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EVALUATION OF NUTRIENT INPUTS ON SOIL FERTILITY STATUS AND GRAPE YIELD OF VINEYARDS IN RED SOILS (ALFISOLS) OF KOPPAL DISTRICT KARNATAKA INDIA

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ABSTRACT

A study was conducted to evaluate the major nutrient status in different vineyards and its influence on soil fertility and grape yields in red soils of Yelburga taluk Koppal district 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 soil samples were collected before October pruning and after harvest of the crop. The soil pH and EC did not show significant difference among different groups of vineyards. Significantly higher soil organic carbon (7.54 ± 0.34 g kg^{-1}) was recorded in HYV group. The available nitrogen (384.57 ± 57.06 kg ha^{-1}), phosphorous (75.25 ± 14.22 kg ha^{-1}) and potassium status (667.37 ± 59.22 kg ha^{-1}) were noticed significantly higher in HYV group. 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}). The differences in yields of vineyards is depends on nutrient inputs applied and soil fertility status. Hence, it is important to adopt good nutrient management practices to ensure sustainable grape yields in vineyards.
Keywords **:** Vineyards, Soil Fertility, Nutrients, Grape yield, Red soils etc.

Introduction

Grape (*Vitis vinifera* L.) is a commercially important fruit crop in India belonging to family vitaceae. It was introduced to India by pavsior invaders from Iran and Afghanistan during 1300 A.D. (Thapar, 1960). It is well adapted to sub-tropical climate of peninsular India. Grapes are grown in an area of 139 thousand hectare with 2920 thousand tonnes of annual production in India (Anonymous, 2018). Tamil Nadu, Maharashtra, Karnataka, Andhra Pradesh, Haryana and Punjab are the largest grape growing states. Among such states, Maharashtra occupies the largest area (105.50 thousand hectare) followed by Karnataka (26.61 thousand hectare). About 80 % of production comes from Maharashtra followed by Karnataka. The grape productivity in Karnataka is 19.70 Mt ha^{-1} and production 524.20 thousand tonnes (Anonymous, 2018).

Nutritional management is considered as one of the important aspects in successful grape cultivation. The nutrients present in soil and grapevine must be observed regularly and maintained for optimal efficiency. Therefore, it has to constantly changing; the best set up is soil sampling for regular analysis to overcome nutrient deficiency and reduce excess use of nutrient inputs. Based on the available nutrient content in soil, the fertilizer recommendations are required in vineyards.

Indiscriminate use of chemical fertilizers to get better yield can alter the fertility status of the soil and leads to nutrients toxicity. The sustainable soil fertility maintenance is essential for grape production. The available nutrient concentration is often analyzed by properties of soil and nutrient interactions. For the optimum use of soil for increased crop production, its fertility status is of prime importance. In the semi-arid region of Karnataka, grape cultivation has claimed great significance. Now the area under grape cultivation in the Koppal district is increasing. Grape production has also been decreasing. In this region, studies have shown that the issues are mainly related to nutrient imbalance. Keeping these facts in view and with an objective to study the effect of nutrient inputs on soil fertility status of vineyards a study entitled "Studies on Evaluation of nutrient inputs on soil fertility status and grape yield of vineyards in Red Soils of Koppal district, Karnataka" was undertaken during the year 2019-20.

Material and Methods

A survey-based study was conducted during the year 2019-20 to assess the effect of various nutrient inputs on soil fertility status, petiole nutrient content in the vineyards in red soils of Yelburga taluk, Koppal district of Karnataka. 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. The quantities of fertilizers added were converted to unit weights (kg) of N, P_2O_5 and K_2O per hectare. The amount of nutrients added through organic manures were estimated based on quantity of organic manure used and average nutrient contents of N-0.5, P_2O_5-0.25 and K_2O-0.5 per cent for FYM on dry weight basis. 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). Collected soil samples were air dried in shade. The dried samples were ground by wooden pestle and mortar and to separate the coarse fragments (>2 mm) it passed through 2 mm sieve.

