS) and acidity is important aspect for wine preparation. Minimum TSS and acidity was found in Shiraz variety 0.62 and 18.5. Highest yield variety was recorded in Grenache. From the study, it is observed that performance of Shriraz variety is most suitable for wine preparation in Malwa plateau.

Corresponding author: E-mail: sranjanave@gmail.com;

1. INTRODUCTION

The grape (*Vitis vinifera*) is belong to family vitaceae, which consist 12 genera and 600 species, genus vitis consist 60 species. The grape grown is in relatively warm temperate climates and well adapted to sub-tropical or tropical areas. The grape is deciduous and perennial crop. The grape was one of the first fruit crop cultivated by human to produce table fruits, dry fruits, juice and wine preparation [1]. The grape is one of the world most widely grown fruit and history of grape cultivation is as old as that of man. Grape is unique fruit, not only a major global horticultural crop but also grape was one of the oldest fruit [2].

The genus Vitis comprises of three natural groups based on climatic adaption viz., North America, Eurapian and Asiatic. Eurapian has only one important species *Vitis vinifera,* which is major cultivated in the world. The Vitis vinifera originated in 'Caucasus' region between Caspian Sea and Black Sea, and secondary centre of origin of grape is North-West Himalaya, South Europe and Western Asia. Two-third of grape production in world comes from Europe. Grape production in the world is 74.50 MT with area 7.11 M ha and grape production major countries viz. China, USA, Italy, Spain, France and India etc. In India grape area and production is 136 Thousand ha and 2683 Thousand tonnes respectively. The India is highest grape productivity (21.91 t/ha) in the world (NHB, [3]).

In India grape cultivation is concentrated in the peninsular India, accounting for 90 percent of the total area covering major states Maharashtra, Karnataka, Andhra Pradesh, Tamil Nadu, Punjab, Haryana and M.P. etc. In India three distinct region of grape cultivation viz., temperate (Jammu & Kashmir, and H.P.), sub-tropical (Punjab, Haryana, Rajasthan and western U.P.) and tropical (Andhra Pradesh, Maharashtra, Karnataka and Tamil Nadu). The 94 percent of grape production in India comes from tropical region [4] as the state of Maharashtra share highest area (71.5%) and contribute 80% of total production in India followed by Karnataka and Andhra Pradesh. About 78 percent of world harvest is processed into wine, 9 percent is fresh consumed and 13 percent dried for raisins. Over fertilization of Nitrogen lead to vigorous growth (which may adversely affect wine quality). In Madhya Pradesh the production of grape only did in three district namely Ratlam, Mandsour and Neemach. Pruning weight or pruning intensity is important criteria in grape to determine and differentiate vigorous, non-vigorous varieties. Several studies have support that high yielding lines produced large pruning weight with high vigorous growth of wine and vice-versa [5,6,7] and number of canes produced by wine after pruning also determines the wine. Sprouting buds on spur is varietal character and response of wine to prevailing environmental conditions.

Numbers of leaves and leaf area per cane are two important traits which increase the photosynthesis in grape. Several authors support that variation in leaf area per cane [8,9] resulting in different yielding capacity of plant. The grape wine flowers are borne in clusters or panicle which develops on the third to fifth nodes of the currently growing shoot. The panicle develops on the node opposite the leaf. In fruitful cultivar up to 4 panicles (inflorescences) per shoot have been found. Fruits of grape wine are botanically called 'Berries' and a cluster of berries on rachis are known as Bunches. Each berry consists of a multi-layered pericarp and may contain up to four seeds, although a number of cultivar for fresh consumption are seedless.

The concept of heat unit requirement can be effectively used for determining the optimum time of harvest [10]. The time required for grapes to reach maturity is determined by the total amount of heat received from full bloom to ripening, which is expressed in terms of degree days [11]. Important product of grape wine juice, raisin and wine. The fermented product of grapes, wine has important way of consuming grapes [12]. Grape juice considered a beverage with positive energetic, nutritional and bioactive effects [13,14]. Wine is considered as a health drink and has been used as an important adjunct to the diet and has many medicinal value due to the presence of anti-oxidants which cure most of the human ailments especially the cardio vascular disease [15].

