Evaluation of vegetative characteristics of white wine grape varieties for growth and yield parameters in semi-arid conditions of India

Abstract

The present study was conducted at ICAR- National Research Centre for Grapes, Pune during fruiting season of 2022-2023 and 2023-24. The variety Sauvignon Blanc stood out among white wine varieties, showing superior growth parameters like pruned biomass (0.853 Kg/vine), shoot length (102.56 cm), internodal length (7.89 cm), number of leaves (25.61/fruiting shoot) and yield parameter like number of bunches (60.50/vine). Minimum days taken to bud sprout (8.50 days) and higher shoot diameter (7.94 mm) was recorded in Charak-2. Higher leaf area was recorded in Riesling (3532.27 cm^2/fruiting shoot) and Muscat Petit (150.21 cm^2/leaf) varieties. Higher chlorophyll content was recorded in White Muscat (22.28 mg/ml). Higher number of berries (157.56/bunch) recorded in Trebbiano. Yield-related metrics like bunch weight (183.20 g) higher in Muscat Petit, 100 berry weight (186.80 g) in Riesling, yield in Marsanne (8.53 kg/vine and 10.32 MT/acre) for pooled mean basis.

Key words: white wine varieties, Grape, food product, vegetative characteristics

Introduction

Grape (*Vitis spp*. L.) is considered to be originated about 54 million years ago, but it's only been 6000 years when humans started domesticating and cultivating grapes (McGovern, 2003). Grape occupies an eminent position in fruit industry both in terms of area and economic returns and is grown widely in subtropical and temperate climates. Although grape is basically a crop of temperate origin, it is mainly grown in sub-tropical and tropical agro climatic conditions (Ghule *et. al*., 2021; Somkuwar *et. al*., 2021). In India, about 98% of the total area is covered for table or raisin purpose. Out of total production, only about 2% of the total production of grapes is being used for juice and winemaking (Ausari *et al*. 2024).

The International Organization of Vine and Wine (OIV) defines wine as a food product made solely through the complete or partial alcoholic fermentation of fresh grapes or their must, whether pressed or unpressed. Chemically, wine is a complex drink composed of water, ethanol, sugars, amino acids, polyphenolic compounds, anthocyanins, and various organic and inorganic substances (Avram *et al*., 2014; Karataș *et al*., 2015 and Bora *et al*., 2016). During 2023, global wine production, excluding juices and musts, was estimated at 237 mhl (OIV, 2024). Wine is one of the most popular beverages prepared from grapes through fermentation under the controlled conditions (Somkuwar *et al*. 2019). Due to rising

worldwide demand and consumption, wine market had quickest rate of growth, and the output increased by more than 40% in the last ten years (OIV, 2024). Berries with a high acidity and low sugar content and pH are advantageous for wines, as their quality is mostly determined by their acid level (Jones *et al*., 2014). Not only the climate affects and disrupt in grapes composition but also vineyard managements can improve the necessary acidity, sugar, and pH levels (Lavras, 2017).

Grape quality is directly affected by several factors, including the grape variety, eco-climatic conditions, soil properties (both physical and chemical), the winemaking process, transportation and storage of the wine, the extent of applied agro-technical practices, and the vineyard's location (Bora *et al*., 2015a; Condurso *et al*., 2015). A favorable climate is essential for stabilizing the productivity, while the inter-annual variability of atmospheric conditions can strongly influence the quality of grapes (Jones and Goodrich, 2008) and consequently the wine quality.

Wineries make wine using over 20 different types of white grapes. Around 90% of wine grapes cultivated in the world trace back to a single group known as *Vitis vinifera*. Among the white grape wine varieties, Sauvignon Blanc, Chenin Blanc, Chardonnay, Riesling, Semillon, Symphony, Gewurztraminer etc. are major varieties utilized for wine making. Quality of wine mainly depends upon grape variety grown in area, the climate available during the cultivation, management practices followed in the vineyard during growth stages and fermentation techniques (Karibasappa, 2013). The micro climates of grape growing regions of Maharashtra specifically Nashik and Pune are suitable to grow wine varieties and produce acceptable quality wine.

