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Studies on nutrient composition in petioles of grapes under different vineyard groups and grape yield in Alfisols soils of Northern dry zone of Karnataka

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Abstract
A study was conducted to evaluate the nutrient status in different vineyards and its influence petiole nutrient contents and grape yields during 2019-2020 in Alfisols soils of Northern Dry Zone of Karnataka. Based on the previous year yield data, the thirty vineyards were classified into three groups namely, low yielding vineyards (LYV), medium yielding vineyards (MYV) and high yielding vineyards (HYV). The petiole nitrogen (1.41±0.21%), phosphorus (0.48±0.06%) and potassium (3.07±0.40%) contents were found significantly higher in HYV group followed by MYV and LYV. The petiole Ca and Mg contents were found non significant while, the sulphur content was found significantly higher (0.25±0.04%) in HYV. Petiole micronutrients namely, iron, manganese, zinc and copper in three different vineyard groups were found in the order Mn > Fe > Zn > Cu. The grape yield was recorded significantly higher (33.15±2.69 t ha^{-1}) in HYV group compared to MYV (26.25±1.02 t ha^{-1}) and LYV group (19.70±1.58 t ha^{-1}).

Keywords: Vineyards, petiole nutrient, yield, alfisols, micronutrients etc.

Introduction
Grape (*Vitis vinifera* L.) is one of the most economically important fruit crops (Ruel and Walker, 2006) [12]. Its cultivation is believed to have originated in Armenia near the Caspian Sea in Russia. Later, it appears to have spread westward to Europe and eastward to Iran and Afghanistan. Muslim invaders from Iran and Afghanistan introduced grapes to India during 1300 A.D. (Thapar, 1960) [13]. However, the crop is well acclimatized for the Indian subcontinent possessing sub-tropical and tropical agro climatic conditions and now, viticulture is being practiced as one of the most remunerative farming enterprises. Petiole nutrient analysis, at a particular stage during the plant growth, is being used since long time as a tool to assess grape quality and its yield potentiality. However, successful nutrient management in grapes is determined by both soil and plant analyses together, instead of one method alone (Marschner, 1995) [8].

Petiole analysis is a method to determine the nutrient concentration of grapevines at a stipulated time in the life cycle of plant. This research is helpful to assess the consistency of fertilizers application to minimize this nutrient imbalance in vineyards (nutrient monitoring) or be a factor in diagnostic testing. It is also a valuable method for fertilizer recommendations for evaluating the nutrient status of vines during the growing season. When all the necessary nutrition is provided, optimum growth and fruit quality can be achieved. If optimum proportions of nutrients are not available, then physiological processes of the plants are disturbed then yield and quality of the grape fruit get adversely affected. Petiole analysis at bloom stage could be used as a diagnostic tool for grape quality and to introduce midterm corrections, if needed, through nutrient applications. Considering these importance, a study was carried out to assess petiole nutrient contents among the three different vineyard groups in Alfisols soils of Northern Dry Zone of Karnataka.

Materials and Methods
Location
A study area in Yelburga taluk of Koppal district, Northern Karnataka is located between 15.63°N latitude and 76.02°E longitude with an average elevation of 605 m above the mean sea level which falls under Northern dry zone (zone 3). The mean annual precipitation was 65.01 mm (2019-20) and mean temperature was 19.54 °C to 32.55 °C throughout this year except in November- December. The soils have neutral to alkaline pH and red soils generally designated under Alfisols.

Vineyards classification
Classification of vineyards was done based on previous year yield data of grapes. The thirty vineyards were classified into three groups and Each group contains 10 vineyards namely, LYV- Low yielding vineyards, MYV- Medium yielding vineyards and HYV- High yielding vineyards.

Sample collection and analysis
Grape petioles were sampled by adopting standard method as prescribed by IIHR (Bhargav, 2001) [2]. The leaves present on the opposite of the first inflorescence of the cane were chosen for petiole sampling (Patel and Chada, 2002) [10]. Petiole sampling was done in the morning hours at the rate of 3-4 leaves per plant and only the petioles were retained. Petiole sampling was done during the month of November to match it with 40-45 days after 2nd pruning. Three sets of petiole samples were drawn separately for each variety. The fresh petioles were rinsed for 30 seconds in plastic trays having solutions of 0.1 N HCl, then with 1% detergent and finally, in distilled water (2 times) to remove all the adsorbed surface chemicals. These washed petioles were air dried for a day in shade and then, oven dried at 65 °C for 48 hrs. The dried petioles samples were powdered in stainless steel jars using Kitchen Mixie and kept in air tight containers for further analysis.

Nutrient analysis
The petiole nitrogen content was determined by Kjeldhal distillation method (Piper, 1966) [11]. For other nutrients, 0.5 g of powdered petiole samples were separately digested in diacid mixture HNO_3: $HClO_4$ (10:4 ratio). The digested colourless solution was diluted to 100 ml and stored in airtight containers for further analysis. The methodologies adopted for estimation of different nutrients are presented in Table 1.

