Evaluation of juice and wine varieties of grapes (Vitis spp) for petiole nutrient content, bud break, yield and yield components

D Vijaya, G Ram Reddy, Veena Joshi, Mamatha and D Anitha Kumari

Abstract

Twelve grape varieties (six wine grape varieties from Vitis vinifera and six juice varieties derived from the V. labrusca and complex interspecies hybrids with V. vinifera) were evaluated for Southern Telangana Zone at Grape Research Station, SKLTSHU, Hyderabad. The experiment was conducted for six years from 2009-10 to 2014-15 for petiole nutrient content, bud break, yield and yield components. The petiole N concentration varied significantly from 0.90% in Chenin Blanc to 1.17% in Savignon Blanc and a negative correlation was recorded with juice yield (r = - 0.46). The petiole P content ranged significantly from 0.51% in Gulabi × Bangalore Purple to 0.66% in Savignon Blanc (%) and a positive correlation was recorded with yield (r = 0.37) and juice yield (r = 0.33). The petiole K content was significantly lowest in Bangalore Blue (2.95 %) and highest in Shiraz (4.09 %) and a positive correlation was recorded with yield (r = 0.44) and juice yield (r = 0.67). Hence petiole nutrient content should be considered when developing fertilization programs where it is possible to reduce the application of nutrients in varieties recording high absorption capacity. Significantly lesser number of days for bud break was required for varieties Chenin Blanc (8.6 days) and Pusa Navrang (9.9 days). A strong negative correlation was observed (r = - 0.88) between yield and days taken for bud break. Significantly highest yield was recorded with red wine variety Shiraz (25.2 kg vine⁻¹) followed by white wine cv Chenin Blanc (21.6kg vine⁻¹) and juice variety Pusa Navrang (17.8 kg vine⁻¹). Lower yields ranging from 3 to 4.2 kg vine⁻¹ was recorded with red wine cv Zinfandel, Merlot and Cabernet Sauvignon. While other varieties recorded moderate yields. Significantly highest juice recovery was recorded in white wine cv Chenin Blanc (66.7%) followed by juice cv Athens, H - 23 and Pusa Navrang and red wine cv Shiraz and Cabernet Sauvignon. These results signify the high potential of Southern Telangana Zone for growing wine and juice varieties with further efforts to improve the quality.

Keywords: Wine cultivars, juice cultivars, mineral nutrient content, bud break, yield

Introduction

Grape cultivation in India has been commercially taken up under a wide range of soil and climatic conditions. Major grape-growing states are Maharashtra, Karnataka, Telangana, Andhra Pradesh, Tamil Nadu, and the north-western region covering Punjab, Haryana, western Uttar Pradesh, Rajasthan and Madhya Pradesh. Currently, Thompson Seedless is the ruling grape variety occupying 55% of the area with its clones. In India, productivity is highest among the grape growing countries of the world (http://apeda.gov.in/). In India only 4 percent of the fruits are processed compared to China (23 %), Indonesia (50 %) and Brazil (70 %) (https://www.midh.gov.in). On the other hand, in India approximately 85 percent of the total production in India, irrespective of the variety, is consumed fresh. About 120,000 tonnes of Thompson Seedless and its mutants, namely, Tas-A-Ganesh, Sonaka and Manik Chaman are dried for raisins. Some 20,000 tonnes of Bangalore Blue are crushed to make juice, and 10,000 tonnes of Bangalore Blue, Cabernet Sauvignon, Chenin Blanc, Chardonnay, Merlot, Pinot Noir and Uni Blanc are crushed to process into wine (http://www.fao.org/docrep/003). The commercial variety of grapes cultivated in Telangana State is Thompson Seedless and its clones. There is hardly any cultivation of juice and wine grapes in Telangana region. There is a need to diversify the uses of grapes in this region. Grape growers of this region are facing many cultural problems in cultivation of table grapes such as scarcity of water, heavy plant protection schedule, excess use of plant growth regulators, ideal canopy management and quality yield in addition to the disorders. Similarly, more attention needs to be given for berry size, colour and weight, bunch weight, sugar content, acidity etc. to produce quality grapes for export, which further increases the cost of production (Ramteke, 2000) [39]. Diversification of
grape uses to wine / juice can ease the marketing problems, add to the value chain, reduce risk and increase profitability. The juice and wine sector is currently demonstrating positive and dynamic growth mainly due to a change in lifestyle, the tendency of consumers to prefer healthy products and an increase in purchasing power. Fruit juices and wine form part of what are termed the “new age beverages.” India is not traditionally a wine drinking country. The Indian wine industry has been steadily growing over the last ten years. Wine is gradually becoming a part of urban Indian lifestyle. This shows the need for development of juice and wine industry in Telangana, for domestic as well as for export market. As a preliminary step there is a need to find the suitability of this region for growing grape varieties suitable for juice and wine making, which require less attention as and also give good returns to grape growers as compared to table grapes by considering the returns per unit cost of production. Grape juice is obtained from crushing and blending grapes into a liquid. In the wine industry, grape juice that contains 7-23 percent of pulp, skins, stems and seeds are often referred to as “must”. The sugars in grape juice allow it to be used as a sweetener, and fermented and made into wine, brandy, or vinegar. Petiole mineral nutrients not only effect yield but also quality. Keeping this in view six wine grape varieties from Vitis vinifera, i.e four red wine varieties (Merlot, Syrah, Zinfandel and Cabernet Sauvignon) and two white wine varieties (Sauvignon Blanc and Chenin Blanc) as well as six juice varieties derived from the V. labrusca and complex interspecies hybrids with V. vinifera (Athens, Pusa Navrang, Bangalore Blue, E 12/2, Gulabi x Bangalore Purple and H23) were evaluated for their influence on petiole nutrient content, bud break, yield and yield components with an objective to find suitability of Southern Telangana Zone for growing juice and wine varieties at Grape Research Station, SKLTSHU.