The soil pH was determined in 1: 2.5 soil water suspensions by using digital pH meter (Systronics, model 361) as described by Jackson (1973). Electrical conductivity of soil samples was determined in the supernatant solution of 1:2.5 soil water suspensions using digital conductivity meter (Elico, Model CM 180) and results were expressed in dS m^{-1} at 25°C (Jackson, 1973). The soil organic carbon was determination by wet oxidation method (Walkley and Black, 1934). Available-N content in vineyard soils was determined by alkaline permanganate method as described by Subbiah and Asija (1956). Available phosphorous in soil was extracted with the help of Olsen's extractant (0.5 M $NaHCO_3$) and Darco-G-60 (activated P-free charcoal powder). Ascorbic acid method was used to for color development and expressed in kg ha^{-1}(Jackson, 1973). The exchangeable and water soluble potassium in the soil was extracted using neutral normal ammonium acetate solution and was estimated by feeding it to the flame 25 photometer after making suitable dilutions as suggested by Jackson (1973).

The yield data books of farmer's field were used as data source for grape yields. Finally, these data were utilized for obtaining grape yield per unit area (t ha^{-1}) and data was used for all statistical studies and interpretations using one way ANOVA technique.

Results and Discussion

Nutrient's addition

Nutrients required for grape cultivation were applied through chemical fertilizers and organic manure (FYM). The application rate differed to a greater extent and the amount of nutrient added among three group vineyards were depicted in Table 1 and 2. Nitrogen applied to vineyards was ranged from 230 kg N to 400 kg N ha^{-1}. Among different vineyard groups low yielding vineyards (LYV) received significantly lower (286.0 ± 32.8 kg N ha^{-1}) amounts of nitrogen compared to medium yielding vineyards (MYV) (351.5 ± 30.0 kg N ha^{-1}) and high yielding vineyards (HYV) (372.0 ± 18.7 kg N ha^{-1}). Nitrogen additions through fertilizer were found significantly different in the order: HYV = MYV > LYV vineyards (Table 2). Phosphorus application through fertilizer ranged from 280.0 to 500 kg P_2O_5 ha^{-1}. The amounts of phosphorus applied were found to be 366.0 ± 46.7, 440.0 ± 24.3 and 454.0 ± 21.3 kg P_2O_5 ha^{-1} in LYV, MYV and HYV respectively. The phosphorus fertilizer additions were found significantly different in the order HYV = MYV > LYV. Similarly, the amount of potassium applied ranged from 450.0 to 675.0 kg K_2O ha^{-1}. Among three groups of vineyards high yielding vineyards (HYV) received significantly higher amounts of potassium (616.5 ± 43.3 kg K_2O ha^{-1}) whereas medium yielding vineyards MYV (574.0 ± 19.4 kg K_2O ha^{-1}) and low yielding vineyards (LYV) received lower (521.1 ± 33.7 kg K_2O ha^{-1}) amount of potassium (Table 2). The K application among three groups differed significantly in the order of HYV > MYV > LYV in vineyards. The availability of organic manure and financial status of individual farmer may be important factors to decide the application of organic manures. Earlier studies carried out also reported similar amount of nutrient

addition by the grape growers (Kondi, 2016, Naraboli, 2016 and Shivannanavar, 2016).

The quantity of nitrogen applied through organic manure ranged from 87.5-312.5 kg N ha^{-1}. Significant difference was found among three vineyard groups. The quantity of N added in low yielding vineyards (LYV) (106.9 ± 11.7 kg N ha^{-1}) was low compare to medium yielding vineyards (MYV) (189.5 ± 55.5 kg N ha^{-1}) and high yielding vineyards (HYV) (202.5 ± 61.8 kg N ha^{-1}). The N additions in the vineyards groups found in the order of HYV = MYV > LYV vineyards (Table 2). Similar amount of nutrients application were given by Yogeeshappa (2007), Patil *et al*. (2006) and Naraboli (2016).

