Original Research Article

Influence of secondary and micro nutrients status of soils on grape yield of vineyards in Northern Dry Zone of Karnataka

Abstract:

A studywas conducted to study the influence of secondary and micro nutrients status of soils on grape yield of vineyards during the year 2019-20 in Yelburga taluk of Koppal district. 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 soil samples collected after harvest of crop recorded slight increase in the exchangeable Ca and Mg content compared to the soil samples collected before October pruning. The HYV [11.16± 2.61 and 12.08±2.76 c mol (p+) kg^{-1}] soils recorded higher calcium content compared to other groups in both the sampling seasons respectively. HYV [6.81± 1.26 and 6.88 ± 1.19 c mol (p+) kg^{-1}] recorded highest exchangeable Mg content compared to other two groups in both the sampling seasons respectively. The sulphur content in group HYV was significantly higher (51.67 ± 16.46 and 64.09 ± 18.59mg kg^{-1}) as compared to the other groups at before October pruning and at after harvest, respectively. Distribution of micronutrients in soil samples collected before October pruning and after harvest were found in the order Mn > Fe > Zn > Cu. Vineyard soil sample showed medium to high content of micronutrients. The concentration of DTPA extractable micronutrients among three groups of vineyards differed significantly. The differences in yields of vineyards is depends on soil fertility status. Hence, it is important to adopt good nutrient management practices to ensure sustainable grape yields in vineyards.

Keywords: Vineyards, Fertility, Micro nutrients, Calcium, Magnesium Sulphur etc.

Introduction:

Grape (*Vitis vinifera* L.), belonging to the family vitaceae is one of the most important commercial fruit crop in India. Though it is temperate fruit crop, it is well adopted to sub-tropical and tropical agro climatic conditions prevailing in the Indian sub-continent. Grapes are being cultivated for table purpose and wine industry. Due to its high commercial value, the crop is intensively managed in terms of soil and crop management practices. In the life of vineyards, grape nutrition plays a major role. Therefore, grape growing is primarily achieved through drip irrigation in these dry tracts. Most of the essential nutrients (macro, secondary and micronutrients) are added to soil in the form of basal application (through organic manures and fertilizers) and fertigation (through water soluble fertilizers). The majority of grape growers also practice foliar nutrition, in particular for secondary and micronutrients. In enhancing the grapes quality and productivity, the use of growth regulators plays an important role.

The soils of the study area were red in color and texture varies from sand to clay, and having porous and friable structure. The soils have neutral to alkaline pH and red soils generally designated under Alfisols. The secondary and micronutrients are also applied along with nitrogen, phosphorous and potassium fertilizers. Deficiency of any secondary and micronutrients not only reduce the yield but also the fruit quality. Nutrient management is one of the major cost- economic aspects in grape cultivation. Thus, Assessment of nutritional status and nutritional requirements of vineyards assumes a greater significance for successful viticulture, so the present investigation was undertaken to assess secondary and micronutrients status in vineyards of Koppal district, Karnataka.

Material and Methods

Survey of Vineyards

In this study, thirty vineyards from Yelburga taluk were selected as contact farmers for interview and collection of soil and petiole samples (Fig. 1). These farmers were interviewed initially to collect the information on their vineyards in terms of crop details– variety, age of the orchard, soil type, nutrient management practices, grape yield etc. Classification of vineyards was done based on previous year yield data of grapes. The thirty vineyards were classified into three groups namely, LYV- Low yielding vineyards, MYV- Medium yielding vineyards and HYV- High yielding vineyards presented in Appendix III. Each group contains 10 vineyards.

Soil sample collection

Soil sampling was carried out at two seasons, one before the October pruning i.e. during growth stage and the other one after the harvest of the crop (Feb-March). In each vineyard, soil samples were collected from 6-8 spots at 0-20 cm depth and pooled to get one composite sample of about half kilo gram by quartering technique. Then, the sample was sieved (2 mm) and stored in air tight containers for further analysis. These soil samples were analyzed for secondary nutrients and DTPA extractable micronutrients (metal ions).

Analysis of Secondary nutrient

Theexchangeable Ca and Mg (both exchangeable and water soluble) were extracted with neutral normal ammonium acetate and estimated by Versanate titration method using EBT for Ca+ Mg and P&R indicator for Ca alone (Jackson, 1973). Available sulphur content was determined by turbidometric method after extraction with 0.15% CaCl2 using spectrophotometer at 420 nm (Black, 1965).