Materials and Methods
An experiment on “Influence of juice and wine varieties for petiole nutrient content, yield and yield components” was conducted for six years from 2009 - 10 to 2014 - 15 at Grape Research Station, SKLTSHU (18°45’ N; 77°85’ E) situated at an altitude of 542.6 m above mean sea level, with the average annual rainfall of 800 mm, R’Nagar, Hyderabad. A field trial was carried out with 12 grape varieties grafted on Dogridge rootstock replicated four times in a Randomized Block Design, four-vines were grown in each replication. To know the suitability of juice and wine cultivars for cultivation in Telangana State six wine grape varieties from Vitis vinifera, of which four belong to red wine varieties (Merlot, Syrah, Zinfandel and Cabernet Sauvignon) and two belong to white wine varieties (Sauvignon Blanc and Chenin Blanc) in addition to six juice varieties derived from the V. labrusca and complex interspecies hybrids with V. vinifera (Athens, Pusa Navrang, Bangalore Blue, E 12/2, Gulabi x Bangalore Purple and H23) grafted on Dogridge were evaluated for the influence of these cultivars on petiole nutrient content, bud break, yield and yield components.

Red Wine Varieties
- **Cabernet Sauvignon:** It is one of the world's most widely recognized red wine grape varieties. It is grown in nearly every major wine producing country among a diverse spectrum of climates. The grapes have thick skins and the wines are hearty and naturally low yielding.
- **Zinfandel:** It is a variety of black-skinned wine grape. The grapes typically produce a robust red wine.
- **Shiraz:** It also known as Syrah. It is a dark-skinned grape variety grown throughout the world and used primarily to produce red wine.
- **Merlot:** It is a dark blue-colored wine grape variety. It is used as both a blending grape and for varietal wines. It is also one of the most popular red wine varietals in many markets.

White Wine Varieties
- **Chenin Blanc:** It is a white wine grape variety from the Loire Valley of France. Its high acidity means it can be used to make everything from sparkling wines to well-balanced dessert wines.
- **Sauvignon Blanc:** It is a green-skinned grape variety that originates from the Bordeaux region of France. Depending on the climate, the flavor can range from aggressively grassy to sweetly tropical.