Materials and Methods

Experimental site: In the current study, growth, yield, and berry quality parameters of 17 white grape wine varieties (*V. vinifera* L.) grafted on Dogridge rootstock planted at National Research Centre for Grapes, Pune was undertaken during two seasons (2022-23 and 2023-24). The age of the vineyard was seven years old with good health and regular crop. The vines were trained to a mini-Y trellis system with single cordons trained in the horizontal direction while shoots were placed in a vertical position. The soil in the region is heavy black with pH 7.75 and EC 0.46 dS m^{-1}.

Experimental Design: All the varieties were planted at a spacing of 3 m between the rows and 1.5 m between the vines in a completely randomized setup with three replications and five vines per replication.

Procedure to record observations

Seventeen white wine grape varieties (White Muscat, Muscat Petit, Chenin Blanc, Riesling, Clairette, Charak-1, Charak-2, Charak-3, Charak-4, Vermentino, Viognier, Trebbiano, Marsanne, Colombard, Gewurztraminer, Gros Mesang and Sauvignon Blanc) were used as per the treatments for production and for further use in the study.

(A) Growth Parameters

Five vines were selected and marked within each replication and means of five vines was calculated for each parameter.

1. Weight of pruned biomass (kg/vine)

After pruning, pruned material from each vine was collected immediately and weighed using a weighing balance (Param weighing scale). The mean weight of biomass was calculated and expressed in kg/vine.

2. Days taken to bud sprout

Days to bud sprout were calculated after each pruning (foundation and fruit pruning). The first sprouted bud with fully expanded leaf was taken as an indicator to count the days to bud sprout (Satisha *et al.*, 2010)

3. Cane length (cm)

Five canes were selected randomly and tagged to measure cane length using measuring tape at 90 days after fruit pruning (DAP) and was expressed in cm.

4. Cane diameter (mm)

Cane diameter was measured between fifth and sixth node of cane from five different vines and the mean was expressed in millimeters (mm) at 90 days after foundation pruning.

5. Internodal length (cm)

Internodal length was measured between fifth and sixth nodes of canes using a measuring scale at 90 DAP during the fruit pruning. The mean was calculated and reported in centimeters (cm).

6. Number of leaves per fruiting shoots

Number of leaves per fruiting shoot was recorded by counting the number of leaves from selected canes at 90th day of fruit pruning. The mean number of shoots was worked out.

Five shoot were selected from each vines and it was measured using BIOVIS, leaf area meter at days after foundation pruning and their mean was expressed in cm^2.

8. Estimation of Chlorophyll

The chlorophyll content in the various parts of vine was estimated using the method of Witham *et al*. (1971).

(B) Yield Parameters

After harvesting bunches, five healthy bunches/vine were selected for recording the observations for yield and quality parameters.

1. No. of bunches per vine

Number of bunches per vine was recorded by counting number of bunches from three different vines and the mean of the three vines was calculated.

2. No. of berries per bunch

Number of berries was recorded by counting number of berries from five different bunches and mean of the five bunches was calculated.

3. Average bunch weight (g)

Five healthy bunches per replication were selected randomly at the time of harvesting and their mean weight was recorded using weighing balance. The mean average bunch weight was expressed in grams.

4. 100 berry weight (g)

A hundred berries from five bunches were selected under each replication and their mean weight was recorded using weighing balance. The mean 100 berry weight was expressed in grams.

5. Yield per vine (kg)

At the time of harvest, five vines were selected and tagged. The harvested grapes from these vines under each treatment were weighed using weighing balance. The mean yield of each vine calculated and was expressed in Kg.

6. Yield per acre (MT)

The grape yield per acre was calculated by following formula

$$\text{Yield (t/ha)} = \frac{\text{Yield/vine (kg)} \times \text{Vines/acre}}{1000 \text{ kg}}$$

Results and Discussion:

Growth parameters

Among the white wine varieties, Sauvignon Blanc consistently exhibited the highest pruned biomass during both years, indicating robust vine growth. Charak-1 showed the lowest pruning weight across the study period suggesting less vigorous growth compared to other varieties. During 2022-23 season, Sauvignon Blanc showed the highest weight of pruned biomass while during 2023-24 season, Riesling showed the highest weight of pruned biomass followed by Sauvignon Blanc. The difference in pruning weight among the varieties may be attributed to the difference in the vigour of vine resulting from assimilation of carbohydrates due to a greater number of canes, number of leaves produced and other growth parameters resulted in more dry matter production (Somkuwar *et al*., 2024b). A wide range of pruning weight was reported by several workers as 0.04 to 2.42 kg/vine (Kadu *et al*., 2007), 0.44 to 2.93 kg/vine (Havinal *et al*., 2008), 4.6 to 20.4 kg/vine (Shellie, 2007), 2.51 to11.09 t ha^{-1} (Karibasappa and Adsule, 2008), 0.91 to 3.78 kg/vine (Ratnacharyulu, 2010), 1.32 to 4.28 kg/vine (Jayalakshmi *et al*., 2019).

