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Secondary and micronutrient status in soils of wine and table type grape orchards of northern Karnataka

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Abstract
A Survey was carried out in 83 grape orchards to assess the available secondary and micro nutrient status in soils of Bagalkot and Jamakhandi taluka during 2015-16. Three different grape orchards namely table purpose white, table purpose coloured and wine grape types. During February-march surface soil samples were collected after the harvest of the crop. The samples were processed and analyzed for available secondary and micro nutrients. Among different grape soils, wine grape orchards recorded significantly higher available calcium compared to white and coloured table grape soils. Contrastingly, the available magnesium contents were found significantly higher in table grape orchards compared to wine grape types. Distribution of available-S in three different grape orchards was found in medium to higher availability ranges. In grape orchard soils micronutrients were found in the order Mn > Zn > Cu > Fe. DTPA Mn and Zn were in higher range in majority of soil samples while, DTPA – Cu and Fe were observed in both medium and higher ranges. Thus, nutrient management practices had influenced the availability of secondary and micronutrients.

Keywords: Table grapes, wine grapes, secondary nutrients, micronutrients

Introduction
Grape (*Vitis vinifera* L.), belonging to the family *vitaceae* is one of the most important commercial fruit crop of Vijayapur and Bagalkot. 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. The soils are calcareous and exhibit mostly alkaline pH (Kirankumar *et al*., 2016) [7] and hence 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 Bagalkot and Jamakhandi talukas of grape orchards.

Material and Methods
Survey of Grape Orchards
In this study, 83 well established grape orchards in Bagalkot and Jamakhandi talukas were surveyed and all the orchards were visited individually to collect soil sample. The grape plants are planted at 1.5 m in rows spaced at 3.0 m apart. In terms of nutrient management the plant nutrients are added directly through fertilizers (in bands) and fertigations trough dippers spaced at 45 to 60 cm all along the rows.

Collection of soil samples
In each grape orchard, three sampling points were identified and soil samples 1.2 to 1.5 kg were collected at 0-20 cm depth after the harvest of the crop (during Feb and March). The collected soil samples were air dried, mixed thoroughly and reduced to half kilo 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

Available-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) [6]. Available sulphur content was determined by turbidometric method after extraction with 0.15% $CaCl_2$ using spectrophotometer at 420 nm (Black, 1965).

Analysis of DTPA-Extractable micronutrients

Available 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) [8]. 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 ANOVA, Student-t test, F-test 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 available secondary nutrients namely, calcium, magnesium and sulphur are presented in Table and respective mean values of different grape orchards are depicted in Figure 1. More than 3/4th of grape soil samples recorded medium to higher available calcium and magnesium contents. Among three grape categories, wine grape orchards recorded significantly higher calcium availability (30.96 ± 5.00 meq/100g) compared to white and coloured table grape soils. Contrastingly, the available magnesium contents were found significantly higher in table grape orchards (white grape 8.68 ± 2.80 meq $100g^{-1}$) and (colour grape 8.12 ± 3.40 meq 100 g^{-1}) compared to wine grape types 8.15 ± 3.14 meq 100 g^{-1}. However, no significant differences were observed among white and coloured grape types *w.r.t* both available calcium and magnesium availability content. Similar levels of calcium and magnesium contents in grape soils were reported by Bhargava and Raghupathi (2001) [2] and Shreekanth *et al*., 2018) [12].

Generally, these black soils are known to exhibit higher exchangeable Ca^{2+} closer to their exchange capacities (Dhir *et al.*, 1979) [4]. However, high additions of K and Mg in grape orchards results in replacement of each calcium by potassium and magnesium to some extent (Anita *et al*., 2018) [1] Variations *w.r.t* exchangeable calcium and magnesium among different grape categories could be attributed additions of potassium and magnesium at varied levels (Vinod *et al*., 2017) [14]. Available-Mg contents among three different grape groups further confirm the effect of added fertilizer on exchangeable cations (Majer, 2004) [9].

Among grape orchards available sulphur content was found only in medium (36.15% with 10-20 ppm S) and higher (> 20 ppm) availability ranges. None of the grape soil samples showed low sulphur availability. Among different grape orchards, soils of table grape types, both white and coloured recorded significantly higher available –S. Higher sulphur availability could be attributed to application of higher amounts of organic manure. The organic manure itself is a source of sulphur and hence, it is known to enhance availability in soils (Swarup and Ghosh, 1979) [13]. In addition, application of $MgSO_4$ and use of Bordeaux mixture in grapes might have enhanced available sulphur (Martin *et al.*, 2004) [4]. Lower available-S in wine grape soils may be attributed to less use of organic manures and $MgSO_4$.