Juice Varieties
- **Pusa Navrang:** It is a hybrid released from IARI, New Delhi. Parentage is Madelien Angevine x Rubi Red. The vines are anthracnose resistant, spur bearer and early ripener. Teinturier berries, dark red coloured, suited for juice and port wine.
- **Athens:** It is a red seeded variety with bold berry size. The fruit is pleasantly flavoured suited for juice and port wine. It belongs to Vitis labrusca species.
- **Bangalore Blue:** It is a vinifera and labrusca hybrid. Skin is thick, slip skin type, rough, transparency poor. Pulp is mucilaginous, juicy, foxy in flavour, veins visible but not prominent. Juice purple thick, coloured, clear, pleasantly flavoured.
- **E 12/2:** It is a hybrid between Bangalore Blue x Convent large black. The juice of this variety is slightly purple coloured and has high acidity.
- **Gulabi x Bangalore Purple:** It is the hybrid variety superior than Bangalore purple and has the characters of Gulabi. The Dogridge rootstock was planted with 1.83 m between vines in rows spaced 3.05 m apart during March 2009. All the twelve varieties were grafted on Dogridge rootstock by wedge grating method as scions. All the vines were trained to Y trellis. The initial soil pH (1:2.5 soil:water) = 6.2, EC (1: 2.5 soil: water) = 0.08 dS m⁻¹, organic carbon =0.48 %, mineralizable N = 268.8 kg ha⁻¹, available P (Olsen’s P) = 10.1 kg ha⁻¹ and Ammonium Acetate extractable K⁺ = 201 kg ha⁻¹. The vineyard was drip-irrigated using 2 emitters with a flow rate of 8 l/hr, placed 60 cm apart. The vines were fertilized with a dose of 500 kg N (five splits), 500 kg P₂O₅ (four splits), and 1000 kg K₂O per ha/year (five splits) along with FYM 20 t ha⁻¹ and micronutrients. Necessary prophylactic plant protection measures were undertaken to overcome the pests and diseases. If the yield potential is to be influenced in the current season by fertilizer practices, it is necessary to sample prior to bud differentiation so that treatments can be applied to increase the number of inflorescences at the expense of tendrils if necessary. (Bhargava and Sumner, 1987) [6].

All the vines were pruned twice in an annual growth cycle, which is a common practice in tropical viticulture. Mineral nutrient composition (Total N, P and K) was analyzed for three years from 2009-10 to 2012-13 in the petioles collected from 5th leaf at bud differentiation (45 days after back pruning) following standard methods.
The samples were washed; oven dried at 65°C and then pounded using agate mortar and pestle. The petiole samples were digested with di acid and analyzed for nutrients using standard procedures. P was estimated by vanado molybdate yellow colour method using spectrophotometer and K by using flame photometer. Total N in petioles was determined by the Kjeldahl distillation method after digesting with sulphuric acid (Tandon, 2005) [33]. Only the average values over the three years are presented in this report.

The observations were recorded for six years on days taken for bunches vine−1, average bunch weight (g) 100 berry weight (g), TSS (° Brix) which was measured after forward pruning. Yield (kg vine−1) was determined as number of bunches vine−1 x average bunch weight (g). Juice yield (%) was estimated crushing 100 g of representative berries. The juice was expressed through muslin cloth by hand and was weighed on a weighing balance and percent juice yield was calculated and its total soluble solids (° Brix) were recorded using hand refractometer. Results of all six years (2009-10 to 2014-15) were combined and analyzed online using OPSTAT Statistica. Only average values over the six years are presented in this report.

Results and Discussion

Petiole Mineral Nutrient Content

Nitrogen (%)
The grand mean value (mean over three years) revealed significant differences in petiole total nitrogen concentration of wine and juice varieties of grapes (Table 1). Among wine varieties significantly lowest mean N content was found in Chenin Blanc (0.90%) and higher content in Savigon Blanc (1.17%) which was on par with Zinfandel (1.16%). Whereas, among juice varieties mean petiole N content ranged from significantly lowest in E12/2 (1.0%) to highest in Gulabi x Bangalore Purple (1.29%). This indicates an overall variation of 0.39 per cent petiole N content among genotypes. In agreement with this variation observed Christensen (1984) [8] in study with twenty-six grape cultivars over three years stated that total N did not show wide cultivar differences. When only the mean values were considered without taking the yearly variation into consideration for correlation. There was a negative correlation between mean petiole N content and mean yield per vine (r = -0.26) and mean juice yield (r = -0.46). The low correlation values indicate that in addition to petiole analysis values much work is necessary to elucidate all the factors and conditions leading to fluctuations in fruit and juice yield. However, in a survey conducted in 30 tropical vineyards by Muthukrishnan and Srinivasan (1974) [26] a significant negative correlation (r = -0.946) was recorded between petiole N and fruitfulness.