Charak-2 exhibited the quickest bud sprouting with a pooled mean of 8.50 days. While Muscat Petit, Chenin Blanc and Clairette all showed the slowest bud sprouting taking about 13.00 days on average across both years. This indicated a rapid initiation of growth cycle, which could be advantageous for regions with shorter growing seasons. The slower bud sprouting may suggest a more prolonged dormancy or slower transition into active growth. Bud burst is a varietal character as it marks the beginning of seasonal growth and is strongly influenced by temperature. The data on the growth parameter clearly indicated that prevailing temperature after pruning affects the time required for bud break in the same variety and the influence of temperature is more than that of variety (Somkuwar *et al.*, 2024a). Similar studies were reported by Gupta *et al*., (2015).

The shoot length of white wine varieties varied from 66.34 cm to 106.66 cm with maximum shoot length in Sauvignon Blanc during 2023-24 and pooled mean while Chenin Blanc recorded maximum shoot length during season 2022-23. Shoot growth is heavily affected by factors such as temperature, soil moisture, the nutrient and reserve status of the grapevine, the level of pruning, the age of the plant, and the genetic traits of the rootstock or scion (Keller *et. al*., 2010 and Jayalakshmi *et al*., 2019). Similar results were found by Anupama *et al*., (2016) and Ingole *et al*., (2018).

Higher shoot diameter reported was recorded in Charak-2 during 2022-23 with highest in White Muscat variety during 2023-24. Differences in cane diameter may be influenced by the vine's vigor as well as its age (Somkuwar *et al*., 2010). It was obvious that the vigour of the individual shoot increased with the decreased canes per vine which could be attributed to diversion of more metabolites to the canes (Anupama *et al*., 2016). Similar observations were also reported by Pina and Bautists (2006), Havinal *et al*., (2008), Soni *et al*., (2019) and Nidhi *et al*., (2023). In a well-maintained vineyard, the vines with thicker canes and shorter internodes are known to bear a good crop as it is reflecting optimum vigour in the vines. More photosynthates were partitioned rigorously during peak vegetative phase. This might have deposited more food material (Chalak *et al*. 2012).

Chenin Blanc showed higher internodal length during season 2022-23 and pooled mean data while during 2nd year maximum internodal length was reported in Charak-2. Higher internodal length in Syrah may be due to more shoot length which increases internodal length in between cane. Mostly shorter internodes accumulate higher carbohydrates food reserves which are pre-requisite for flower bud initiation (Jayalakshmi *et al*., 2019; Somkuwar and Ramteke, 2008)

Among the white wine varieties, Sauvignon Blanc recorded the highest number of leaves per fruiting shoot during both season (2022-23 and 2023-24) and pooled mean while Marsanne remained the variety with the lowest number of leaves per shoot. Such variation among the white grape wine varieties for leaf number may be attributed to difference in number of canes and vigour of the vine and the inherent varietal character (Veena *et al*., 2015). Similar results were also reported by Anupama *et al*., (2016).

Among the white wine varieties, Muscat Petit had the largest leaf area per fruiting shoot during 2022-23 season. During 2023-24 season and pooled mean data, Riesling led with the highest leaf area per fruiting shoot. The increase in leaf area per shoot and vine with

more leaves was due to the direct correlation between the number of leaves and the overall vegetative growth of the vine. However, decrease in leaf area per leaf showed limited resource distribution or reduce efficiency as the leaf number increased (Somkuwar *et al.*, 2024c, 2024d). Leaf area is strongly correlated with the annual shoots and cane growth; the most vigorous varieties usually have the highest annual growth (Borca *et al*., 2020). The optimum leaf number enhanced the overall leaf area, potentially contributing to higher photosynthetic capacity (source) and resource distribution (sink) for grape development (Somkuwar *et al.*, 2024e and Thoke *et al.*, 2024).