Availability of micronutrients

The grape soils were analyzed for DTPA extractable micronutrients (metal ions) to assess their availability. The distribution of micronutrients are given in Table 2 and their mean values were depicted in Figure 2. The amount of DTPA-Fe present in grape soils ranged from 2.48 ppm in coloured table grape orchard to 11.07 ppm in white type table grape orchards. Almost all the soil samples analyzed were found in medium (62.65%; n = 52) to higher ranges (36.14%; n = 30) of availability. In terms of their mean availability, significant values were observed in table purpose colour type with a mean value of (3.86 ± 0.84 ppm) while, wine grape orchards (4.42 ± 1.08 ppm) and table purpose white grape orchards 4.95 ± 1.66 ppm recorded higher amounts.

DTPA-extractable manganese (DTPA-Mn) content in grape orchards ranged from 7.85 ppm to 36.44 ppm (Table 2). All the soil samples were recorded in higher ranges (> 4.0 ppm). Among different grape orchards, significantly higher amounts of available Mn (20.63 ± 7.27 ppm) were found in soils of table purpose white grape orchards. While, Table purpose colored grape soils (15.91 ± 5.09 ppm) recorded the least.

The DTPA-Zn contents ranged from 1.03 to 27.26 ppm. Majority of the grape soil samples (n=80; >96%) were observed with high range of DTPA-Zn (>1.5 ppm) None of the samples were observed in lower range of DTPA-Zn. Comparison of DTPA-Zn values of different grape orchards revealed that the DTPA-Zn was found in the order table purpose white grape > table purpose colored grapes = wine grape types and their contents were found to be 11.48 ± 8.76 ppm, 6.65 ± 6.31 ppm and 5.46 ± 3.05 ppm respectively.

The amount of DTPA-extractable copper (DTPA-Cu) in different grape orchards ranged from 2.15 ppm to 15.45 ppm. Nearly 40 per cent of the soil samples (n = 34) analysed were observed in medium range (0.2-5.0 ppm) while, 59% (n = 49) were seen in higher range (> 5.0 ppm). Among different grape orchards, table purpose white grape soils recorded higher amounts of DTPA-Cu (7.66 ± 3.46 ppm) and it was found on par with table purpose coloured grape type (6.42 ± 2.76 ppm). Significantly, lower amounts of DTPA-Cu was recorded in wine orchards with a mean of 3.99 ± 2.20 ppm.

The data on DTPA extractable micronutrients namely, DTPA Fe, Mn, Zn and Cu, is diagrammatically presented in Figure 2. In grape soils, micronutrients were found in the order Mn > Zn > Cu > Fe. It was interesting to note that none of the grape soils showed deficiency of micronutrients. Majority of the grape soils shared higher availability of DTPA Mn and Zn while, DTPA – Cu and Fe was observed in both medium and higher ranges.

Comparison of three grape categories of grape orchards indicated that the DTPA extractable micronutrients were significantly higher in white table type grape orchards while they were low in wine and coloured table grape soils. The variations in concentrations of DTPA micronutrients could be attributed to the nature and behavior of the element in soil itself (Lindsay and Norwell, 1978) [8]. Use of organic manures and micronutrient mixtures might have contributed for higher availability (Rao, 1986) [11]. The benefit of soil organic matter on micronutrients availability through mineralization and chelation are well documented (Lindsay and Norwell, 1978;

Harmsen and Vlek, 1985) [8, 5]. Intensive nutrient management in white grape type orchards might have induced higher availability. These results indicate that use of organic manures and application of secondary and micronutrients helped to maintain higher availability.

Table 1: Extent of secondary nutrient availability among different grape orchards

Grape type	**No. of samples with available-Ca ranges (meq/100g)**		
	Low<24.00	**Med. 24.0-32.0**	**High(>32.00)**
Wine Grape (n=25)	3 (3.6)	12 (14.4)	10 (12.1)
Table White Grape (n=42)	12 (14.4)	22 (26.5)	8 (9.6)
Table Coloured Grape (n=16)	6 (7.2)	5 (6.1)	5 (6.1)
Total (n=83)	21 (25.3)	39 (46.9)	23 (27.7)
Grape type	No. of samples with available-Mg ranges (meq/100g)		
	Low <6.0	Med. 6.0-8.0	High >8.0
Wine Grape (n=25)	8 (9.6)	4 (4.8)	13 (15.6)
Table White Grape (n=42)	11 (13.2)	8 (9.6)	23 (27.7)
Table Coloured Grape (n=16)	7 (8.4)	1 (1.2)	8 (9.6)
Total (n=83)	26 (31.3)	13 (15.6)	44 (53.1)
Grape type	No. of samples with available-S ranges (ppm)		
	Low<10	Medium10-20	High>20
Wine Grape (n=25)	0 (0)	13 (15.6)	12 (14.4)
Table White Grape (n=42)	0 (0)	12 (14.4)	30 (36.1)
Table Coloured Grape (n=16)	0 (0)	5 (6.1)	11 (13.2)
Total (n=83)	0 (0)	30 (36.1)	53 (63.8)