Table 1: Standard methods adopted for petiole nutrient analysis

Nutrient	Method	Instrument	Reference
Nitrogen	Kjeldhal digestion and distillation method	Kjeldhal digestion and distillation Unit	Piper, 1966 [11]
Phosphorous	Vanadomolybdate complex method	Spectrophotometer	Piper, 1966 [11]
Potassium	Atomic Emission spectrometry	Flame photometer	Piper, 1966 [11]
Calcium and magnesium	EDTA titration		Jackson, 1973
Sulphur	Turbidometry method	Spectrophotometer	
Iron, zinc, manganese and Copper	Absorption spectrometry	Atomic Absorption Spectroscopy	Lindsay and Norvell, 1978 [7]

Table 2: Nitrogen, phosphorus and potassium composition in petioles of different vineyards at full bloom stage after October pruning

Vineyard groups	Nitrogen (%)	Phosphorus (%)	Potassium (%)
	Mean ± SD	Mean ± SD	Mean ± SD
Low yielding vineyards	1.15±0.21^b	0.30±0.02^c	2.24±0.35^b
Medium yielding vineyards	1.33±0.20^{ab}	0.40±0.04^b	2.60±0.51^b
High yielding vineyards	1.41±0.21^a	0.48±0.06^a	3.07±0.40^a
S.Em ±	0.06	0.01	0.13
C.D. at 5%	0.19	0.04	0.39

Note: 1. Different letters in mean column imply significant difference at $p \leq 0.05$

Table 3: Calcium, magnesium and sulphur composition in petioles of different vineyards at full bloom stage after October pruning

Vineyard groups	Calcium (%)	Magnesium (%)	Sulphur (%)
	Mean ± SD	Mean ± SD	Mean ± SD
Low yielding vineyards	1.26±0.29^a	0.52±0.12^a	0.19±0.02^b
Medium yielding vineyards	1.36±0.37^a	0.65±0.16^a	0.23±0.04^a
High yielding vineyards	1.42±0.17^a	0.68±0.17^a	0.25±0.04^a
S.Em ±	0.04	0.05	0.01
C.D. at 5%	NS	NS	0.03

Note: 1. Different letters in mean column imply significant difference at $p \leq 0.05$

Table 4: Iron, manganese, zinc and copper content in petioles of vineyards at full bloom stage after October pruning

Vineyard groups	**Iron (mg kg^{-1})**	**Manganese (mg kg^{-1})**
	Mean ± SD	**Mean ± SD**
Low yielding vineyards	64.80±12.70^b	91.00±25.10^a
Medium yielding vineyards	78.30±13.00^a	106.40±21.20^a
High yielding vineyards	87.60±16.40^a	101.40±26.80^a
S.Em ±	4.47	7.75
C.D. at 5%	12.96	NS
Vineyard groups	Zinc (mg kg^{-1})	Copper (mg kg^{-1})
	Mean ± SD	Mean ± SD
Low yielding vineyards	46.70±6.20^b	22.20±3.00^a
Medium yielding vineyards	62.80±15.10^a	24.10±4.50^a
High yielding vineyards	65.30±9.50^a	25.90±2.00^a
S.Em ±	3.44	1.06
C.D. at 5%	9.99	NS

Note: 1. Different letters in mean column imply significant difference at $p \leq 0.05$

Table 5: Yields obtained in different vineyard groups

Vineyard Groups	**Yield (t ha^{-1}) Mean ± SD**
LYV: Low yielding vineyards	19.70±1.58^c
MYV: Medium yielding vineyards	26.25±1.02^b
HYV: High yielding vineyards	33.15±2.69^a
S.Em ±	0.60
C.D. at 5%	1.74

Note: 1. Different letters in mean column imply significant difference at $p \leq 0.05$

Statistical Data analysis

The data obtained were subjected to statistical tests using normal one way ANOVA technique, and Descriptive statistical analysis. Simple correlation studies were also made to understand their interaction effects.

Results and Discussion

The petiole N content was noticed significantly different among high yielding vineyards (HYV) and low yielding vineyards (LYV) groups. The HYV recorded significantly higher (1.41±0.21 per cent) petiole N compared to other groups which might be attributed to high amount of fertilizers application compared to other groups under study (Table 2). Thus, the petiole N content increased as a result of nitrogen application. Higher nitrogen content in grape petioles could be attributed to high nitrogen application (Ahlawat and Yamadagni, 1988) [1].

The highest petiole P (0.48±0.06 per cent) content was recorded in high yielding vineyards (HYV) and lowest (0.30±0.02 per cent) in low yielding vineyards (LYV). The high yielding vineyards (HYV) group receiving high fertilizers recorded higher petiole P content whereas least was recorded in low yielding vineyards (LYV) group receiving low fertilizers (Table 2). Higher uptake of phosphorus with application of phosphorus fertilizers in perennial horticulture crops was reported by Nagaraj, 1997.