The variety White Muscat had highest average chlorophyll content followed by Muscat Petit. The chlorophyll content in leaf gives an indication of the efficiency of leaf to prepare food through photosynthesis (Somkuwar *et al.*, 2024d). The results of the present study confirm the earlier results of Somkuwar *et al*., (2024c) that the chlorophyll content in leaf ranged from 29.15 to 25.30 mg/ml among the treatments and 21.35 mg/ml to 19.14 mg/ml. More leaves can increase overall photosynthetic capacity. There may be an optimum leaf number beyond which chlorophyll content per leaf might begin to decrease. Maintaining an appropriate number of leaves can produce maximum chlorophyll content and photosynthetic efficiency without any negative effect (Somkuwar *et al.*, 2024d). Petrie *et al*., (2000) and Somkuwar *et al*., (2014b) observed that leaf removal led to an increase of chlorophyll content.

Yield Parameters

Sauvignon Blanc recorded the highest number of bunches per vine during both seasons (2022-23 and 2023-24). This difference in the number of bunches per vine may be attributed to varietal character due to a greater number of canes or immaturity of canes in different varieties. The increased number of bunches per vine increases the grape yield per vine with an increment in carbohydrate content in the berries to the maximum extent (Somkuwar *et al*., 2013 and Veena *et al*., 2015). Similar line of work in grapes was reported by Havinal (2007) and Jayalakshmi *et al*., (2019) Somkuwar *et al.*, (2024b).

The variety Trebbiano exhibited maximum average number of berries per bunch during both season (2022-23 and 2023-24). With the reduction in number of berries per bunch, there was increased berry length and diameter due to efficient utilization of nutrients into fruiting. Somkuwar *et al*., (2024b) reported maximum number of berries per bunch in Gross Mesang (127.22). In the present study, minimum number of berries per bunch was

recorded in Riesling (71.59). Similar line of findings was earlier reported by Havinal *et al*., (2008); Tecchio *et al.*, (2022).

The variety Muscat Petit had the highest average bunch weight, making it consistently heavy fruit bearer among the varieties studied. On the lower end, Gewurztraminer reported the lightest bunch. Similar line of work was reported earlier by Havinal *et al*., (2008); Anupama *et al*., (2016); Jayalakshmi *et al*., (2019) and Somkuwar *et al*., (2024b). Similar line of work was done earlier by Leao *et al*., (2017); Ingole *et al*., (2018).

The variety Riesling consistently had the highest berry weight, making it the variety with the most substantial berries while, Viognier had the lowest berry weight, indicating consistently smaller berries. The variation in the berry weight might be due to the difference in diameter and length of berries as was reported by Richard *et al.* (1999). The variation in berry weight may arise from differences in both the diameter of the berries and the number of berries/bunch (Thakur *et al.,* 2008).

The maximum yield was recorded in variety Marsanne (8.53 kg/vine) while minimum in Gros Mesang (2.75 kg/vine). Wide range of yield among different varieties of grape screened at different location has been reported from India and abroad (Shellie 2007; Ghosh *et al*. 2008; Karibasappa and Adsule 2008; Havinal *et al*. 2008 and Ratnacharyulu 2010) which support the results of the present study. Similar line of work is reported by Somkuwar *et al*. (2024a, 2024b), Tecchio *et al.*, (2022); Anjanawe et al., (2020); Ingole *et al*. (2018); Vijaya *et al*., (2018); Leao *et al*., (2017); Veena *et al*. (2015). In contrast, Anupama *et al*., (2016) found that the maximum yield was recorded in Tempranillo (27.40 kg/vine), followed by Grenache Blanc (24.33 kg/vine) while the minimum yield was recorded in Tsimlyansk Charny (7.50 kg/vine) which was on par with Sauvignon Blanc (8.03 kg/vine).

Conclusion:

The evaluation of growth and yield parameters of different white wine grape varieties over the 2022-23 and 2023-24 seasons revealed significant varietal differences. Sauvignon Blanc stood out among white wine varieties, showing superior growth parameters like pruned biomass, shoot length, number of leaves and yield parameter like number of bunches per vine. Minimum days taken to bud sprout; higher shoot diameter was recorded in Charak-2. Higher internodal length was observed in Chenin Blanc. Higher leaf area recorded in Riesling and Muscat Petit varieties. Higher number of berries per bunch recorded in Trebbiano. Varieties such as Muscat Petit excelled in yield-related metrics like bunch weight and 100

berry weight. Higher yield was observed in Marsanne. These findings underscore the varietal adaptability and potential for different wine profiles based on growth conditions and seasons, providing valuable insights for viticulture practices aimed at optimizing grape yield and wine quality.