Phosphorus content (%)
P plays role in promoting fruitfulness through synthesis of higher rates of DNA in the buds (Madhavarao and Srinivasan, 1971) [23]. Adom Jacobs (2002) reported P content induces the flower initiation through synthesis of proteins and nucleic acids favorable for inflorescence formation. Its role also has bearing on energy storage and transfer. The grand mean across three years which gives a general indication of the P status of variety, revealed that significantly lower mean P content among juice varieties was found in the Gulabi x Bangalore Purple (0.51%) which was on par with H23 and E12/2 and a higher content was observed with Bangalore Blue (0.60%) which was on par with Pusa Navrang. Among wine varieties Merlot (0.57%) and Savigon Blanc recorded significantly lower P content whereas Shiraz (0.66%) and Cabernet Sauvignon (0.64%) recorded significantly higher values. The 12 cultivars tested did not show wide cultivar differences. Among a variation of 0.15% in the P content was recorded (Table 1). This could be one of the reason for obtaining less positive correlation value between yield (r = 0.37), juice yield (r = 0.33). Higher yields and juice were obtained in cultivars like Chenin Blanc as compared to Cabernet Sauvignon without showing a substantial increase in petiole P content. This can be substantiated by the findings of Grant Mathews (1996) [13] who reported that Chenin Blanc is more suitable for low P soils and its growth was less inhibited by exposure to - P than Cabernet Sauvignon.

Potassium content (%)
The grand mean petiole K value which gives a general indication of the K status of variety, revealed that significantly lower mean petiole K content among juice varieties was found in Bangalore Blue (2.95%) and higher content was observed with H-23 (4.51%). Among wine varieties Merlot (2.95%) and Zinfandel (3.14%) recorded significantly lower K content whereas Shiraz (4.09%) recorded significantly higher values which were on par with remaining wine varieties. A wide difference of 1.56 % K content was recorded among genotypes. In concomitance with this result Christensen (1984) [8] in study with twenty-six grape cultivars over three years stated that cultivars showed wide K level differences among them, especially in the petioles. This variation among the varieties for petiole K content may be attributed to varietal character. Across the yearly variation the mean petiole K contents of varieties showed positive correlations with yield (r = 0.44) and juice yield (r = 0.67). There have been several suggestions on role of K in inflorescence formation in the grape vine and to promote fruitfulness through its enzyme activating property (Srinivasan and Mullins, 1981) [36].

Calcium content (%)
Among juice varieties significantly lower mean Ca concentration was found in the E 12/2 (0.96%) which was on par with H - 23 (0.96 %), while the higher content was recorded in Athens (1.45%) which was on par with Bangalore Blue (1.37%). Among wines varieties mean petiole Ca concentration varied significantly from a lower Ca content was recorded in Cabernet Sauvignon (0.96 %) and Chenin Blanc (1.16%) to higher content in Zinfandel (1.40 %) and Merlot (1.37%). There was a variation of 0.55 per cent petiole Ca content among genotypes (Table 1).There was a negative correlation between mean petiole Ca content and mean yield per vine (r = -0.21) and juice yield (r = -0.07). In a hortodic study, Garcia et al. (1999) [12] investigated the effects of Ca and K ratios on the nutrition of grapevine. The Ca concentration in the petiole increased with the application of Ca but it was noticed that the increase in Ca content in the plant was dependent on the K concentration.

Juice recovery (percent)
Juice recovery percent was significantly highest in wine cv Chenin Blanc (66.7%) whereas it was between 60 - 65 % in juice cv Athens H - 23 and Pusa Navrang and wine cv Shiraz and Cabernet Sauvignon. Juice percent ranged between 55 - 60 % in wine cv Merlot, Savigon Blanc & Zinfandel and juice cv Gulabi x Bangalore Purple & Bangalore Blue.
followed by lowest in juice cv E 12/2 (49.6%) (Table 1). Among other studies which included some of the wine varieties used in this study Karibasappa and Adsule (2008) recorded higher juice recovery in Cabernet Sauvignon (70.0%), Chenin Blanc (67.8%), Zinfandel (67.5%) and Shiraz (67.6%). Among the studies that included juice variety cv Pusa Navrang a juice percent of 64.4% was recorded in a study conducted at Lucknow (Ram et al. 2002) while 69.1% was recorded at West Bengal (Ghosh et al. 2008) and 68% was recorded at NRCG, Pune in Pusa Navrang. In addition, juice percent of cv Gulabi x Bangalore Purple and Country Bangalore was reported to be 67.2 and 66.7% at NRCG, Pune. (http://www.krishisewa.com/articles)