Analysis of DTPA-Extractable micronutrients

The DTPA extractable micronutrients (metal ions namely Fe, Mn, Zn and Cu) were extracted with DTPA buffer at 1:2 soil to extractant ratio (Lindsay and Norwell, 1978). The concentration of DTPA-Fe, Mn, Zn and Cu in the extract were determined by atomic absorption spectrophotometer (Thermofisher model).

Statistical 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

Availability of Secondary nutrients

Extent of distribution of secondary nutrients namely, calcium, magnesium and sulphur are presented in Table 1 and respective mean values of different vineyards are depicted in Fig. 1.

The available exchangeable calcium was recorded low in medium yielding vineyards with 9.55 ± 2.87 c mol (p+) kg^{-1} as compared to the low yielding vineyards [10.17 ± 3.04 c mol (p+) kg^{-1}] and high yielding vineyards [11.16 ± 2.61 c mol (p+) kg^{-1}]. The soils after harvest of crop recorded slight increase in the exchangeable Ca content compare to the soils before October pruning (Table 1). High yielding vineyards recorded higher [6.81 ± 1.26 c mol (p+) kg^{-1}] exchangeable Mg content followed by medium yielding vineyards [5.64 ± 1.93 c mol (p+) kg^{-1}] and low yielding vineyards [5.59 ± 1.83 c mol (p+) kg^{-1}].

There was an increase in the exchangeable Mg content were observed in the soils after harvest as compared to the soils before October pruning. Exchangeable Ca and Mg content in vineyards soils were found low because red soils generally contain low Ca and Mg content compared to black soils as the cation exchange capacity (CEC) of the red soil is low compared to black soil (Ananthanarayan, 1978). The variation might be due to differences in additions of lime and Mg. They are also known to be influenced by management practices, nutrient inputs, amendments used (Nagaraja 1997). After the harvest, exchangeable Ca and Mg content increased due to high temperature, Soil water evaporation and capillary rise of salts along with water might be attributed. Similar levels of Ca and Mg contents were reported by Bhat*et al*. (2017) in grape soils and Ganai*et al*. (2018) in apple orchards.

Available sulphur content in vineyards ranged between medium to high. Among different groups, high yielding vineyards (HYV) recorded significantly higher available sulphur content in both the seasons (51.67 ± 16.46 and 64.09 ± 18.59 mg kg^{-1} in soils collected before October pruning and after harvest respectively). Least S content was recorded in fields of low yielding vineyards (26.45 ± 4.90 and 29.00 ± 5.33 mg kg^{-1} in soils collected before October pruning and after harvest respectively). High sulphur content in high yielding vineyards (HYV) may be attributed due to application of sulphate form of micronutrient ($ZnSO_4$ and $FeSO_4$). Also, high application of organic matter resulted in higher availability of sulphur in vineyards as reported by Basumurthy and Talukdar (1999).Similar levels of sulphur content in vineyard soils were also reported by Yogeeshappa (2007), Dar *et al*. (2015) and Shivannanavar (2016).

Availability of DTPA extractable micronutrients

The iron content in soils after harvest was found to be higher as compared to the iron content of soils before October pruning. The mean values of iron were found significantly high in HYV (4.73 ± 0.96 mg kg^{-1}). However, the other two groups namely LYV (3.70 ± 0.52 mg kg^{-1}) and MYV (3.96 ± 0.82 mg kg^{-1}) were on par with each other(Table 2 and Fig. 2).

The LYV recorded significantly low Mn content (3.28 ± 0.44 mg kg^{-1}) and manganese content in MYV (3.79 ± 0.68 mg kg^{-1}) and HYV (4.21 ± 0.38 mg kg^{-1}) were found on par with each other.

The Zn content in LYV recorded significantly low (0.92 ± 0.11 mg kg^{-1}), and Zn content of MYV (1.11 ± 0.23 mg kg^{-1}) and HYV (1.12 ± 0.08 mg kg^{-1}) were found on par with each other. However, the soils after harvest of crop recorded slight increase in the Zn content compared to the soils collected before October pruning.

The mean values of copper were found significantly higher in HYV (0.80 ± 0.30 mg kg^{-1}). However, the Cu content in other two groups namely LYV (0.33 ± 0.10 mg kg^{-1}) and MYV (0.55 ± 0.34 mg kg^{-1}) remained on par with each other.