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Table 1: Pruned biomass, days taken to bud sprout and shoot length data of white grape wine varieties during two growing seasons (2022-23 and 2023-24) and pooled mean data

Varieties	Pruned biomass (Kg)			Days taken to bud sprout			Shoot length (cm)		
	2022-23	2023-24	Pooled Mean	2022-23	2023-24	Pooled Mean	2022-23	2023-24	Pooled Mean
White Muscat	0.478	0.582	0.530	12.67	11.50	12.09	85.44	96.34	90.89
Muscat Petit	0.607	0.602	0.605	13.00	13.00	13.00	94.14	102.98	98.56
Chenin Blanc	0.694	0.721	0.707	13.00	13.00	13.00	99.22	104.33	101.78
Riesling	0.747	0.821	0.784	9.50	10.00	9.75	98.68	105.20	101.94
Clairette	0.540	0.628	0.584	13.00	13.00	13.00	88.67	98.00	93.34
Charak-1	0.384	0.535	0.460	9.67	10.00	9.83	82.77	87.89	85.33
Charak-2	0.379	0.507	0.443	8.00	9.00	8.50	80.11	90.34	85.22
Charak-3	0.300	0.290	0.295	10.67	10.00	10.34	66.34	71.86	69.10
Charak-4	0.346	0.385	0.365	11.33	11.00	11.17	78.70	83.57	81.13
Trebbiano	0.319	0.323	0.321	9.67	10.00	9.83	69.34	79.78	74.56
Marsanne	0.509	0.476	0.493	9.67	10.00	9.84	81.48	90.06	85.77
Viognier	0.470	0.572	0.521	9.33	10.00	9.67	84.80	91.86	88.33
Vermentino	0.503	0.546	0.525	10.67	10.00	10.33	86.20	91.53	88.87
Gros Mesang	0.513	0.549	0.531	9.50	10.00	9.75	89.35	94.88	92.11
Colombard	0.621	0.678	0.650	9.67	10.00	9.83	97.65	103.02	100.33
Gewurztraminer	0.537	0.574	0.555	9.33	10.00	9.67	87.31	98.46	92.89
Sauvignon Blanc	0.939	0.766	0.853	9.67	10.00	9.83	98.45	106.66	102.56
S.Em. (±)	**0.023**	**0.021**	**0.013**	**0.311**	**0.301**	**0.271**	**3.700**	**3.221**	**2.405**
C.D. (0.05)	**0.065**	**0.060**	**0.037**	**0.895**	**0.868**	**0.780**	**10.660**	**9.279**	**6.927**

Table 2: Shoot diameter, internodal length and number of leaves per shoot data of white grape wine varieties during two growing seasons (2022-23 and 2023-24) and pooled mean data

Varieties	Shoot diameter (mm)			Internodal length (cm)			Number of leaves per shoot		
	2022-23	2023-24	Pooled Mean	2022-23	2023-24	Pooled Mean	2022-23	2023-24	Pooled Mean
White Muscat	7.00	7.29	7.14	5.58	6.44	6.01	20.00	20.67	20.33
Muscat Petit	6.89	6.42	6.66	6.09	7.33	6.71	22.00	22.83	22.42
Chenin Blanc	7.33	6.72	7.03	6.58	7.89	7.23	23.00	24.67	23.83
Riesling	6.78	6.58	6.68	6.71	8.00	7.36	23.22	25.83	24.53
Clairette	5.89	5.28	5.59	6.06	6.89	6.47	21.44	21.50	21.47
Charak-1	6.22	5.95	6.09	4.85	6.00	5.42	19.00	19.67	19.34
Charak-2	8.89	7.00	7.94	4.82	5.89	5.36	18.89	19.33	19.11
Charak-3	8.11	6.17	7.14	3.98	5.00	4.49	15.44	18.67	17.06
Charak-4	7.55	6.84	7.20	4.80	5.88	5.34	18.55	19.17	18.86
Trebbiano	6.44	6.09	6.27	4.67	5.80	5.23	17.28	19.00	18.14
Marsanne	7.34	6.93	7.14	5.01	6.00	5.51	19.56	19.86	19.71
Viognier	5.00	5.58	5.29	5.09	6.20	5.64	19.72	20.33	20.03
Vermentino	6.44	5.84	6.14	5.32	6.22	5.77	19.83	20.50	20.17
Gros Mesang	5.80	6.03	5.92	5.93	6.71	6.32	20.33	20.83	20.58
Colombard	6.00	5.80	5.90	6.26	7.80	7.03	22.83	23.50	23.17
Gewurztraminer	5.89	5.49	5.69	6.03	6.78	6.41	21.11	21.18	21.15
Sauvignon Blanc	6.00	5.66	5.83	6.89	8.89	7.89	25.22	26.00	25.61
S.Em. (±)	**0.332**	**0.178**	**0.191**	**0.341**	**0.200**	**0.201**	**0.950**	**0.734**	**0.580**
C.D. (0.05)	**0.957**	**0.513**	**0.551**	**0.983**	**0.575**	**0.580**	**2.738**	**2.115**	**1.672**