**TSS (Brix)**

The results presented in table 1 revealed that TSS was significantly highest in juice cv Bangalore Blue (20.8 B) followed by Savignon Blanc (19.4 B). The TSS of juice cv Pusa Navrang, Athens and wine cv Zinfandel, Cabernet Sauvignon varied between 18-19 B followed by juice cv E 12/2, Gulabi x Bangalore Purple, wine cv Merlot, Chenin Blanc, and Shiraz which varied between 17-17.5 B and the lowest TSS was recorded in cv H-23 (16.4 B). Negative correlation (r = - 0.22) was recorded between yield and TSS. These results are in agreement with the findings at NRCG, Pune which recorded a TSS of 17.9, 18 and 16.5 B with Pusa Navrang, Gulabi x Bangalore Purple and country Bangalore respectively (http://www.krishisewa.com/articles/). Among the other studies that included juice variety cv Pusa Navrang a TSS of 18.0 B was recorded at Lucknow (Ram et al., 2002) and 18.6 B was recorded at West Bengal (Ghosh et al., 2008). Most of the studies conducted in India and abroad recorded much higher TSS in the wine genotypes than obtained in the present study which could be because of the management practices followed to improve the quality. A weak negative correlation (r = -0.22) was recorded between yield and TSS. In a similar study conducted at NRCG, Pune, Karibasappa and Adsule (2008) noticed higher TSS of the must in Merlot (23.1 B) and Cabernet Sauvignon (22.2 °B). Sauvignon Blanc (20.8 °B) while low TSS was recorded in Chenin Blanc (18.5 °B). Haselgrove et al. (2000) reported that TSS of Shiraz was 21.3 °B at 35 days and increased to 25.8 °B at 46 days after veraison. Substantiating this Anupama (2015) observed that the TSS increased from 23.1 to 26.3 °B in Shiraz, from 18.6 to 19.1 °B in Chenin Blanc while it decreased from 25.4 to 24.4 °B in Savignon Blanc and slightly from 20.3 to 20.2 °B in Cabernet Sauvignon when the number of days for harvest increased from 35 to 42 days respectively. Across different rootstocks Keller et al. (2012) recorded 23.9 ± 0.2 in Syrah and 24.0 ± 0.2 in Merlot in arid eastern Washington. In research carried out at ICAR-NRC for Grapes significant differences were observed in TSS under different training system recording a maximum of 23.97 °B in Cabernet Sauvignon on 110R (Annual Report 2016-17). A significant effect of rootstocks was recorded with 24 °B in Sauvignon Blanc on Dogridge a rootstock used in this study (Annual Report 2017-18). The variation in TSS could be because of experimental conditions. Hence, further studies are required in this region for improving the quality of wine and juice grapes by regulation of bunch load, training, pruning level, pruning time, harvest time, irrigation, fertilization etc.

**Yield and Yield Components**

In the present work, the effect on yield and yield components of scions seem to result from specific interactions between scion and rootstock cultivars (Table 2).

**Number of Bunches**

When six years of data was averaged, it was observed that there was a wide variation among the genotypes with respect to number of bunches which ranged from 21.2 in Athens to 125 bunches in Chenin Blanc. Significantly lesser number of bunches (<30) were produced in juice varieties Athens, H-23 and wine varieties Zinfandel, Merlot. Significantly higher number of bunches (> 100) were recorded in wine varieties Chenin Blanc and Shiraz followed by Savignon Blanc and juice varieties Pusa Navrang, Gulabi x Bangalore Purple which recorded between 70 - 100 bunches. Remaining varieties recorded medium number of bunches ranging
between 30 – 50 (Table 2). In previous work on own root Veena et al. (2015) [38] also reported highest bunches in Shiraz among red wine varieties, and Chenin Blanc among white varieties. A wide range in number of bunches was reported by several workers 9.3 to 33.4 (Kadu et al., 2007); 58.3 to 142.0 (Ratnacharyulu, 2010) [31]. A very strong correlation was obtained between number of bunches and grape yield (r = 0.94) in this study which could because of the increase in carbohydrate content with increased number of bunches per vine. In most of the previous work fixed number of bunches were retained for obtaining good quality unlike in the present study making the comparison difficult.