Distribution of micronutrients in grape soils considered for the study were observed in the order of Mn> Fe> Zn> Cu in soils collected before October pruning and after harvest, the values were recorded low to moderate in range. However, the micronutrients (DTPA - Fe, Mn, Zn and Cu) in soils collected after the harvest of the crop recorded higher values.

This variation in concentrations might be due to the nature and behavior of the element in soil as determined by pH and soil organic matter content. Soil micronutrients are enhanced by release and chelation of metal ions (Lindsay and Norwell, 1978) and also direct addition of micronutrients to the crop might have enhanced their availability among soils. Intensive nutrient management in white grape type orchards might have induced higher availability.

Application of Zn-fertilizers under Zn deficiency conditions has been associated with improved yield and quality of grapes (Malakouti, 2007). Samiullah*et al.* (2013) while studying the micronutrient status of peach orchard soils of swat valley, they reported the concentration of Fe in the 0-45 cm soil ranged from 5.73 ug to 116.14 ug g^{-1} soil with a mean value of 27±18.97.

These results indicate that use of organic manures and application of secondary and micronutrients helped to maintain higher availability. Soil micronutrients are enhanced by release and chelation of metal ions (Lindsay and Norwell, 1978) and also direct addition of micronutrients to the crop might have enhanced their availability among soils. Similar observation recorded by Patiram et al. (2000), Yogeeshappa (2007), Thakre*et al.* (2013).

Bhargava and Raghupathi (1994) investigated the optimum range of DTPA extractable soil Zn for Anab-e-Shahi was 8 to 24.9 ppm and for Thompson Seedless it was 4.5 to 8.2 ppm. The optimum range of Zn in petioles at bud differentiation stage was 25 to 94 ppm for Anab-e-Shahi and 47 to 88 ppm for Thompson Seedless.

Grape yields (t ha^{-1})

The fruit yields in LYV, MYV and HYV groups were found to be 19.70 ± 1.58, 26.25 ± 1.02 and 33.15 ± 2.69 t ha^{-1} respectively and HYV recorded significantly higher grape yields as compared to MYV. Thus, significant differences were observed and the yields recorded followed the order of HYV> MYV> LYV (Table3 and Fig. 3). The differences in yields could be attributed to variations in nutrient status of soil as determined by application of nutrients (Bhargava and Sumner, 1987). 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), Naraboli, 2016 and Kondi*et al.* (2018).

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Table 1: EDTA exchangeable calcium (Ca), magnesium (Mg) and available sulphur (S) status in soils of different vineyards before October pruning and after harvest

Vineyard groups	**Exchangeable calcium [cmol (p+) kg^{-1}] Mean ± SD**		**Exchangeable magnesium [cmol (p+) kg^{-1}] Mean ± SD**		**Available sulphur (mg kg^{-1}) Mean ± SD**	
	Before October pruning	After harvest	Before October pruning	After harvest	Before October pruning	After harvest
Low yielding vineyards	10.17 ± 3.04[a]	10.48 ± 2.46[a]	5.59 ± 1.83[a]	5.84 ± 1.54[a]	26.45 ± 4.90[b]	29.00 ± 5.33[c]
Medium yielding vineyards	9.55 ± 2.87[a]	10.12 ± 2.04[a]	5.64 ± 1.93[a]	5.94 ± 1.99[a]	35.41 ± 5.58[b]	40.34 ± 6.78[b]

High yielding vineyards	11.16 ± 2.61[a]	12.08 ± 2.76[a]	6.81 ± 1.26[a]	6.88 ± 1.19[a]	51.67 ± 16.46[a]	64.09 ± 18.59[a]
S.Em ±	**0.90**	**0.77**	**0.55**	**0.51**	**3.30**	**3.74**
C.D. at 5%	**NS**	**NS**	**NS**	**NS**	**9.57**	**10.86**

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

Table 2: DTPA extractable micronutrient status in soils of different vineyards before October pruning and after harvest