Wine is the fermented product known to the man kind since time of civilization. The production of wine is negligible in India due to limited domestic consumption and non availability of standard wine varieties to produce good quality wine of international standards. Most of the commercial grapes grown in our country are table varieties, when used for wine making, result in poor quality production of wine because of varieties suitable for wine making have specific characteristics to make sure quality of wine. Particular variety performs better under certain set of agro-climatic

conditions and may not perform well similarly under another set of agro-climatic conditions.

Wine contain complex product have volatile compounds, which is responsible for unique flavour. The flavour composition of wine is based on the variety and ripeness of the grape, climate & soil conditions, and wine making technique. These factors were affect wine quality and flavour of wine [16]. Studies conducted to classify wine according to origin by utilizing data regarding their volatile composition [17]. Sensory descriptive analysis studies to cluster wine into groups of different geographic origin [18,19].

2. MATERIALS AND METHODS

2.1 Multiyear Trial Analysis Randomized Block Design (RBD)

The experiment has been initiated during 2013-14 to 2015-16 at research field of College of Horticulture, Mandsaur, under AICRP on Fruits (Grapes).In present study multiple trial analysis randomized block design (RBD) method was carried out. The trial was laid out with 10 treatments (grape varieties) in RBD replicated four times . To meet the objective of investigation combined trial analysis has been used. To see the statistically significance between the treatments Tukey's mean separation method is used. Statistical analysis has been in JMP software [20]. The treatment details are:

Table A. Treatment details

Treatment no	Variety name
T_1	Cinsault
T_2	Convent Large Black
T_3	Grenache
T_4	Tempranillo
T_5	Cabernet France
T_6	Cabernet Sauvignon
T_7	Shiraz
T_8	Sangiovese
T_9	Carignane
T_{10}	Tsimlasky Chernyi

2.2 Present Study Based on Following Parameters

1. Girth of the stem (mm): The stem girth majored by vernier caliper in each treatment. Main stem girth measured in mm.
2. Number of mature cane/wine: The number of canes retained per wine after the fruit pruning was recorded.
3. No. of fruitful cane/wine: The number of canes retained per wine after the fruit pruning was recorded.
4. Days to panicales appearance: The panicle appearance was observed on the basis of day after fruit pruning.
5. Days to anthesis:The flower opening (days to anthesis) was observed on the basis of day after fruit pruning.
6. Days to fruit set:The days to fruit set was observed on the basis of days after fruit pruning.
7. Days to fruit ripening: The days to fruit ripening was observed on the basis of day after fruit pruning.
8. Average number of seed/berry: Average number of seed/berry was recorded by selecting and harvests five berries randomly in each replication than counting total of number of seed and divided by five.
9. Acidity(%): The acidity ratio (%) determined through titration of NaOH and phenolphthalein using of this formula.

Titrate X Acid Factor X 100 Percentage Acid
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10 (ml Juice)

10. TSS^{0}Brix:TSS (^{0}Brix) were majored by Hand refract meter in berries recorded .
11. Weight of bunch(g):The weight of bunch was determined by digital balance.
12. Weight of 100 berry (g): From each treatment hundred berries were randomly selected at harvest and their mean weight was recorded in grams.
13. Diameter of berry(mm): Average diameter of berry was recorded with the help of Vernier calipers at harvesting time by selecting five berries randomly in each treatment and was expressed in millimeters.
14. Berry Length(mm): Mean berry length was recorded with the help of Vernier calipers at harvest by selecting five berries randomly in each variety and was expressed in millimeters
15. Number of bunch:The mean bunch number was worked out on the basis of observations from a composite sample of ten canes chosen at random from every wine of each variety.
16. Yield/wine(kg):The number of bunches borne on the labeled spurs in each treatment was noted and weighed. The combined weight of these bunches was considered as the total yield per treatment and expressed in kilograms.

