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

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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) [29]. 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 life style. 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 suitably 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 vines are hardy 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 mucilageneous, 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 P_2O_5 (four splits), and 1000 kg K_2O 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 motar 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 crushing100 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 (º 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 Savignon 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 RNA 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 ×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 Savignon 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, which 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 (0.90%) 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 in Savignon Blanc (1.10 %) 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 hydroponic 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, Savignon 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) [18] 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) [14] 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) [14]. 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) [18] 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) [15] 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 23.1to 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) [19] 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, fertigation etc.

Bud Break

Bud break is a varietal character as it marks the beginning of seasonal growth and it is strongly influenced by a cultivar-specific minimum temperature (Manuel Oliveira, 1998). The mean number of days taken for bud break after fruit pruning was significantly affected by genotypic differences among varieties (Table 2).It serves as an index to classify grape varieties as early, medium and late depending upon the number of days taken for bud burst. Significantly lesser number of days was required for bud break in varieties Chenin Blanc (8.6 days) Pusa Navrang (9.9days) followed by Shiraz, Savignon Blanc, Gulabi x Bangalore Purple which can be classified as early (< 12 days) while significantly higher number of days were required for Merlot (17.9 days), E 12/2 (16.3 days) and Cabernet Sauvignon (16.2 days) which can be classified as late (> 16 days).The remaining varieties which took 12 -16 days for bud break were classified as medium. The early bud break might be attributed to the increased activity of peroxidase activity (POD) and fewer growth inhibitors in their buds as reported by Jogaiah *et al*. (2013) [16]. The changes in peroxidase and polyphenol oxidase (PPO) activity could be an indicator of when endogenous changes occur, as the enzymes might lead to the scavenging of the accumulation of H_2O_2 in the buds and thus release dormancy, resulting in early bud sprouting (Tripathi *et al*., 2006) [35]. With certain varieties this result is almost consistent with earlier research conducted at this station on own roots (veena *et al.*, 2015) [38], which classified varieties in to early (Pusa Navrang, Bangalore Blue, Chenin Blanc), mid (Sauvignon Blanc, Shiraz, Zinfandel, and Cabernet Sauvignon) and late (Athens) bursting varieties. While with varieties like cv Bangalore Blue, Athens and Cabernet Sauvignon a different trend was observed which could be because of their interaction with Dogridge rootstock and the temperature at the time of bud break. Kliewer (1975) [20] reported in cv Cabernet Sauvignon that bud break and bloom occurred 3 to 8 days earlier at 25-30º C than at 11º C and also the number of buds that broke per vine increased was 2 to 3 times. The influence of varieties on the number of days taken for bud break was established in previous studies (Mandelli *et al*. 2003., Duchêne *et al.* 2010 and Ratnacharyulu, 2010) [21, 9, 31]. In this experiment a strong a negative correlation was recorded between yield and number of days taken for bud break (r = - 0.88) this indicates that by decreasing the number of days taken for bud break the yield levels can be increased. Though weak a negative correlation (r = -0.14) between petiole P and bud break indicates the role of P on early bud break. Lavee and May, (1997) [22] reported that in warm-winter regions, prolonged dormancy is a major obstacle to the commercial production of table grapes. Therefore HCN is commonly used for bud burst.

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 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 Navrang (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 Hissar (Daulta *et al*., 1972) [10], ranging from 230 to 575g 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 in number of canes, bunch load, Number of berries per bunch and berry size and also vine 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 (21.6kg vine^{-1}) and Savignon Blanc (13.2kg 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 Navrang (17.8 kg vine^{-1}) followed by Gulabi x Bangalore Purple (13.4kg 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 kgvine^{-1} (Zinfandel, Athens, Cabernet Sauvignon); and low yielders ranging from 6.74 to 4.51 kgvine^{-1}(Bangalore Blue and Sauvignon Blanc). Chalak *et al.* (2012) recorded higher yield in Chenin Blanc (12.26 kgvine^{-1}) as compared to Savignon 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 Navrang (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. Kliewer and Dokoozlian (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 (94.5g). (Table 2) A similar variation in 100 berry weight was recorded in these cultivars by Veena *et al.* (2015) [38] on their own roots. In other studies 120 g was recorded in Cabernet Sauvignon and 147gin 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 Navrang 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 (º Brix).

