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EFFECT OF MULTI-NUTRIENTS APPLICATION ON THE YIELD AND QUALITY OF GRAPES VARIETY MUSCAT

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ABSTRACT

A field experiment was conducted to assess the effect of soil and foliar application of secondary and micronutrients in the existing eight years old grapevine orchard (Muscat) located at Theethipalayam village of Coimbatore district with ten treatments and three replications under randomized block design revealed that soil and foliar application of Ca, Mg and Zn, Fe, B with NPK increased the bunch yield of grapes from 12.5 to 16.4 t ha⁻¹ with a mean of 14.5 t ha⁻¹. Bunch weight ranged from 158 to 407 g bunch⁻¹ and the numbers of fruits varied from 60.7 to 145 per bunch with an average of 254 and 101 respectively. Higher bunch yield of 16.4 t ha⁻¹, bunch weight of 407 g bunch⁻¹ and number of berries/bunch of 145 were recorded with the application of RDF (200: 160:1200 g/vine in two splits) + 25 kg ZnSO₄ 50 kg FeSO₄ 10 kg borax along with foliar spraying of 0.5% CaNO₃ + 0.5% MgSO₄ 0.5% K₂SO₄ twice during flowering and early berry formation stage. Higher juice content of 87% and TSS of 18.1 (Brixo) was also recorded in the same treatment. This was comparable with the same basal soil application of RDF micronutrients foliar spraying of 0.1 % Boric acid + 0.2% ZnSO₄+0.5% FeSO₄. The micronutrient concentrations in petiole and bulb were also increased considerably and the values for Fe were: 84.2 to 101.4 mg kg⁻¹ and 66.5 to 78.9 mg kg⁻¹ Fe in petiole and berry respectively and sustained the micronutrient availability in soil.

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1 Introduction

Grape (*Vitis vinifera* L.) is an important commercial fruit crop of tropical and temperate regions. It is a good refreshing table fruit, rich in sugars, acid, and minerals like nitrogenous compounds, iron, calcium, magnesium. Grapes are also rich in vitamins B1, B2, C, and tannins (Swathi et al., 2019). Next to banana, it is preferably consumed by all people which leads to greater demand. Globally it is grown in an area of about 8.92 million hectares with an annual production of 64.9 million tonnes. Theni, Dindigul, Krishnagiri, and Coimbatore are the major grape growing districts in Tamil Nadu. In the grape orchard, water, soil health, and vine maintenance are the three major factors that decide the yield of the crop. Among these three, soil health is very important, hence nutrient removal has to be replenished adequately based on the demand of crop to get maximum berry yield. Soil fertility affects the yield and quality of berries (Bhat et al., 2017). Integrated nutrient management plays a crucial role in the production and quality of the grape. Earlier studies well supported the application of nutrients in increasing the yield and quality of grapes. During critical stages of the crop and at adverse soil conditions foliar application is one of the best methods to support the nutrients to the plant when compared to soil application alone (Souri & Hatamian, 2019). Epibrassinolides foliar application improved the zinc and boron efficiency on increasing fruit set and grape yield per vine. Biochemical and reproductive characteristics as well as fruit set percentage was highly influenced by zinc sulfate (2 g L⁻¹) and boric acid (0.5 g L⁻¹) foliar application followed by Foliar spray of epibrassinolide (mg L⁻¹). Boric acid spray @0.3% positively influenced the cluster weight, width, volume, grape yield, and concentrations of nutrients like NPK, Ca, Mg, Zn, and Cu in leaves (Bilir et al., 2018).

Hence a holistic nutrient management package is a vital key for every orchard system to obtain higher productivity, yield, and to sustain the soil health. Nutrient application at the critical stage of the crop will ensure good quality, higher yield, and health of the vine system as a whole. Foliar application is one of the best methods to substitute the nutrient demand particularly during critical stages of the crop. All parts for attaining normal physiological and biochemical functions demand an adequate supply of macro as well as micronutrients. With this background a field experiment was conducted at Theethipalayam village of Thondamuthur block, Coimbatore district to study the effect of foliar application of micro and secondary nutrients on the yield and quality of grapes.