3. RESULTS AND DISCUSSION

The girth of the stem indicates the growth and standing of plant. From the (Table 1) result revealed that there was significant difference in various varieties of grapes. The Maximum girth of the main trunk (mm) was recorded in Variety Convent Large Black (35.66 mm) followed by Shiraz (34.41) and the lowest girth of the main trunk was recorded in the cabernet France(24.09).From the table any one can see that shiraz and cabernet sauvignon are statistically at par. The maximum mature cane per wine was recorded in variety Shiraz (39.61) while minimum mature cane per wine recorded in Cabernet France (23.62). Since the mature cane range are between 24 to 40 for all varieties.Also the all varieties are numerical different to each other, but statistically they are not significant to each other. Due to increase of number of mature cane it is effect number of fruiting cane in plant.

The difference in the pruning weight among the varieties may be attributed to the difference in the vigour of wine resulting from assimilation of carbohydrates due to more number of canes, number of leaves produced and other growth parameters result in more dry matter production. High pruning weight can be attributed to high number of cane per wine [21].

The highest fruitful canes per wine were observed with Tsimlasky Chernyi (25.14) followed by shiraz (22.05) and lowest fruitful cane per wine was recorded in sangiovese (6.33). Tsimlasky Chernyi and Shiraz are statistically different by using Tukey's mean separation. The earliest days for panicle appearance recorded in shiraz (18.5) while maximum days for panicle appearance was recorded in variety Carignane (21.5). In panicle appearance all the varieties are statistically at par to each other. Like the panicle appearance anthesis also shiraz variety has recorded minimum days. The more number of days to anthesis was recorded in variety Tempranillo (40.42) while lowest days to anthesis was recorded in Shiraz (35.33). The earliest days to fruit set was recorded in variety Convent Large Black (41) while maximum days to fruit set was recorded in variety Cabernet France (48.58). From the table, it is observed that in panicales appearance,anthesis and days of fruit set all the varieties are statistically not different to each other. The performance of Shiraz variety found better in paniclesappearance, anthesis and fruit days to ripening. This might be due to the genotypic character of the variety. The climatic

parameters influenced the grape wine phenology and grape ripening [22]. The earliest days to fruit ripening was recorded in variety Shiraz (135.75) while maximum days to fruit ripening was recorded in variety Cabernet (152.75).In case of Average number of seed per berry all the treatments was statistically at par. The highest average number of seed berry found in Sangivoese (2.49) and lowest in cabernet Sauvignon (1.57).

Wines with thicker canes and shorter internodes are known to bear a good crop as it is reflecting an optimum vigour in the wines.More photosynthates were portioned rigorously during vegetative phase. Deposited more food material at basal portion of the shoot. Thus, the cane diameter was more at lower buds and was less at distal end buds [23].