The quantity of phosphorus added through organic manure ranged from 35 to 125 kg P_2O_5 ha^{-1}. Vineyard groups differed significantly among the three groups high yielding vineyards (HYV) and medium yielding vineyards (MYV) group received more amount of phosphorus (81.0 ± 24.7 kg P_2O_5 ha^{-1}, 75.8 ± 22.2 kg P_2O_5 ha^{-1}) respectively (Table 2). The low yielding vineyards (LYV) received low (42.8 ± 4.7 kg P_2O_5 ha^{-1}) amount of Phosphorus. Similarly, the amounts of K_2O added through organic manure ranged from 87.5-312.5 kg K_2O ha^{-1}, and among three groups were found to be 106.9 ± 11.7 kg K_2O ha^{-1}, 189.5 ± 55.5 kg K_2O ha^{-1} and 202.5 ± 61.8 kg K_2O ha^{-1} in LYV, MYV and HYV, respectively and it varied significantly in the order HYV= MYV > LYV. (Table 2).

Total nitrogen applied in vineyards ranged from 345-712.50 kg N ha^{-1}. The amounts of nitrogen applied were noted significantly different among three groups of vineyards. The N additions found in the order HYV (574.5 ± 72.0 kg N ha^{-1}), MYV (541.0 ± 65.1 kg N ha^{-1}) and LYV (392.9 ± 35.6 kg N ha^{-1}). The quantity of phosphorus added in LYV (408.8 ± 51.3 kg P_2O_5 ha^{-1}) was low compared to MYV (515.8 ± 26.2 kg P_2O_5 ha^{-1}) and HYV (535.0 ± 40.8 kg P_2O_5 ha^{-1}). The LYV, MYV and HYV differed significantly with respect to total P_2O_5 application. Similarly, the total amounts of K_2O added were showed significantly different among three groups in the order: HYV (819.0 ± 101.8 kg K_2O ha^{-1}) > MYV (763.5 ± 53.5 kg K_2O ha^{-1}) > LYV (628.0 ± 44.1 kg K_2O ha^{-1}).

Soil analysis

The soil pH ranged from neutral to slightly alkaline. The corresponding soil pH values for after harvest soils were found to be 7.58 ± 0.15, 7.57 ± 0.37 and 7.49 ± 0.23 among LYV, MYV and HYV respectively. The pH of ground water used for irrigation also might have altered the pH of the grape soil (Kumar *et al*., 1986; and Kiran, 2014). Similar findings were also observed in vineyards of Northern Karnataka by Yogeeshappa *et al*. (2013) and Shivannanavar (2016). The EC values in soil collected after harvest were slightly higher with respective values of 0.38 ± 0.04 dS m^{-1}, 0.36 ± 0.07 dS m^{-1} and 0.37 ± 0.05 dS m^{-1} in soils of LYV, MYV and HYV (Table 3). It might be due to application of fertilizers with frequent irrigation. The soil management practices, irrigation water used and drainage condition of field might have altered the EC of the soil (Chabbra, 1996).

The soil OC content was found higher in soils collected after harvest compared to samples collected before October pruning. The corresponding organic carbon content in soils after harvest was 6.30 ± 0.37, 7.17 ± 0.18 and 7.52 ± 0.34 g kg^{-1} in LYV, MYV and HYV respectively. However, the carbon content in soils of HYV was found significantly higher compared to other two groups. Thus, the soil organic carbon content in both before October pruning and after harvest collected soil samples varied significantly in the order of HYV > MYV > LYV. Higher levels of soil organic carbon in soil samples collected after the harvest might be due to incorporation of organic manures before October pruning. Similar quantity of soil organic carbon content in vineyards were also reported by Demirer *et al.* (2007), Kumar *et al.* (2009), Dar *et al*. (2012) and Yogeeshappa *et al*. (2013).