**Bunch Weight (g)**

The data presented in table 2 revealed that the bunch weight varied among the genotypes from 121.2 g in Cabernet Sauvignon to 320 g in H - 23. The bunch weight of juice varieties Bangalore Blue and E 12/2 and wine varieties Cabernet Sauvignon, Savignon Blanc, Zinfandel and Merlot was statistically similar which ranged from 125 to150 g, followed by juice cv Pusa Navrangi (154.9 g) and wine cv Chenin Blanc (165.3 g). Higher bunch weight ranging from 180 to 320 g was recorded with other varieties under study with fairly significant cultivar differences. Yield per vine was very weakly correlated with bunch weight (r = 0.14) which indicates that the yield of these varieties was related more to bunch number rather than bunch weight. In concomitance with the results obtained lowest bunch weight was recorded in Cabernet Sauvignon among red wine varieties (Annual Report 2013-14, NRC for Grapes). Earlier reports conducted at various places suggest high variation in bunch weight ranging from 44.9 to 436.1 g among 30 grape varieties evaluated at Hassar (Daulta et al., 1972) [10], ranging from 230 to 757 g in grape cultivars useful for processing in Himachal Pradesh (Sharma et al., 1993) [37], ranging from 88 to 310 g in wine cultivars of Australia (Richard et al., 1999) [32]. The differences in the bunch weight in different varieties may be attributed to inherent genetic character of the variety, difference of number of canes, bunch load, Number of berries per bunch and berry size and also wine canopy size.

**Fruit Yield (kg vine ~1~)**

For the most part, the variation in growth, yield formation, will be dominated by scion cultivar, spatial differences across the vineyard site, and climate variation among years. The results presented in table 2 reveals that significantly highest yield was recorded with red wine variety Shiraz (25.2 kg vine~1~) followed by white wine variety Chenin Blanc (21.6 kg vine~1~) and Savignon Blanc (13.2 kg vine~1~). Lower yields ranging from 3.0 to 4.2 kg vine~1~ were recorded with wine cv Zinfandel, Merlot and Cabernet Sauvignon. Among juice varieties significantly highest yield was recorded with Pusa Navrangi (17.8 kg vine~1~) followed by Gulabi x Bangalore Purple (13.4 kg vine~1~). Medium yield ranging from 6.2 kg vine~1~ to 8.9 kg vine~1~ were recorded with juice varieties Bangalore Blue, E 12/2 and H - 23. Lowest yield among juice varieties was recorded with juice cv Athens (5.1 kg vine~1~). In concomitance with the results obtained in this study in another field trial conducted at same place that included some of cultivars used in this study Veena et al. (2015) [38] classified varieties on own root ranging from 16.81 to 10.78 kg vine~1~ (Chenin Blanc, Shiraz and Pusa Navrang) as high yielders; medium yielders ranging from 9.91 to 7.31 kg vine~1~ (Zinfandel, Athens, Cabernet Sauvignon); and low yielders ranging from 6.74 to 4.51 kg vine~1~ (Bangalore Blue and Sauvignon Blanc). Chalak et al. (2012) recorded higher yield in Chenin Blanc (12.26 kg vine~1~) as compared to Sauvignon Blanc, while maximum fruitfulness was recorded by Havinal et al. (2008) in Chenin Blanc (95.0%) followed by Syrah (93.3 %) as compared to Merlot (61.8 %). In study conducted at NRC Grapes, Pune, higher yield was recorded with Chenin Blanc (11.2 kg vine~1~), Pusa Navrangi (10.26 kg vine~1~) and Shiraz (9.65 kg vine~1~) as compared to Merlot (8.6 kg vine~1~). Zinfandel (8.0 kg vine~1~) among the twenty three wine varieties evaluated by Karibasappa and Adsule (2008) [18]. Among the other studies that included juice cv Pusa Navrang highest yield of 16.2 (t/ha) was recorded in Pusa Navrang by Ram et al. (2002) at Lucknow and 12.2 kg vine~1~ was recorded in the Western part of West Bengal by Ghosh et al. (2008) [14]. Yield is variable among the different varieties of grape and is genetically inherent. Hence it can be conferred from various other studies conducted by several workers in India that Chenin Blanc, a white wine variety Shiraz, a red wine variety and Pusa Navrang a teinturier, dark red coloured juice variety recorded higher yield potential though the yield level varied with location. On the other hand medium and low yielding genotypes in this study were not so consistent with those obtained in other studies. Reports from abroad recorded wide differences in yield under different management practices with same varieties of grape screened in the present study. Naor et al. (2002) [27] reported that yield of Sauvignon Blanc grape increased proportionally with number of bunches up to 44 bunches vine~1~ reaching a maximum yield of 14.5 kg vine~1~ at Israel. Kliiever and Dokoozliian (2005) [21] in a trial conducted at Davis, California reported that 11.8, 24.3 and 22.0 kg vine~1~ yield in cv Cabernet Sauvignon with 75, 233 and 274 bunches vine~1~ under standard spur pruned, hedge pruned and minimal pruned vines respectively. In a root stock trial conducted in SE Washington, with Merlot and Shiraz Keller et al. (2012) [19] reported that there was significant rootstock x scion interaction however, across rootstocks statistically similar yield was recorded with Merlot (4.6 kg vine~1~) and Shiraz (4.9 kg vine~1~). From the above studies it is clear that the yield potential of a grape variety is inherent subject to adoption to varying agro-climatic conditions and management practices. (Bunch load, training system, rootstock used etc.) which have a substantial bearing on yield and hence cannot be compared with the results from the present study.