2 Materials and Methods

2.1 Experimental vineyard

About 8-year-old grape vineyard grown with variety Muscat (panneer) was selected for the study and vines were planted in quincunx system, with a spacing of 4 m X 3 m. The field was located in the western zone of Tamil Nadu at 76° 49' East longitude and 11° 00' North latitude at Theethipalayam village of Thondamuthur block, Coimbatore district, Tamil Nadu, India. The initial soil sample was collected from 0-15 cm depth and analyzed for various physicochemical characteristics (Table 1).

2.2 Experimental design

The experiment was conducted during the rabi 2017 vegetative season, ten treatments were imposed in a randomized block design with three replications comprising 4 vines in each replication (12 vines were maintained for each treatment). The treatment details were furnished below in Table 2.

Table 1 Details of analytical procedures employed in soil and plant sample analysis

Parameters	Methodology	Reference
Physicochemical Properties		
Soil reaction (pH)	Potentiometry (1:2.5 soil: water suspension)	(Jackson, 2005)
Electrical conductivity	Conductometry (1:2.5 soil: water suspension)	(Jackson, 2005)
Free CaCO ₃	Rapid titration method	(Piper, 1944)
Chemical Properties		
Soil Organic Carbon	Chromic acid wet digestion method	(Walkley & Black, 1934)
Available Nitrogen (N)	Alkaline permanganate method	(Subbiah & Asija, 1956)
Available Phosphorus (P)	Olsen method	Olsen et al. (1954)
Available Potassium (K)	Neutral N NH ₄ OAC	(Stanford & English, 1949)
Soil and plant: Zn, Cu, Fe & Mn	DTPA extraction AAS method	(Lindsay & Norvell, 1978)

Table 2 Detail of imposed treatments along with used concentrations

Treatments
RDF - Recommended dose of NPK@ (200:160:1200 g/vine)
25 kg ZnSO ₄ +50 kg FeSO ₄ +10 kg Borax
0.1 % Boric acid+ 0.2% ZnSO ₄ +1.0% Urea FS
0.1% Boric acid+0.2% ZnSO ₄ +0.5% FeSO ₄ FS
1% DAP+1%Urea+0.5% K ₂ SO ₄ FS
0.5% CaNO ₃ +0.5% MgSO ₄ +0.5% K ₂ SO ₄ FS
0.1% Boric acid+0.2%ZnSO ₄ +0.5% FeSO ₄ &1% DAP+1% Urea+0.5% K ₂ SO ₄ FS
0.1% Boric acid+0.2%ZnSO ₄ +0.5%FeSO ₄ +0.5% CaNO ₃ +0.5% MgSO ₄ +0.5% K ₂ SO ₄ FS
25 kg ZnSO ₄ +50 kg FeSO ₄ +10 kg borax+0.1% Boric acid+0.2% ZnSO ₄ +0.5% FeSO ₄ FS
25 kg ZnSO ₄ +50 kg FeSO ₄ +10 kg borax+0.5% CaNO ₃ +0.5% MgSO ₄ +0.5% K ₂ SO ₄ FS

*FS - Foliar spray during flowering and early berry formation stage RDF is common to all the treatments

Secondary nutrients calcium, magnesium, and micronutrients were applied as foliar sprays twice during flowering and at the early berry formation stage as per the treatment schedule in the morning hours. Manual weed control was practiced and pests and disease control measurements were taken up regularly as and when needed. Secondary and micronutrients were applied as foliar sprays twice during flowering and at the early berry formation stage as per the treatment schedule in the morning hours. Manual weed control was practiced and pests and disease control measurements were taken up regularly as and when needed.

2.3 Yield and quality parameters

The ripened bunches were harvested from each treatment separately and the number of bunches per vine and bunch weight per vine was recorded. Cluster weight was determined and expressed in grams. Cluster length (cm) and width (cm) were measured with a ruler by using thread. The total soluble solids content of the extracted juice was determined by using an Erma hand refractometer (0-32° B) and expressed as degree Brix (Ranganna, 1997).

2.4 Statistical analysis

The experimental data collected relating to different parameters were statistically analyzed using the procedure given by Panse & Sukhatme (1967). The data were subjected to Fisher's method of analysis of variance and the level of significance used in the F test was $P = 0.05$. The critical difference was calculated at 5 percent probability level whenever the F value was found to be significant.