Vineyard groups	Fe (mg kg^{-1}) Mean ± SD		Mn (mg kg^{-1}) Mean ± SD	
	Before October pruning	After harvest	Before October pruning	After harvest
Low yielding vineyards	2.63 ± 0.37^{b}	3.70 ± 0.52^{b}	3.28 ± 0.44^{b}	3.97 ± 0.33^{c}
Medium yielding vineyards	3.37 ± 0.72^{a}	3.96 ± 0.82^{b}	3.79 ± 0.68^{a}	4.41 ± 0.39^{b}
High yielding vineyards	3.85 ± 1.11^{a}	4.73 ± 0.96^{a}	4.21 ± 0.38^{a}	4.85 ± 0.45^{a}
S.Em ±	**0.25**	**0.25**	**0.16**	**0.12**
C.D. at 5%	**0.73**	**0.72**	**0.48**	**0.36**
Vineyard groups	**Zn (mg kg^{-1}) Mean ± SD**		**Cu (mg kg^{-1}) Mean ± SD**	
	Before October pruning	After harvest	Before October pruning	After harvest
Low yielding vineyards	0.67 ± 0.14^{b}	0.92 ± 0.11^{b}	0.33 ± 0.10^{b}	0.42 ± 0.11^{b}
Medium yielding vineyards	0.92 ± 0.27^{a}	1.11 ± 0.23^{a}	0.55 ± 0.34^{b}	0.64 ± 0.33^{ab}
High yielding vineyards	0.91 ± 0.15^{a}	1.12 ± 0.08^{a}	0.80 ± 0.30^{a}	0.87 ± 0.30^{a}
S.Em ±	**0.06**	**0.05**	**0.08**	**0.08**
C.D. at 5%	**0.18**	**0.14**	**0.24**	**0.24**

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

Table 3: 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 $P \leq 0.05$

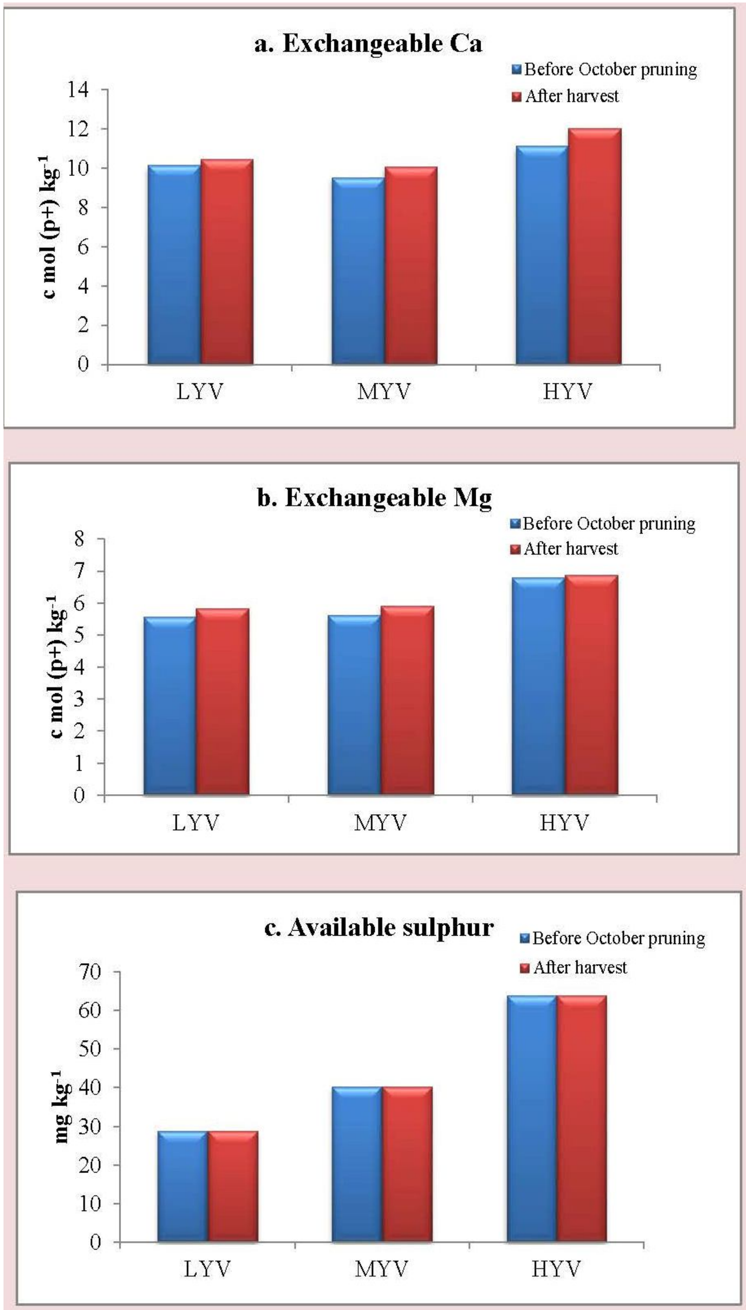

Fig. 1: DTPA Exchangeable calcium, magnesium and available Sulphur status in soils of different vineyard groups before October pruning and after harvest