Table 2 provided the information of phonological characters acidity,TSS,weight of bunch, weight of 100 berry, diameter of berry and yield. From the table, it observed that acidity and TSS all treatment looks numerically different to each other but statistically they are same. In acidity highest found in Grenache (0.68) and lower in Shiraz and Tsimlasky (0.62) both.In TSS lowest recorded in Shiraz (18.5) and highest in Tsimlasky Chernyi (21.83). The bunch weight is not significantly among the treatments. The data obtained on bunch weight is presented in (Table 2).The maximum bunch weight (103.37 g) was recorded in Cinsault which was at par with Tsimlasky Chernyi. Generally the variety performed well with respect to bigger sized berries and number bunch which might have added to the bunch weight. Ibrahim et al. [24] reported that increase in cluster weight was probably due to the increase of berry weight and increase of leaf area per cluster in Deiss Anz cultivar. Whereas, the minimum bunch weight (52.27 g) was found Convent Large Black.
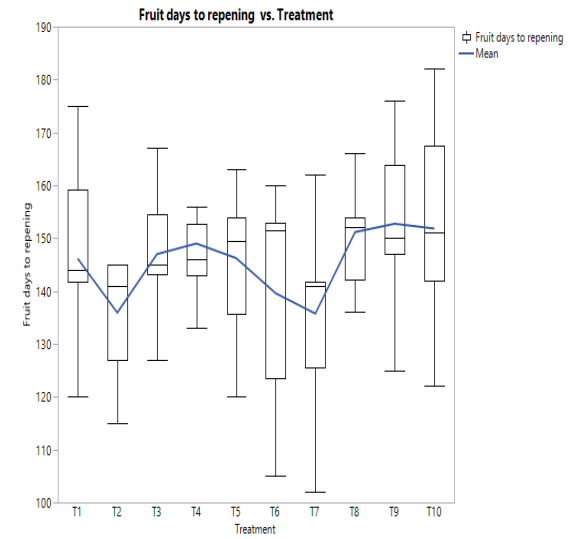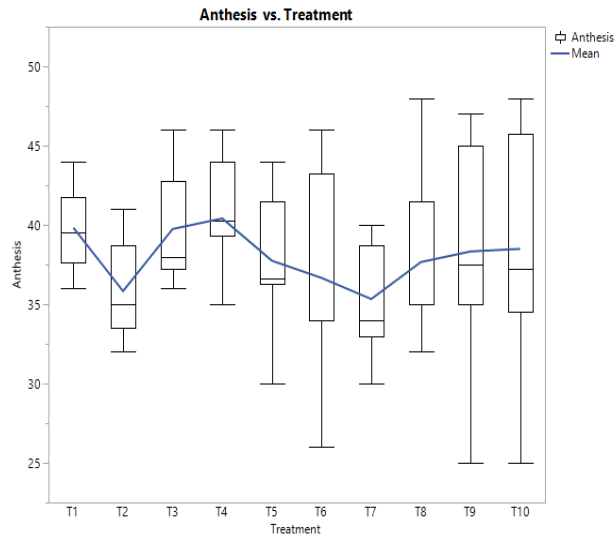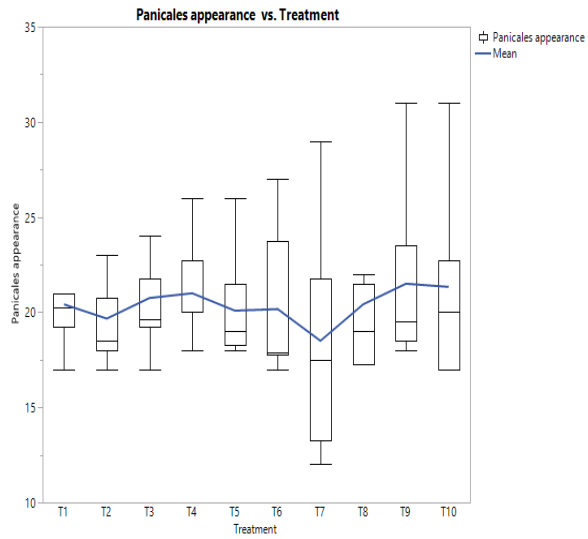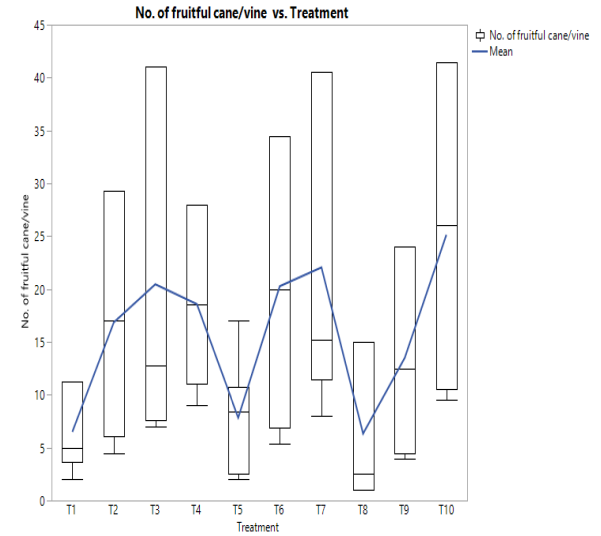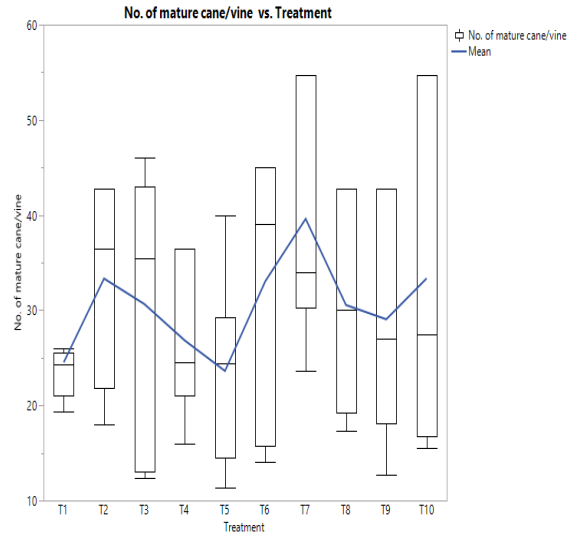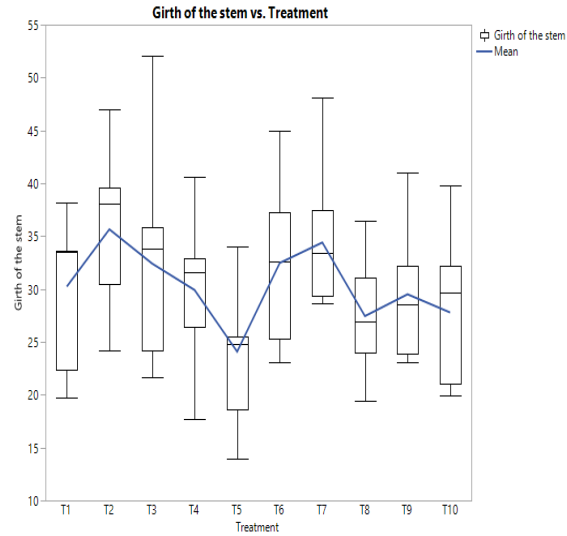
The maximum berry diameter of (17.42 mm) during harvesting was recorded in Convent Large Black which was at par with Cinsault. The minimum berry diameter of (11.72 mm) during harvesting was recorded in Cabernet Sauvignon followed by Shiraz (Table 2). Tempranillohad tendency of reduced berry diameter at later stages of berry development. Reduction in number of berries per bunch there will be increased berry length and diameter due to efficient utilization of nutrients into fruiting. The similar trends were obtained by Bravdo et al. [25] and [22] in Convent Large Black and Cabernet Sauvignon. The maximum 100 berry weight