3 Results and Discussion

The experimental soil was sandy clay loam in texture, slightly calcareous, and shallow. The grape variety viz, Panneer (Muscat) was grown as test crop and various yield attributes like bunch weight, numbers of berries bunch⁻¹ and bunch yield was recorded and reported. Besides, soil and plant samples were collected at the post-harvest stage and analyzed for various micronutrients. The experimental soil was slightly alkaline in pH (8.30) and free from salinity with an electrical conductivity of 0.20 dS m⁻¹. The organic carbon content was medium with low available N status (232 kg N ha⁻¹), medium available P (20.1 kg P ha⁻¹), and high in K (618 kg ha⁻¹) and S (21.6 kg ha⁻¹). The soil was deficient in DTPA Fe (4.12 mg kg⁻¹) while the status of other micronutrients was sufficient (Table 3).

Table 3 Initial soil characteristics of experimental field

Characteristics	Values
pH	8.30
Electrical conductivity (dS m ⁻¹)	0.20
Organic carbon (g kg ⁻¹)	6.52
Available Nutrients (kg ha ⁻¹)	
Nitrogen	232
Phosphorus	20.1
Potassium	616
Sulphur	21.6
DTPA Micronutrients (mg kg ⁻¹)	
Zinc	1.08
Iron	4.12
Copper	5.41
Manganese	11.2

3.1 Grape yield

The bunch yield of grapes ranged from 12.5 to 16.4 t ha⁻¹ with a mean of 14.5 t ha⁻¹. Among the treatments, higher bunch yield of 16.4 t ha⁻¹ was recorded with the combined soil application of RDF+ 25 kg ZnSO₄+50 kg FeSO₄+10 kg borax and foliar spraying of 0.5% CaNO₃ + 0.5% MgSO₄ + 0.5% K₂SO₄ twice during flowering and early berry formation stage which was comparable with the same basal soil application of RDF + micronutrients + foliar spraying of 0.1 % Boric acid + 0.2% ZnSO₄+ 0.5% FeSO₄ (Table 3). This indicated that soil application along with foliar spraying of micronutrients was found effective in increasing the grape yield and yield attributes. Foliar application of micronutrients had been associated with an improved number of clusters, average cluster weight, and the quality of vines (Akbar et al., 2013; Abo Ahmedeh et al., 2020). The lowest bunch yield (12.5 t ha⁻¹) was recorded in the treatment that received RDF alone. The yield increase was 31.2% for the basal combined application of RDF+25 kg ZnSO₄+50 kg FeSO₄+10 kg borax + foliar spraying of 0.5% CaNO₃ + 0.5% MgSO₄ + 0.5% K₂SO₄.

3.2 Yield attributes

Bunch weight ranged from 158 to 407 g bunch⁻¹ and the number of fruits varied from 60.7 to 145 per bunch with an average of 254 and 101g respectively. Among the treatments, higher bunch weight of 407 g bunch⁻¹ and number of berries/bunch of 145g per bunch

were recorded with the combined soil application of RDF+ 25 kg ZnSO₄+50 kg FeSO₄+10 kg borax and foliar spraying of 0.5% CaNO₃ + 0.5% MgSO₄ + 0.5% K₂SO₄ twice during flowering and early berry formation stage which was comparable with the same basal soil application of RDF+micronutrients + foliar spraying of 0.1 % Boric acid + 0.2% ZnSO₄+ 0.5% FeSO₄ (Figure 1 & 2).

The results indicated that soil application along with foliar spraying of micronutrients was found effective in increasing the grape yield and yield attributes of grapes. Increased cluster weight which sprayed with B and Zn could be attributed to increased berry set, numbers of berry in a cluster, and size of berry (Ebadi et al., 2001). The lowest bunch weight (158 g bunch⁻¹) and numbers of berries/bunch (60.7 per bunch) were recorded in the treatment that received RDF alone. All parts for attaining normal physiological and biochemical functions demand an adequate supply of macro as well as micronutrients. Besides basic nutrients (NPK), other elements like Calcium, Magnesium, Iron, Zinc and boron are considered to be essential for grapevine metabolism, growth processes, fruit set as well as berry development, because they are co-factors and activators of many metabolic processes (Ashley, 2011).