Table 3: Leaf area per leaf, leaf area per fruiting shoot and cane chlorophyll content of white grape wine varieties during two growing seasons (2022-23 and 2023-24) and pooled mean data

Varieties	Leaf area per leaf			Leaf area per fruiting shoot			Chlorophyll content (mg/ml)		
	2022-23	2023-24	Pooled Mean	2022-23	2023-24	Pooled Mean	2022-23	2023-24	Pooled Mean
White Muscat	96.61	83.59	90.10	1953.52	1726.44	1839.98	22.10	23.95	23.03
Muscat Petit	152.91	147.32	150.12	3359.65	3362.01	3360.83	20.72	23.84	22.28
Chenin Blanc	97.55	72.26	84.90	2244.88	1778.29	2011.59	11.66	12.38	12.02
Riesling	137.63	150.28	143.96	3198.63	3865.92	3532.27	8.91	10.05	9.48
Clairette	131.36	120.60	125.98	2817.34	2597.78	2707.56	7.72	8.70	8.21
Charak-1	97.48	95.86	96.67	1854.55	1887.58	1871.06	12.43	13.47	12.95
Charak-2	119.10	104.65	111.87	2248.83	2023.03	2135.93	9.73	11.19	10.46
Charak-3	135.77	148.37	142.07	2096.10	2772.86	2434.48	7.55	8.02	7.79
Charak-4	94.04	109.15	101.60	1745.40	2092.88	1919.14	8.87	9.81	9.34
Trebbiano	137.97	120.06	129.01	2383.30	2287.29	2335.29	7.40	7.86	7.63
Marsanne	87.72	92.42	90.07	1714.97	1835.83	1775.40	8.45	9.53	8.99
Viognier	56.55	66.47	61.51	1116.73	1348.10	1232.41	9.46	10.88	10.17
Vermentino	111.96	92.49	102.23	2223.68	1900.40	2062.04	12.99	14.07	13.53
Gros Mesang	91.28	98.19	94.74	1857.80	2044.07	1950.93	13.41	14.82	14.12
Colombard	107.08	70.43	88.75	2447.63	1661.05	2054.34	17.21	19.80	18.51
Gewurztraminer	57.12	50.77	53.94	1204.52	1073.59	1139.05	14.84	15.76	15.30
Sauvignon Blanc	83.30	81.91	82.60	2101.43	2126.64	2114.03	9.35	10.33	9.84
S.Em. (±)	**2.986**	**3.808**	**2.409**	**142.059**	**92.281**	**86.438**	**0.368**	**0.448**	**0.300**
C.D. (0.05)	**8.603**	**10.970**	**6.940**	**409.225**	**265.831**	**248.997**	**1.061**	**1.291**	**0.864**

Table 4: Number of bunches per vine, number of berries per bunch and Average bunch weight of white grape wine varieties during two growing seasons (2022-23 and 2023-24) and pooled mean data