**100 berry weight (g)**

There was significant variation among the cultivars with respect to 100 berry weight where highest weight was recorded with juice cv Gulabi x Bangalore Purple (290.5 g) followed by H -23, Athens, E12/2, Bangalore Blue and wine cv Merlot. A lower 100 berry weight ranging between 110 to 160 g was recorded in wine cv Savignon Blanc, Chenin Blanc, Shiraz, Zinfandel and juice cv Pusa Navrang with the lowest weight recorded in wine cv Cabernet Sauvignon (94.5 g). (Table 2) A similar variation in 100 berry weight was recorded in these cultivars by Veena et al. (2015) [10] on their own roots. In other studies 120 g was recorded in Cabernet Sauvignon and 147 g in Merlot in Bordeaux, France (Jones and Davis, 2000), 104.0 g in Pusa Navrang was recorded on own root at Lucknow (Ram et al., 2002), 100g in Sauvignon Blanc grafted on Dogridge at ICAR-NRC for Grapes (Annual Report, 2017-18), 165.2, 154.9, 187.2 and 191.2 g was recorded in Cabernet Sauvignon, Shiraz, Chenin Blanc and Savignon Blanc respectively in Karnataka (Anupama, 2015). The variation reported in the 100 berry weight might be due to experimental conditions.
**Number of seeds**

Grape seeds influence wine composition, astringency and bitterness (Pascual et al., 2016). The results presented in table 2 revealed that the juice varieties Gulabi x Bangalore Purple and Pusa Navrangi recorded higher number of seeds (3.1 and 3.2 respectively) followed by Athens, E 12/2. Significantly lesser number of seeds ranging between 2.3 and 2.6 were recorded in wine varieties and the remaining juice varieties.

**Table 1: Influence of juice and wine varieties of grapes on petiole nutrient content (%), juice recovery (%) and total soluble solids (% Brix).**

<table>
<thead>
<tr>
<th>S. No</th>
<th>Juice and Wine Varieties of Grapes</th>
<th>N (%)</th>
<th>P (%)</th>
<th>K (%)</th>
<th>Ca (%)</th>
<th>Juice recovery (%)</th>
<th>TSS °Brix</th>
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<td>T1</td>
<td>H – 23</td>
<td>1.15</td>
<td>0.53</td>
<td>4.51</td>
<td>0.96</td>
<td>64.0</td>
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<td>E 12/2</td>
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<td>3.81</td>
<td>0.90</td>
<td>49.6</td>
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<td>PusaNavrang</td>
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<td>4.17</td>
<td>1.29</td>
<td>64.6</td>
<td>18.0</td>
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<td>Gulabi x Bangalore Purple</td>
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<td>1.28</td>
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<td>Cabernet Sauvignon</td>
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<td>0.64</td>
<td>3.78</td>
<td>1.25</td>
<td>62.8</td>
<td>18.6</td>
</tr>
<tr>
<td>T8</td>
<td>Merlot</td>
<td>1.04</td>
<td>0.57</td>
<td>2.95</td>
<td>1.37</td>
<td>55.4</td>
<td>17.2</td>
</tr>
<tr>
<td>T9</td>
<td>Shiraz</td>
<td>0.99</td>
<td>0.66</td>
<td>4.09</td>
<td>1.21</td>
<td>62.6</td>
<td>17.5</td>
</tr>
<tr>
<td>T10</td>
<td>Chenin Blanc</td>
<td>0.90</td>
<td>0.62</td>
<td>3.98</td>
<td>1.16</td>
<td>66.7</td>
<td>17.2</td>
</tr>
<tr>
<td>T11</td>
<td>Savignon Blanc</td>
<td>1.17</td>
<td>0.58</td>
<td>3.88</td>
<td>1.10</td>
<td>55.8</td>
<td>19.4</td>
</tr>
<tr>
<td>T12</td>
<td>Zinfandel</td>
<td>1.16</td>
<td>0.61</td>
<td>3.14</td>
<td>1.40</td>
<td>58.4</td>
<td>18.0</td>
</tr>
</tbody>
</table>