Table 2: Extent of DTPA extractable micronutrient availability among different grape orchards

Grape type	**No. of samples with available DTPA-Fe range**			**No. of samples with available DTPA-Mn range**		
	Low(<2.5)	**Medium(2.5 – 4.5)**	**High(>4.5)**	**Low(< 2.0)**	**Medium(2.0 – 4.0)**	**High(> 4.0)**
Wine Grape(n=25)	0 (0)	15 (18.0)	10 (12.1)	0 (0)	0 (0)	25 (30.1)
Table White Grape (n=42)	0 (0)	24 (28.9)	18 (21.6)	0(0)	0 (0)	42 (50.6)
Table Coloured Grape (n=16)	1 (1.2)	13 (15.6)	2 (2.4)	0 (0)	0 (0)	16 (19.2)
Total (n=83)	1 (1.2)	52 (62.6)	30 (36.1)	0 (0)	0 (0)	83 (100)
Grape type	No. of samples with available DTPA-Zn range			No. of samples with available DTPA-Cu range		
	Low(< 0.6)	Medium(0.6 – 1.5)	High(>1.5)	Low(<2.0)	Medium(2.0–5.0)	High(>5.0)
Wine Grape(n=25)	0 (0)	0 (0)	25 (30.1)	0 (0)	21 (25.2)	4 (4.8)
Table White Grape (n=42)	0 (0)	3 (3.6)	39 (46.9)	0 (0)	13 (15.6)	29 (34.9)
Table Coloured Grape (n=16)	0 (0)	0 (0)	16 (19.2)	0 (0)	0 (0)	16 (19.2)
Total (n=83)	0 (0)	3 (3.6)	80 (96.3)	0 (0)	34 (40.9)	49 (59.0)