Table 1. Evaluation of grape varieties for wine on quantitative attributes

Treat no	Variety name	Girth of the stem	No. of mature cane/wine	No. of fruitful cane/wine	Day to panicales appearance	Day to anthesis	Day to fruit set	Day to fruit repening	Av. No. of seed/berry
T1	Cinsault	30.25(abc)	24.53(a)	6.5(b)	20.42(a)	39.83(a)	43(a)	146.17(abc)	1.84(a)
T2	Convent Large Black	35.66(a)	33.33(a)	16.86(ab)	19.67(a)	35.83(a)	41(a)	135.92(c)	2.28(a)
T3	Grenache	32.43(ab)	30.65(a)	20.46(ab)	20.75(a)	39.75(a)	45.42(a)	147(ab)	2.12(a)
T4	Tempranillo	29.92(abc)	26.83(a)	18.58(ab)	21(a)	40.42(a)	48(a)	149(ab)	1.81(a)
T5	Cabernet France	24.09(c)	23.62(a)	7.83(b)	20.08(a)	37.75(a)	48.58(a)	146.25(abc)	2.1(a)
T6	Cabernet Sauvignon	32.48(ab)	33.06(a)	20.28(ab)	20.17(a)	36.67(a)	41.33(a)	139.58(bc)	1.57(a)
T7	Shiraz	34.41(ab)	39.61(a)	22.05(ab)	18.5(a)	35.33(a)	44(a)	135.75(c)	1.94(a)
T8	Sangiovese	27.45(bc)	30.55(a)	6.33(b)	20.42(a)	37.67(a)	45.5(a)	151.17(a)	2.49(a)
T9	Carignane	29.52(abc)	29.05(a)	13.5(ab)	21.5(a)	38.33(a)	47.25(a)	152.75(a)	1.94(a)
T10	Tsimlasky Chernyi	27.79(bc)	33.35(a)	25.14(a)	21.33(a)	38.5(a)	45.17(a)	151.83(a)	2.04(a)

Table 2. Evaluation of grape varieties for wine on qualitative attributes

Treat no	Variety name	Acidity	TSS	Weight of bunch(g)	weight of 100 berry(g)	Diameter of berry(mm)	Berry Length(mm)	Number of bunch	Yield/wine(kg)
T1	Cinsault	0.66(a)	18.92(a)	103.37(a)	228.89(ab)	15.97(ab)	18.28(a)	12.83(c)	1.31(a)
T2	Convent Large Black	0.65(a)	20.17(a)	52.27(a)	267.29(a)	17.42(a)	19.53(a)	76.5(a)	3.8(a)
T3	Grenache	0.68(a)	20(a)	83.9(a)	218.5(ab)	13.75(bc)	14.93(b)	72.92(ab)	6.04(a)
T4	Tempranillo	0.66(a)	19.75(a)	82.89(a)	158.47(ab)	13.71(bc)	14.75(b)	50.33(abc)	3.93(a)
T5	Cabernet France	0.65(a)	19.75(a)	81.77(a)	128.81(b)	12.19(c)	13.87(b)	15.17(c)	1.37(a)
T6	Cabernet Sauvignon	0.63(a)	19.08(a)	55.9(a)	110.48(b)	11.72(c)	12.7(b)	30.75(bc)	1.81(a)
T7	Shiraz	0.62(a)	18.5(a)	61.22(a)	126.95(b)	12.53(c)	14.57(b)	77.5(a)	5.6(a)
T8	Sangiovese	0.67(a)	20.67(a)	91.6(a)	129.4(b)	12.9(c)	14.42(b)	13.5(c)	1.31(a)
T9	Carignane	0.67(a)	19.5(a)	77.83(a)	122.77(b)	13.2(c)	14.19(b)	23.75(23.75)	1.86(a)
T10	Tsimlasky Chernyi	0.62(a)	21.83(a)	76.29(a)	119.63(b)	12.95(c)	14.07(b)	63.5(ab)	5.12(a)