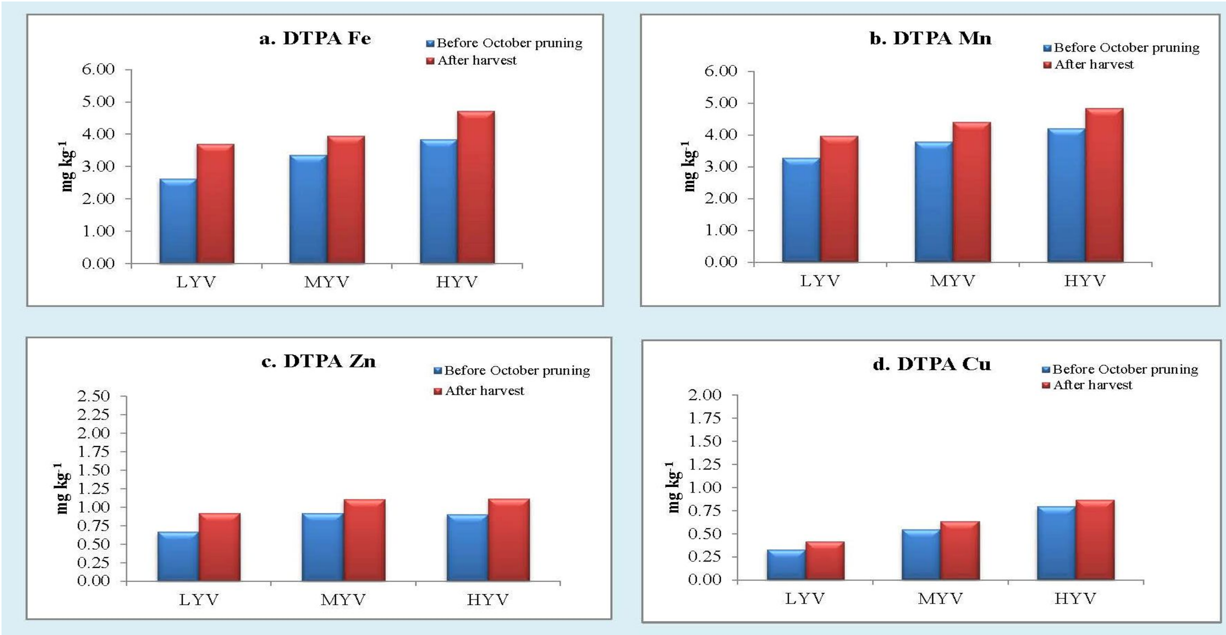

Fig. 2: DTPA extractable iron, manganese, zinc and copper status in soils of different vineyards groups before October pruning and after harvest

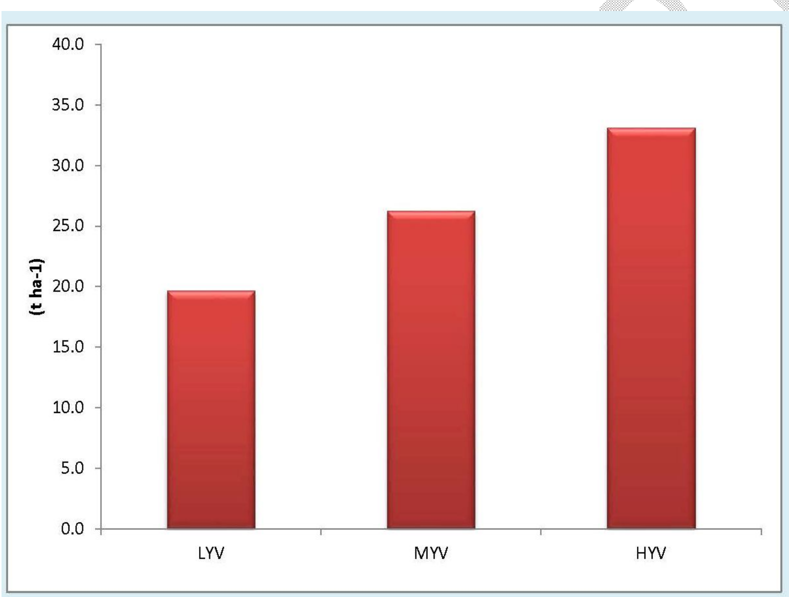

Fig. 3: Yield of different vineyard groups.