The available nitrogen status of soils before October pruning was found low to medium. Significant difference was noted among different groups with respect to nitrogen content in soil sample collected before October pruning. The available nitrogen was found significantly low in LYV with 273.50 ± 35.88 kg ha^{-1} as compared to the MYV (333.50 ± 38.55 kg ha^{-1}) and HYV (361.60 ± 57.55 kg ha^{-1}) (Table 4). The available nitrogen content in MYV and HYV are on par with each other. However, the soils after harvest of crop recorded an increase in available N content. Among the three groups significantly low nitrogen content was recorded in LYV (295.04 ± 40.56 kg ha^{-1}) (Table 4). The nitrogen content in MYV (351.54 ± 38.71 kg ha^{-1}) and HYV (384.57 ± 57.06 kg ha^{-1}) were found on par with each other.

Phosphorus availability in soils before October pruning of different vineyards was presented in Table 4. The availability of phosphorus in vineyards varied from medium to high. Among different vineyard groups high yielding vineyards recorded high (56.36 ± 17.58 kg ha^{-1}) phosphorus content. Low phosphorus (34.38 ± 9.89 ka ha^{-1}) values were recorded in low yielding vineyards group and accordingly, significant difference was noted in between HYV and LYV groups. The phosphorus content in all the three groups

of vineyards was found to be significant and the available phosphorus varied significantly in the order of HYV (75.25 ± 14.22 ka ha^{-1}) > MYV (59.03 ± 12.28 ka ha^{-1}) = LYV (47.62 ± 10.72 ka ha^{-1}) vineyards (Table 4). High phosphorous content might be due to external supplementation of phosphorus fertilizers and organic manures. Available phosphorus content was found higher after harvest of the crop compared to soil samples collected before October pruning and this might be due to the fact that phosphorus build-up in horticultural crop on external fertilizer application as reported by Nagaraja (1997).

The available K_2O content was found higher in soils after harvest compared to soils collected before October pruning. Available K_2O in soils after harvest was found to be 667.69 ± 59.22, 561.63 ± 56.54 and 440.25 ± 24.63 kg K_2O ha^{-1} in HYV, MYV and LYV groups respectively. The available K_2O content among 3 groups varied significantly in the order HYV > MYV > LYV (Table 4). Higher availability of potassium is attributed due to application of external potassium fertilizer and organic manures in vineyards (Sharma *et al*., 2004).

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 (Table 5). 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).

Table 1: Details of management practices adopted by grape growers in Yelburga taluk, Koppal district.

Vineyard Groups	Organic manure added (t ha^{-1})	Fertilizer nutrient added (Kg ha^{-1}) N: P_2O_5: K_2O	Fertilizer used
LYV: Low Yielding Vineyards	21.38 ± 7.81^{b}	286.0: 366.0: 521.1	Urea (46% N), DAP (18% N, 46% P_2O_5), MOP (60% K_2O), SOP (50% K_2O, 17.5% S) Ammonium sulphate (21% N, 24% S), SSP (14.5% P_2O_5, 11% S, and 21% Ca) 10:26:26, 19:19:19, $MgSO_4$, $ZnSO_4$, $FeSO_4$.
MYV: Medium Yielding Vineyards	37.90 ± 11.10^{a}	351.5: 440.0: 574.0	
HYV: High Yielding Vineyards	40.50 ± 12.35^{a}	372.0: 454.0: 616.5	

Note: Different letters in mean column imply significant difference at P ≤ 0.05

Table 2: Quantity of nitrogen, phosphorus and potassium added in three different vineyards.