Girth of the stem vs. Treatment

No. of mature cane/vine vs. Treatment

No. of fruitful cane/vine vs. Treatment

Panicales appearance vs. Treatment

Anthesis vs. Treatment
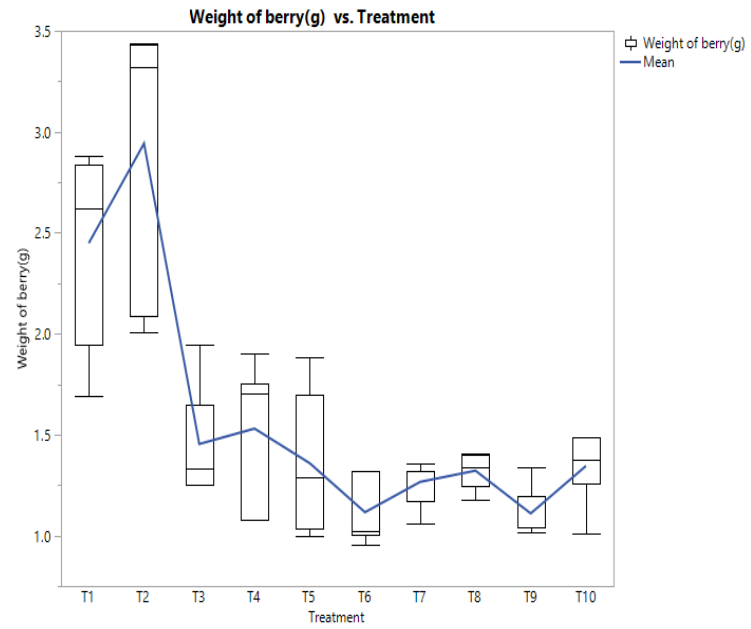

Fruit days to repening vs. Treatment

Fig. 1. Performance of grape wine variety under different characteristics
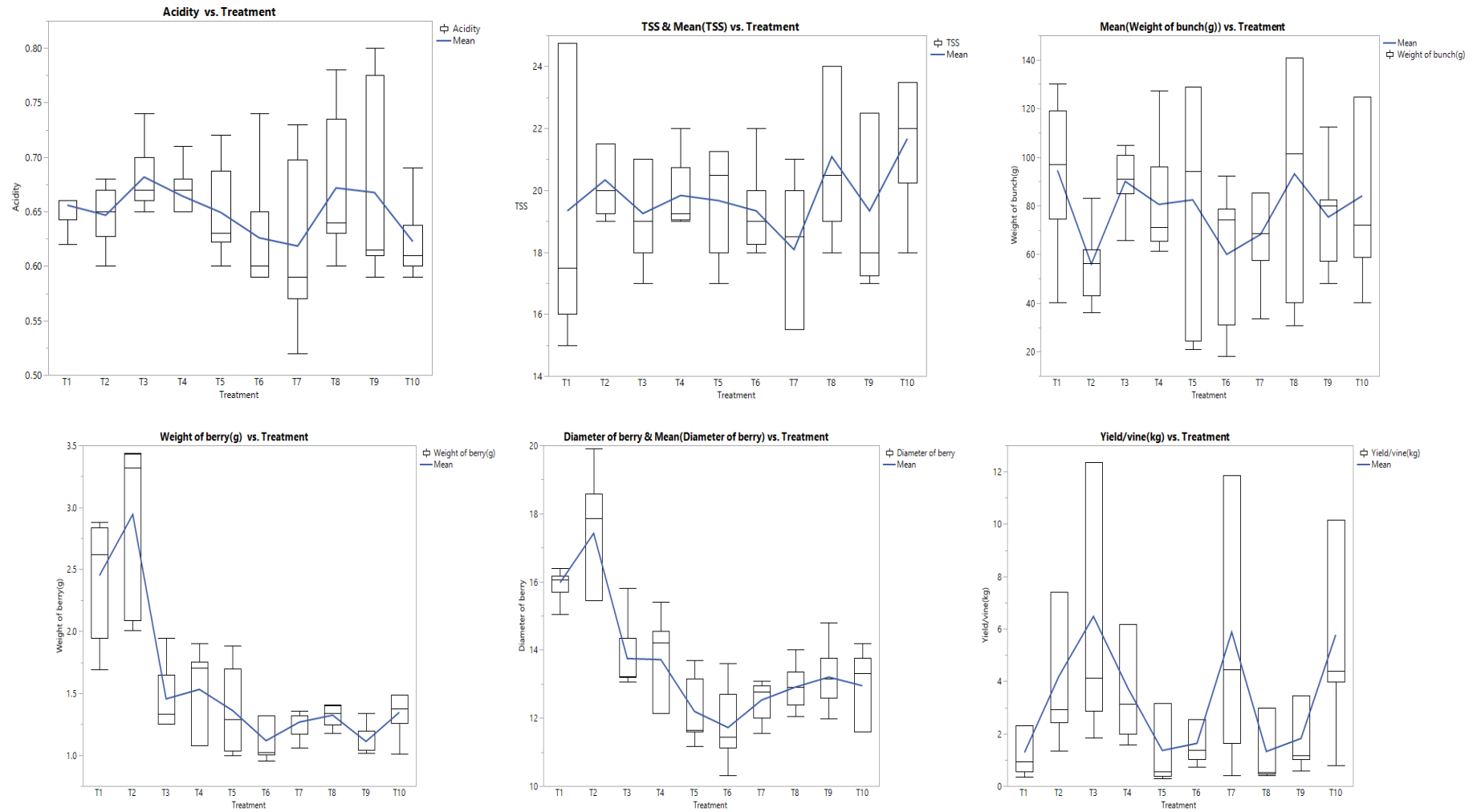
Fig. 2. Performance of grape wine variety for acidity, TSS. weight of bunch, berry and yield