**Table 2: Influence of juice and wine varieties of grapes on bud break, yield and yield components.**

<table>
<thead>
<tr>
<th>Juice and Wine Varieties of Grapes</th>
<th>Avg. time taken for bud break (days)</th>
<th>Avg. No. of Bunches</th>
<th>Avg. Bunch Weight (g)</th>
<th>Avg. Yield (kg vine⁻¹)</th>
<th>Avg. 100 Berry Weight (g)</th>
<th>Avg. No. of Seeds</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>H – 23</td>
<td>13.5</td>
<td>28.4</td>
<td>320.2</td>
<td>8.9</td>
<td>284.8</td>
</tr>
<tr>
<td>T2</td>
<td>E 12/2</td>
<td>16.3</td>
<td>45.3</td>
<td>132.6</td>
<td>6.2</td>
<td>252.7</td>
</tr>
<tr>
<td>T3</td>
<td>PusaNavrang</td>
<td>9.9</td>
<td>117.0</td>
<td>154.9</td>
<td>17.8</td>
<td>122.5</td>
</tr>
<tr>
<td>T4</td>
<td>Gulabi x Bangalore Purple</td>
<td>11.3</td>
<td>71.8</td>
<td>187.3</td>
<td>13.4</td>
<td>290.5</td>
</tr>
<tr>
<td>T5</td>
<td>Bangalore Blue</td>
<td>15.7</td>
<td>46.5</td>
<td>128.4</td>
<td>6.1</td>
<td>179.4</td>
</tr>
<tr>
<td>T6</td>
<td>Athens</td>
<td>14.0</td>
<td>21.2</td>
<td>246.8</td>
<td>5.1</td>
<td>254.8</td>
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<tr>
<td>T7</td>
<td>Cabernet Sauvignon</td>
<td>16.2</td>
<td>36.2</td>
<td>121.1</td>
<td>4.2</td>
<td>94.5</td>
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<tr>
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<td>Merlot</td>
<td>17.9</td>
<td>24.4</td>
<td>142.0</td>
<td>3.5</td>
<td>207.8</td>
</tr>
<tr>
<td>T9</td>
<td>Shiraz</td>
<td>10.6</td>
<td>121.3</td>
<td>202.2</td>
<td>25.2</td>
<td>155.1</td>
</tr>
<tr>
<td>T10</td>
<td>Chenin Blanc</td>
<td>8.6</td>
<td>125.0</td>
<td>165.3</td>
<td>21.6</td>
<td>129.1</td>
</tr>
<tr>
<td>T11</td>
<td>Savignon Blanc</td>
<td>11.2</td>
<td>100.0</td>
<td>133.6</td>
<td>13.2</td>
<td>113.7</td>
</tr>
<tr>
<td>T12</td>
<td>Zinfandel</td>
<td>15.6</td>
<td>23.3</td>
<td>139.2</td>
<td>3.2</td>
<td>156.5</td>
</tr>
<tr>
<td>CD at 5%</td>
<td></td>
<td>1.8</td>
<td>7.6</td>
<td>25.2</td>
<td>1.5</td>
<td>14.7</td>
</tr>
<tr>
<td>SE m ±</td>
<td></td>
<td>0.6</td>
<td>2.7</td>
<td>9.0</td>
<td>0.6</td>
<td>5.3</td>
</tr>
</tbody>
</table>

**Conclusion**

There were significant differences in wine and juice cultivars with respect to their influence on petiole nutrient content, bud break, juice recovery, yield components and yield. The efficacy of these varieties varied in their ability to absorb N, P and K. If petiole nutrient standards are developed it is possible to reduce the application of specific nutrients that have a high absorption capacity for that nutrient and should be considered when developing fertilization programs. However, the yield potential of wine and juice varieties clearly indicates the possibility of growing these varieties in Southern Telangana Zone diversifying the grape uses in this zone from table grapes. Further research on standardization of pre-harvest factors (regulation of bunch load, training, pruning level, pruning time, harvest time, irrigation, fertigation) is required for production of quality wine and juice.

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**References**

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