3.3 Quality attributes

Quality parameters like juice content (%) and TSS (Brix°) were recorded and the results varied from 83.1 to 87% and 16.3 to

Figure 1 Effect of foliar application of nutrients on the bunch weight of grapes

Figure 2 Effect of foliar application of nutrients on number of berries per bunch

Table 4 Effect of multi- nutrients application on the quality parameters of grapes

Treatment details	Grape yield (t ha ⁻¹)	Juice content (%)	TSS (Brix°)
Recommended NPK(RDF)	12.5	83.1	16.3
25 kg ZnSO ₄ +50 kg FeSO ₄ +10 kg borax	14.6	85.0	17.4
0.1% Boric acid+ 0.2% ZnSO ₄ +1.0% Urea FS	13.5	83.8	16.7
0.1 % Boric acid+ 0.2% ZnSO ₄ +0.5% FeSO ₄ FS	13.1	84.0	16.9
1%DAP+1%Urea+0.5%K ₂ SO ₄ FS	14.2	84.3	17.1
0.5%CaNO ₃ +0.5%MgSO ₄ +0.5%K ₂ SO ₄ FS	13.9	85.3	17.6
0.1 % Boric acid+ 0.2% ZnSO ₄ +0.5% FeSO ₄ + 1%DAP+1%Urea+0.5%K ₂ SO ₄ FS	14.9	86.0	17.8
0.1 % Boric acid+ 0.2% ZnSO ₄ +0.5% FeSO ₄ + 0.5%CaNO ₃ +0.5%MgSO ₄ +0.5%K ₂ SO ₄ FS	15.4	86.6	18.0
25 kg ZnSO ₄ +50 kg FeSO ₄ +10 kg borax + 0.1 % Boric acid+ 0.2% ZnSO ₄ +0.5% FeSO ₄ FS	16.1	87.0	18.1
25 kg ZnSO ₄ +50 kg FeSO ₄ +10 kg borax + 0.5%CaNO ₃ +0.5%MgSO ₄ +0.5%K ₂ SO ₄ FS	16.4	84.9	17.5
SEd	0.16	0.96	0.40
CD (P=0.05)	0.33	2.02	0.80

*FS - Foliar spray during flowering and early berry formation stage

* RDF is common to all the treatments

18.1(Brix°) respectively. Among the treatments, higher juice content of 87% and TSS of 18.1 (Brix°) was recorded with the combined soil application of RDF+ 25 kg ZnSO₄+50 kg FeSO₄+10 kg borax and foliar spraying of 0.5% CaNO₃ + 0.5% MgSO₄ + 0.5% K₂SO₄ twice during flowering and early berry formation stage (Table 4). The lowest juice content (83.1%) and TSS (16.3 Brix°) was recorded in the treatment that received RDF alone. This differential response was due to the impact of different fertilization doses. In this study, the

number of fruits per bunch, yield per vine and yield per hectare were increased with the combined soil application of RDF+ 25 kg ZnSO₄+50 kg FeSO₄+10 kg borax and foliar spraying of 0.5% CaNO₃ + 0.5% MgSO₄ + 0.5% K₂SO₄ twice during flowering and early berry formation stages. This might be due to the combined influence of secondary and micronutrients thereby increased photosynthetic activity, good shoot and reproductive growth finally resulted in more bunch weight and yield.

Table 5 Effect of Effect of multi- nutrients application on the micronutrients contents (mg kg⁻¹) in petiole

Treatment details	Petiole			
	Zn	Fe	Mn	Cu
Recommended NPK(RDF)	71.1	84.2	66.8	21.1
25 kg ZnSO ₄ +50 kg FeSO ₄ +10 kg borax	81.4	94.6	79.3	26.8
0.1% Boric acid+ 0.2% ZnSO ₄ +1.0% Urea FS	72.4	89.3	68.9	22.8
0.1 % Boric acid+ 0.2% ZnSO ₄ +0.5% FeSO ₄ FS	72.0	86.8	67.4	22.4
1%DAP+1%Urea+0.5%K ₂ SO ₄ FS	73.0	92.4	69.1	23.3
0.5%CaNO ₃ +0.5%MgSO ₄ +0.5%K ₂ SO ₄ FS	73.8	93.7	70.8	23.7
0.1 % Boric acid+ 0.2% ZnSO ₄ +0.5% FeSO ₄ +1%DAP+1%Urea+0.5%K ₂ SO ₄ FS	76.9	95.9	74.6	24.9
0.1 % Boric acid+ 0.2% ZnSO ₄ +0.5% FeSO ₄ +0.5%CaNO ₃ +0.5%MgSO ₄ +0.5%K ₂ SO ₄ FS	80.1	97.1	76.1	25.1
25 kg ZnSO ₄ +50 kg FeSO ₄ +10 kg borax+0.1 % Boric acid+ 0.2% ZnSO ₄ +0.5% FeSO ₄ FS	83.2	98.8	80.6	25.6
25 kg ZnSO ₄ +50 kg FeSO ₄ +10 kg borax+0.5%CaNO ₃ +0.5%MgSO ₄ +0.5%K ₂ SO ₄ FS	86.8	101	84.5	28.9
SEd	1.52	1.31	0.99	1.33
CD (P=0.05)	3.15	3.76	2.09	2.81