Vineyard groups	Fertilizer	Organic manure	Total
Nitrogen (Kg N ha^{-1})			
LYV : Low Yielding Vineyard	286.0 ± 32.8^{b}	106.9 ± 11.7^{b}	392.9 ± 35.6^{b}
MYV : Medium Yielding Vineyard	351.5± 30.0^{a}	189.5 ± 55.5^{a}	541.0 ± 65.1^{a}
HYV : High Yielding Vineyard	372.0 ±18.7^{a}	202.5 ± 61.8^{a}	574.5 ± 72.0^{a}
Phosphorus (Kg P_2O_5 ha^{-1})			
LYV : Low Yielding Vineyard	366.0 ±46.7^{b}	42.8 ± 4.7^{b}	408.8 ± 51.3^{b}
MYV : Medium Yielding Vineyard	440.0 ±24.3^{a}	75.8 ± 22.2^{a}	515.8 ± 26.2^{a}
HYV : High Yielding Vineyard	454.0 ±21.3^{a}	81.0 ± 24.7^{a}	535.0 ± 40.8^{a}
Potassium (Kg K_2O ha^{-1})			
LYV : Low Yielding Vineyard	521.1 ± 33.7^{c}	106.9 ± 11.7^{b}	628.0 ± 44.1^{b}
MYV : Medium Yielding Vineyard	574.0 ± 19.4^{b}	189.5 ± 55.5^{a}	763.5 ± 53.5^{a}
HYV : High Yielding Vineyard	616.5 ± 43.3^{a}	202.5 ± 61.8^{a}	819.0 ± 101.8^{a}

Note: Different letters in mean column imply significant difference at P ≤ 0.05

Table 3: Soil reaction, electrical conductivity and soil organic carbon status in soils of different vineyards before October pruning and after harvest.

Vineyard groups	pH (1: 2.5) Mean ± SD		EC (dS m^{-1}) Mean ± SD		SOC (g kg^{-1}) Mean ± SD	
	Before October pruning	After harvest	Before October runing	After harvest	Before October pruning	After harvest
Low yielding vineyards	7.49 ± 0.19^{a}	7.58 ± 0.15^{a}	0.33 ± 0.03^{a}	0.38 ± 0.04^{a}	5.88 ± 0.38^{c}	6.30 ± 0.37^{c}
Medium yielding vineyards	7.34 ± 0.35^{a}	7.57 ± 0.37^{a}	0.31 ± 0.09^{a}	0.36 ± 0.07^{a}	6.88 ± 0.18^{b}	7.17 ± 0.18^{b}
High yielding vineyards	7.34 ± 0.30^{a}	7.49 ± 0.23^{a}	0.35 ± 0.06^{a}	0.37 ± 0.05^{a}	7.27 ± 0.31^{a}	7.52 ± 0.34^{a}
S.Em ±	**0.09**	**0.09**	**0.02**	**0.02**	**0.09**	**0.10**
C.D. at 5%	**NS**	**NS**	**NS**	**NS**	**0.28**	**0.28**

Note: Different letters in mean column imply significant difference at P ≤ 0.05

Table 4: Available nitrogen (N), phosphorus (P_2O_5) and potassium (K_2O) status in soils of different vineyards before October pruning and after harvest.

Vineyard groups	Available nitrogen (kg ha^{-1}) Mean ± SD		Available phosphorus (kg ha^{-1}) Mean ± SD		Available potassium (kg ha^{-1}) Mean ± SD	
	Before October pruning	After harvest	Before October pruning	After harvest	Before October pruning	After harvest
Low yielding vineyards	273.50 ± 35.88^{b}	295.04 ± 40.56^{b}	34.38 ± 9.89^{b}	47.62 ± 10.72^{b}	393.48 ± 27.90^{c}	440.25 ± 24.63^{c}
Medium yielding vineyards	333.50 ± 38.55^{a}	351.54 ± 38.71^{a}	46.79 ± 12.91^{ab}	59.03 ± 12.28^{b}	511.04 ± 54.30^{b}	561.63 ± 56.54^{b}
High yielding vineyards	361.60 ± 57.55^{a}	384.57 ± 57.06^{a}	56.36 ± 17.58^{a}	75.25 ± 14.22^{a}	613.37 ± 68.80^{a}	667.69 ± 59.22^{a}
S.Em ±	**14.24**	**14.61**	**4.37**	**4.16**	**16.80**	**15.61**
C.D. at 5%	**41.33**	**42.38**	**12.69**	**12.08**	**48.74**	**45.30**

Table 5: Yields obtained in different vineyard groups in Yelburga taluk, Koppal district.

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

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