Varieties	Number of bunches per vine			Number of berries per bunch			Average bunch weight (g)		
	2022-23	2023-24	Pooled Mean	2022-23	2023-24	Pooled Mean	2022-23	2023-24	Pooled Mean
White Muscat	31.83	27.00	29.42	135.33	133.33	134.33	146.49	148.87	147.68
Muscat Petit	21.50	22.67	22.08	134.67	136.50	135.59	225.84	227.12	226.48
Chenin Blanc	51.50	49.30	50.40	134.00	130.00	132.00	156.35	152.81	154.58
Riesling	36.50	40.92	38.71	102.00	97.83	99.92	185.24	186.70	185.97
Clairette	33.00	35.33	34.17	74.67	77.33	76.00	93.06	93.02	93.04
Charak-1	33.50	35.00	34.25	107.00	104.33	105.67	173.06	172.88	172.97
Charak-2	49.50	47.84	48.67	102.33	102.00	102.17	159.49	160.60	160.05
Charak-3	43.33	46.00	44.67	116.67	110.17	113.42	164.42	161.34	162.88
Charak-4	30.50	34.33	32.42	109.89	102.00	105.95	134.16	134.69	134.42
Trebbiano	27.33	27.50	27.42	155.11	160.00	157.56	200.03	202.00	201.02
Marsanne	49.33	43.67	46.50	139.78	135.20	137.49	182.21	184.18	183.20
Viognier	40.83	45.33	43.08	150.22	151.00	150.61	134.63	136.07	135.35
Vermentino	41.17	39.75	40.46	83.84	77.33	80.59	133.04	131.11	132.07
Gros Mesang	19.00	17.33	18.17	122.44	117.67	120.06	152.92	150.72	151.82
Colombard	52.17	49.00	50.58	115.33	113.33	114.33	147.69	150.66	149.18
Gewurztraminer	39.50	38.00	38.75	91.00	89.28	90.14	83.47	84.78	84.13
Sauvignon Blanc	58.67	62.33	60.50	141.67	137.33	139.50	129.83	131.07	130.45
S.Em. (±)	**3.483**	**2.039**	**1.692**	**6.067**	**2.829**	**3.588**	**5.381**	**4.742**	**3.405**
C.D. (0.05)	**7.094**	**4.153**	**3.447**	**17.477**	**8.150**	**10.337**	**15.500**	**13.659**	**9.809**

Table 5: 100 berry weight, yield/vine and yield/acre of white grape wine varieties during two growing seasons (2022-23 and 2023-24) and pooled mean data

Varieties	100 berry weight (g)			Yield/vine (Kg)			Yield/acre (MT)		
	2022-23	2023-24	Pooled Mean	2022-23	2023-24	Pooled Mean	2022-23	2023-24	Pooled Mean
White Muscat	108.65	111.69	110.17	4.67	4.02	4.35	5.66	4.87	5.26
Muscat Petit	168.93	166.59	167.76	4.85	5.16	5.00	5.87	6.24	6.06
Chenin Blanc	117.59	117.55	117.57	8.05	7.54	7.80	9.74	9.12	9.43
Riesling	182.43	191.18	186.80	6.76	7.66	7.21	8.18	9.27	8.72
Clairette	124.60	120.96	122.78	3.07	3.29	3.18	3.71	3.98	3.85
Charak-1	161.88	165.92	163.90	5.80	6.04	5.92	7.02	7.31	7.16
Charak-2	156.03	157.53	156.78	7.89	7.66	7.77	9.55	9.27	9.41
Charak-3	141.22	146.27	143.75	7.10	7.44	7.27	8.59	9.00	8.80
Charak-4	123.34	132.05	127.69	4.11	4.63	4.37	4.97	5.61	5.29
Trebbiano	129.06	126.38	127.72	5.41	5.55	5.48	6.55	6.72	6.63
Marsanne	130.38	136.63	133.51	9.02	8.04	8.53	10.92	9.73	10.32
Viognier	90.18	90.17	90.18	5.50	6.16	5.83	6.66	7.46	7.06
Vermentino	158.50	169.62	164.06	5.50	5.21	5.36	6.65	6.31	6.48
Gros Mesang	125.09	128.20	126.65	2.89	2.61	2.75	3.49	3.16	3.33
Colombard	131.09	134.04	132.57	7.72	7.38	7.55	9.35	8.93	9.14
Gewurztraminer	91.86	95.64	93.75	3.29	3.22	3.26	3.98	3.90	3.94
Sauvignon Blanc	91.68	95.51	93.59	7.62	8.16	7.89	9.22	9.88	9.55
S.Em. (±)	**7.841**	**5.075**	**4.081**	**0.449**	**0.307**	**0.242**	**0.543**	**0.371**	**0.293**
C.D. (0.05)	**22.587**	**14.620**	**13.829**	**1.294**	**0.884**	**0.698**	**1.565**	**1.070**	**0.845**