The petiole K content was found significantly high (3.07±0.40 per cent) in high yielding vineyards groups. The petiole potassium content in different groups varied significantly in the order HYV (3.07±0.40 per cent) > MYV (2.60±0.51 per cent) = LYV (2.24±0.35 per cent) (Table 2). Application of more quantity of organic manure and fertilizer was responsible for higher uptake of petiole K. Similar reports of high potassium uptake were also reported by Ahlawat and Yamadagni (1988) [1].

The highest uptake of calcium noticed in high yielding vineyard (1.42±0.17 per cent), the petiole Ca content of different vineyard groups under study did not differ significantly. The petiole calcium values were in concurrence with earlier works carried out on grapes (Yogeeshappa, 2007; Kondi, 2016 and Naraboli, 2016) [14, 5, 9]. High yielding vineyard (HYV) group showed higher amount of Mg (0.68±0.17 per cent) content in petiole compare to low yielding vineyard (LYV) group (0.52±0.12 per cent), the petiole Mg did not differ significantly. Addition of more quantity of organic manure and fertilizer was the reason for more uptake of calcium and magnesium. Reports of similar uptake of magnesium in grape petiole were also reported by Yogeeshappa (2007) [14], Kondi (2016) [5] and Naraboli, (2016) [9].

Among the three different vineyard groups, the group high yielding vineyards (HYV) and medium yielding vineyards (MYV) recorded significantly high petiole S (0.25±0.04 and 0.23±0.04 per cent). In low yielding vineyards (LYV) significantly low (0.19±0.02) petiole S was recorded (Table 3). The group which received high fertilizer and organic manure recorded high sulphur concentration in petiole. Higher sulphur content in grapes petiole is because of high availability of sulphur in soils. Use of sulphur containing fertilizer application and organic matter application might have enhanced the petiole S content (Kapur *et al*., 2005) [4].

Among the three groups studied the highest Fe content recorded in HYV (87.60±16.40 mg kg^{-1}) and MYV (78.30±13.00 mg kg^{-1}). However, significantly lower grape petiole iron was recorded in LYV (64.80±12.70 mg kg^{-1}) (Table 4). The petiole Mn content was recorded high in MYV group (106.40±21.20 mg kg^{-1}) followed by HYV group (101.40±26.80 mg kg^{-1}). LYV group vineyards observed with the least petiole Mn content (91.00±25.10 mg kg^{-1}).

HYV and MYV group orchards recorded higher petiole Zn content (65.30±9.50 mg kg^{-1}) and (62.80±15.1 mg kg^{-1}) as compared to and LYV group vineyards (46.70±6.20 mg kg^{-1}) which recorded significantly least petiole Zn amongst the three groups of vineyards (Table 4). Among the three major vineyard groups studied, HYV recorded high petiole copper content (25.90±2.00 mg kg^{-1}) compared to MYV group (24.10±4.50 mg kg^{-1}) and LYV group (22.20±3.00 mg kg^{-1}) orchards.

The micronutrients concentration in grape petioles were observed in the order Mn> Fe> Zn> Cu (Table 4). Usually the vineyard group which receive high fertilizer maintained higher micronutrient concentration in petiole while, less fertilizer received vineyards had lesser micronutrient concentration. The micronutrients concentrations in grape petioles were similar to studies reported by earlier workers (Gathalal *et al*., 2004; Naraboli, 2016; Kondi, 2016) [3, 5, 9]. The petiole micronutrient variations could be attributed to their soil availability and external applications (Gathalal *et al*., 2004) [3].

The yield was noted to be significantly different in the vineyard groups (Table 5). The fruit yield was highest in HYV group (33.15±2.69 t ha^{-1}) fallowed by MYV (26.25±1.02 t ha^{-1}) and LYV (19.70±1.58 t ha^{-1}). The mean vineyard yields of three different groups were in the line of high yielding vineyards (HYV) > medium yielding vineyards (MYV) > and low yielding vineyards (LYV). The differences in yields could be attributed to variations in nutrient status of soil as determined by application of nutrients (Bhargava and Sumner, 1987) [2]. Here the recorded yield was found to be directly influenced by the soil fertility status, petiole nutrient content and climatic conditions. The results are in accordance with the Yogeeshappa (2007) [14], Naraboli, 2016 [9] and Kondi *et al.* (2018) [6].

Conclusion

This study affirms that strategic nutrient management is crucial for optimizing vineyard productivity and improving the nutritional quality of grapes. By adopting practices that ensure balanced and sufficient nutrient applications, vineyard managers can significantly enhance yield outcomes and the overall health of the vineyards. The findings serve as a valuable reference for developing tailored fertilization programs that cater to the specific needs of vineyards to achieve high yield and quality grape production.

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