S. No	Juice and Wine Varieties of Grapes	N	P	K	Ca	Juice recovery	TSS
		(%)				(%)	ºBrix
T1	H – 23	1.15	0.53	4.51	0.96	64.0	16.4
T2	E 12/2	1.00	0.54	3.81	0.90	49.6	17.2
T3	PusaNavrang	1.09	0.59	4.17	1.29	64.6	18.0
T4	Gulabi x Bangalore Purple	1.29	0.51	3.53	1.28	57.9	17.5
T5	Bangalore Blue	1.19	0.60	2.95	1.37	57.9	20.8
T6	Athens	1.06	0.54	4.30	1.45	61.9	18.6
T7	Cabernet Sauvignon	0.98	0.64	3.78	1.25	62.8	18.6
T8	Merlot	1.04	0.57	2.95	1.37	55.4	17.2
T9	Shiraz	0.99	0.66	4.09	1.21	62.6	17.5
T10	Chenin Blanc	0.90	0.62	3.98	1.16	66.7	17.2
T11	Savignon Blanc	1.17	0.58	3.88	1.10	55.8	19.4
T12	Zinfandel	1.16	0.61	3.14	1.40	58.4	18.0
	CD at 5%	0.04	0.03	0.19	0.17	1.4	0.3
	SE m ±	0.02	0.01	0.07	0.08	0.5	0.1

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

	Juice and Wine Varieties of Grapes	Avg. time taken for bud break (days)	Avg. No. of Bunches	Avg. Bunch Weight (g)	Avg. Yield (kg vine^{-1})	Avg. 100 Berry Weight (g)	Avg. No. of Seeds
T1	H – 23	13.5	28.4	320.2	8.9	284.8	2.5
T2	E 12/2	16.3	45.3	132.6	6.2	252.7	2.9
T3	Pusa Navrang	9.9	117.0	154.9	17.8	122.5	3.2
T4	Gulabi x Bangalore Purple	11.3	71.8	187.3	13.4	290.5	3.1
T5	Bangalore Blue	15.7	46.5	128.4	6.1	179.4	2.4
T6	Athens	14.0	21.2	246.8	5.1	254.8	2.7
T7	Cabernet Sauvignon	16.2	36.2	121.1	4.2	94.5	2.4
T8	Merlot	17.9	24.4	142.0	3.5	207.8	2.6
T9	Shiraz	10.6	121.3	202.2	25.2	155.1	2.5
T10	Chenin Blanc	8.6	125.0	165.3	21.6	129.1	2.3
T11	Savignon Blanc	11.2	100.0	133.6	13.2	113.7	2.3
T12	Zinfandel	15.6	23.3	139.2	3.2	156.5	2.6
	CD at 5%	1.8	7.6	25.2	1.5	14.7	0.27
	SE m ±	0.6	2.7	9.0	0.6	5.3	0.98

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

1. Anonymous. Annual Report, ICAR-NRC for Grapes Annual Report, Manjri Farm P.O, Solapur Road, Pune, 2013-14.
2. Anonymous. Annual Report, ICAR-NRC for Grapes Annual Report, Manjri Farm P.O, Solapur Road, Pune, 2016-17.
3. Anonymous. Annual Report, ICAR-NRC for Grapes Annual Report, Manjri Farm P.O, Solapur Road, Pune, 2017-18.
4. Adam, Jacob. A balanced approach to vine nutrition. The Australian and New Zealand Grape grower and Winemaker, 2002, 22.
5. Anupam H. Evaluation of wine grape varieties for growth, yield and quality under northern dry zone of Karnataka. M.Sc Thesis Submitted to College of Horticulture, University of Horticultural Sciences, Bagalkot, 2015, 1-78.
6. Bhargava BS, Sumner ME. Proposal for sampling grape (*Vitis vinifera* L.) petioles for nutritional diagnosis. Commun. In Soil Sci. Plant Anal. 1987; 13(5):581-591.
7. Chalak SU, Kulkarni SS, Kishrsagar AV, Nimbalkar CA. Pruning studies in some white wine grape varieties for yield and yield contributing parameters under Western