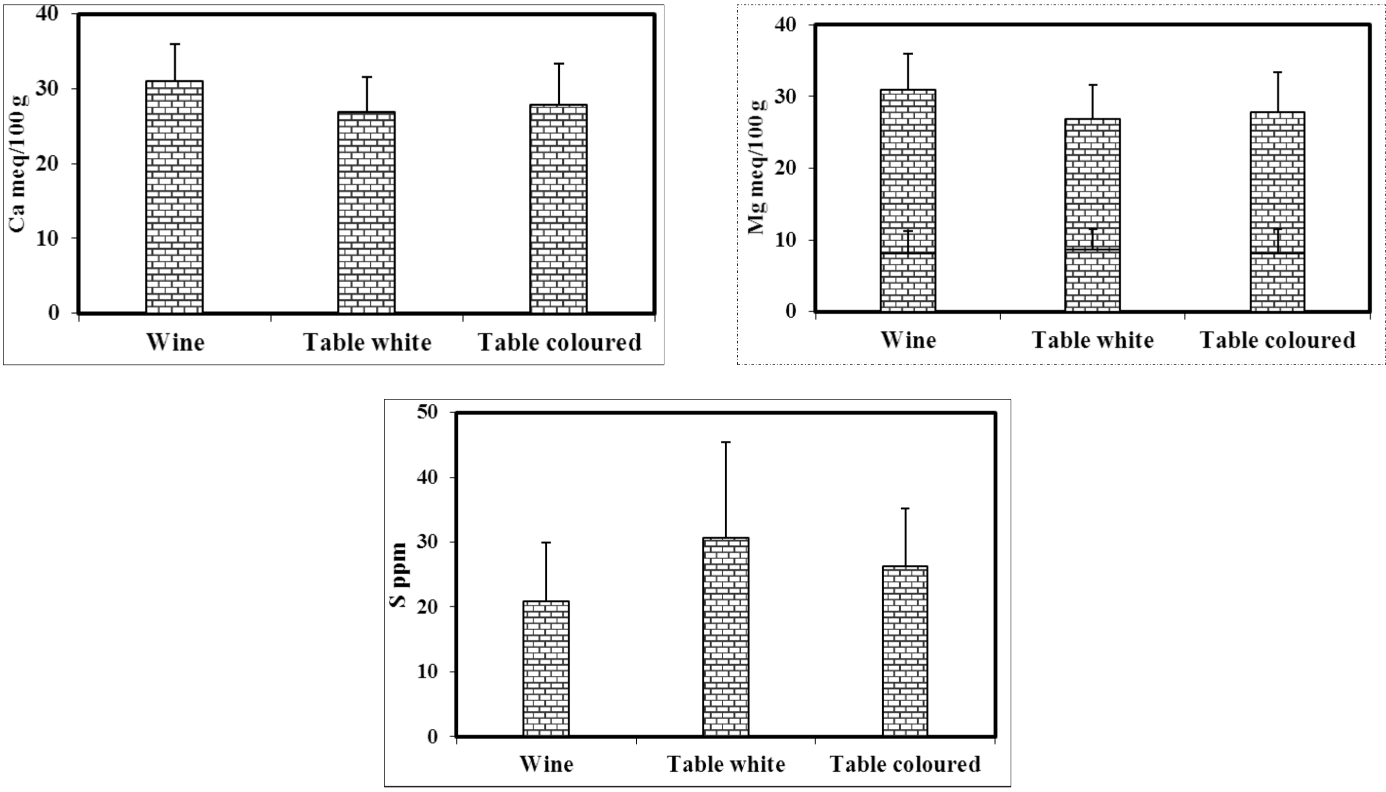

Fig 1: Available calcium, magnesium and sulphur status in soils of different grape orchards

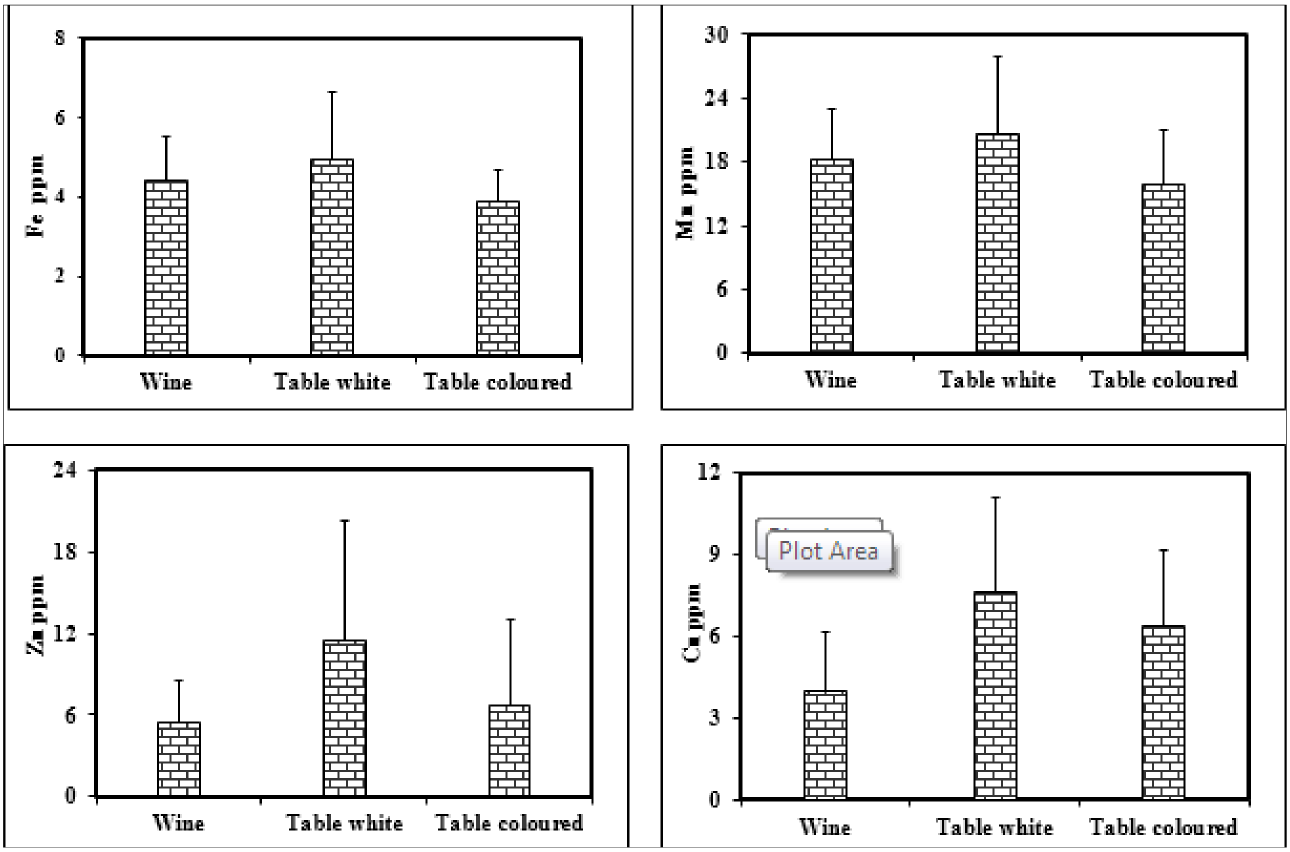

Fig 2: DTPA extractable iron, manganese, zinc and copper status in soils of different grape orchards

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