of (267.29 g) during harvesting was recordedin Convent Large Black. As there will be less competition for nutrients for growth of berries. The minimum 100 berry weight of (110.48 g) was recorded in Cabernet Sauvignon. Cabernet Sauvignon is statistically at par with Sangiovese, Carignane and Tsimlasky Chernyi.

The number of bunches per wine significantly differed among the treatments. The data obtained on number of bunches per wine is presented in (Table 2). The maximum number of bunches per wine (77.5) was recorded Shiraz which was found at par with Convent Large Black. Whereas, the minimum number of bunches per wine (12.83) was recorded in Cinsault and it was on par with Sangiovese.

The mean length of the berry during harvesting was (12.7mm) was recorded in Cabernet Savignon. This may be due to some positive interaction in varieties at different stages of berry development for increasing the berry length. Maximum berry length (19.53 mm) was recorded in Convent Large Black which was on par with Cinsault (Table 2). Thus, Tempranillo had tendency of reduced berry length at later stages of berry development. Reduction in number of berries per bunch there will be increased berry length and diameter due to efficient utilization of nutrients into fruiting. The similar trends were obtained by Bravdo et al. [25] in Cabernet Sauvignon.

The yield in t/ ha significantly at par among the treatments. The data obtained on yield (kg) is presented in Table 2. The maximum yield (6.04 kg/wine ha) was recorded in Grenache, followed by Shiraz. The minimum yield (1.31 kg/wine) was recorded in Cinsault which was at par with Sangiovese. Crop recorded the negative correlation of yield per wine with average bunch weight and berry weight was recorded. The crop yield increased proportionally with the number of clusters per wine. The similar trends were obtained by Myers et al. [26] in Sangiovese grape wines, Somkuwar et al. [27] in grape wines and Noar et al. [28] reported that Sauvignon Blancgrape crop increased proportionally with the number of clusters upto 44 clusters per wine. All the treatments performance shared in Figs.1 and 2 respectively.

4. CONCLUSSION

This article concluded that different grape varieties were evaluated for wine purpose observed significant differences with respect to their quantitative as well as qualitative attributes. The girth of the main trunk, berry diameter and berry length were recorded highest in Convent Large Black. The maximum mature cane per wine and number of bunches per wine were recorded in Shiraz. The highest fruitful cane per wine and TSS were observed in Tsimlasky Chernyi. The highest acidity were observed in Grenache and lowest in Shiraz and Tsimlasky. The lowest TSS were recorded in Shiraz and highest in Tsimlasky Chernyi.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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