Maharashtra conditions. Asian J Hort. 2012; 7(2):468-472
8. Christensen P. Nutrient level comparisons of leaf petioles and blades in twenty-six grape cultivars over three years. Am. J Enol. Vitic. 1984; 35(3):124-133.
9. Duchêne E, Huard F, Dumas V, Schneider C, Merdinoglu D. The challenge of adapting grapevine varieties to climate change. Clim Res. 2010; 41:193-204.
10. Daulta BS, Bakhshi JC, Chandra S. Evaluation of Vinifera varieties for genotypic and phenotypic variability. Indian Jr Hort. 1972; 29(2):151-157.
11. Jones GV, Robert ED. Climate influences on grapevine phenology, grape composition and wine Production and quality Am. J Enol. Vitic. 2000; 51(3):249-26.
12. Garcia M, Daverade P, Gallego P, Toumi M. Effects of various potassium-calcium ratios on cation nutrition of grape grown hydroponically. J Pl Nutri. 1999; 22:417-425.
13. Grant RS, Matthews MA. The influence of phosphorous availability and rootstock on root system characteristics, phosphorous uptake, phosphorus portioning and growth efficiency. Am. J Enol. Vitic. 1996; 47:403-409.
14. Ghosh SN, Ranjan T, Pal PP. Performance of eight grape cultivars in laterite soil of West Bengal. Acta Horticulturae. 2008; 785:73-77.
15. Haselgrove L, Botting D, Heeswijck RV, Hoj PB, Dry PR, Ford C, et al. Canopy microclimate and berry composition: The effect of bunch exposure on the phenolic composition of *Vitis vinifera* L cv. Shiraz grape berries Aust. J Grape and Wine Res. 2000; 6:141-149.
16. Jogaiah S, Oulkar DP, Banerjee K, Sharma J, Patil AG, Maske SR, *et al*. Biochemically induced variations during some phenological stages in Thompson seedless grapevines grafted on different rootstocks. S. Afr. J Enol. Vitic. 2013; 34:36-45.
17. Kadu SY. Evaluation of various grape varieties for wine making. M.SC Thesis submitted to the Mahatma Phule Krishi Vidyapeeth, Rahuri - 413 722, (Agriculture) in Horticulture, 2002, 1-139.
18. Karibasappa GS, Adsule PG. Evaluation of wine grape genotypes by National Research centre for Grapes at their farm at Pune, Maharashtra, India. Acta Horticulturae. 2008; 785:497-504.
19. Keller M, Mills LJ, Harbertson F. Rootstock effects on deficit-irrigated wine grapes in a dry climate: vigor, yield formation, and fruit ripening. Am. J Enol. Vitic. 2012; 63:29-39.
20. Kliewer WM. Effect of root temperature on bud break, shoot growth, and fruit-set of "Cabernet Sauvignon" grapevines Am. J Enol. Viticult. 1975; 26(2):82-89.
21. Kliewer WM, Dokoozlian NK. Leaf Area/Crop Weight Ratios of Grapevines: Influence on Fruit Composition and Wine Quality Am J Enol Vitic. 2005; 56:170-181.
22. Lavee S, May P. Dormancy of grapevine buds – facts and speculation. Aust J Grape Wine Res. 1997; 3:31-46.
23. Madhavarao VN, Srinivasan C. Nucleic acid composition in the developing buds and petioles of grapes. Vitis. 1971; 10:210-214.
24. Mandelli F, Berlato MA, Tonietto J, Bergamaskhim. Phenology of wine grapes in the Seera Gaucharegion. Pesquisa Agropecuaria Gaucha. 2003; 9:129-144.
25. Manuel Oliveira. Calculation of bud break and flowering base temperatures for *Vitis vinifera* cv. Touriga Francesa in the Douro Region of Portugal. Am J Enol Vitic. 1998; 49(1):74-78.
26. Muthukrishnan CR, Srinivasan C. Correlation between yield quality and petiole nutrients in grapes. Vitis. 1974; 12:277-285.
27. Naor A, Gal Y, Bravdo B. Shoot and cluster thinning influence vegetative growth, fruit yield and wine quality of Sauvignon Blanc' grape vines. J Amer. Hort. Sci. 2002; 127(4):628-634.
28. Pascual O, González RE, Gil M, Gómez AS, García RE, Joan MC, *et al*. Influence of Grape Seeds and Stems on Wine Composition and Astringency J Agric. Food Chem. 2016; 64(34):6555-6566.
29. Ramteke SD. Regulation of production and quality. Training programme on new techniques in viticulture. National Research Center for Grapes, Pune, 2000, 29-33.
30. Ram K, Shailendra R, Negi SS, Yadava LP. Genetic variability in Early ripening grape genotypes. J of Applied Hort. 2002; 4(2):118-120.
31. Ratnacharyulu SV. Evaluation of coloured grape varieties for yield, juice recovery and quality. Msc Thesis Submitted to Andhra Pradesh Horticultural University, Rajendranagar, Hyderabad, A.P, 2010.
32. Richard C, Andrew E, Jim F. The Viticultural and oenological evaluation of Arinarnoa, Arriloba and Barbera. The Australian Grape Grower Wine Maker, 1999, 60-64.
33. Tandon HLS. Methods of analysis of soils, plants, waters, fertilisers & organic manures. Fertilizer Development and Consultation Organization New Delhi, 2005.
34. Thatai SK, Chohan GS, Kumar H. Effect of pruning intensity on yield and fruit quality in Perlette grapes trained on head system. Indian J Hort. 1987; 44(1 &2):60-61.
35. Tripathi RD, Kulshreshta K, Ahmad KJ, Agrawal M, Krupa S, Varshney CK, *et al*. Plant Response to Environmental Stress. International Book Distributing Co., USA, 2006, 476. ISBN: 9788181890559.
36. Srinivasan C, Mullins Micheal G. Physiology of flowering in the grapevine-A review. Am. J Enol. Vitic. 1981; 32(1):47-61.
37. Sharma KD, Sharma PC, Thakur KS. Evaluation of some grape cultivars for processing grown under dry temperate climatic conditions of Himachal Pradesh. Indian Food Packer. 1993; 47(5):5-8.
38. Veena J, Vinod K, Manoj D, Santosh P, Variath MT, Santosh K. Multivariate analysis of colored and white grape grown under semi-arid tropical conditions of Peninsular India Int. J Agri Crop Sci. 2015; 8(3):350-365.