*FS - Foliar spray during flowering and early berry formation stage; * RDF is common to all the treatments

Foliar spray of micronutrients was advantageous over soil application, because of rapid response, effectiveness, and elimination of deficiency symptoms. Application of micronutrients through foliage spray could be from 10 to 20 times as efficient as soil application (Kuepper, 2003; El-Sheikh et al., 2007; Swathi et al., 2019). Increased fruit set relevant the important role of Boron in pollen germination and pollen tube growth might have increased the berries per bunch, berry size and thereby increase in yield of the crop. Improvement in grape yield and certain quality attributes in response to the foliar spray of boron has also been reported by Rana & Sharma (1979); Saeed Tadayon (2019).

3.4 Micronutrients concentration

The micronutrient contents in petiole and fruits were analyzed at harvest and reported in table 5. Combined soil and foliar application of micronutrients (25 kg ZnSO₄+50 kg FeSO₄+10 kg borax+0.5% CaNO₃+0.5% MgSO₄+0.5% K₂SO₄) recorded the highest concentration of all the micronutrients in the petiole and fruits when compared to NPK control. The Fe content ranged from 84.2 to 101.4 mg kg⁻¹ and 66.5 to 78.9 mg kg⁻¹ in petiole and berry respectively. Concerning other micronutrients, the values ranged from 66.8 to 84.5, 71.1 to 86.8, and 21.1 to 28.9 mg kg⁻¹ for Mn, Zn, and Cu respectively in petiole while this value was reported from 23.5 to 35.6, 28.7 to 62.0 and 9.23 to 12.4 mg kg⁻¹ respectively for fruit. Though combined application of RDF + micronutrients as basal and foliar spray (25 kg ZnSO₄+50 kg FeSO₄+10 kg borax+0.5% CaNO₃+0.5% MgSO₄+0.5% K₂SO₄) recorded higher micronutrient concentration in petiole and fruits, and it was at par with RDF+ 25 kg ZnSO₄+50 kg FeSO₄+10 kg borax as soil application along with

the foliar spraying of 0.5% CaNO₃ + 0.5% MgSO₄ + 0.5% K₂SO₄ at flowering and early berry forming stages (Table 5) .

The lowest micronutrient content in petiole and fruits was recorded in the NPK control. This indicated that combined application of soil and foliar application of micronutrients (25 kg ZnSO₄+50 kg FeSO₄+10 kg borax+0.5% CaNO₃+0.5% MgSO₄+0.5% K₂SO₄) not only increased the berry yield but also considerably increased the concentrations of Fe, Zn, Mn, Cu and B in both petiole and berry fruit (Table 5). Foliar application of micronutrients had been associated with improved absorption of nutrients, increased number of clusters, average cluster weight, juice content, and quality of vine (Akbar et al., 2013). Foliar application of micronutrients was advantageous over soil application, it might be because of rapid response, effectiveness, and amelioration of deficiency (Kuepper, 2003; El-Sheikh et al 2007).

3.5 Post-harvest soil nutrient availability

The post-harvest soil available micronutrients status (Table 6) showed that the application of either soil or combined soil + foliar application of micronutrients increased the micronutrient availability in soil and sustained all micronutrients. However foliar spraying of micronutrients was not sufficient to increase the micronutrient availability in soil and it ranged from 5.54 to 7.24 mg kg⁻¹ for Fe, 2.06 to 4.56 mg kg⁻¹ for Mn, 1.00 to 1.78 mg kg⁻¹ for Zn and Cu, it ranged from 3.29 to 4.64 mg kg⁻¹. Micronutrients availability in post-harvest soils of vine orchard showed sufficient status of all the micronutrients in the soil. This may be attributed to the mineralogy of the soil, organic manuring, and balanced application of all essential nutrients.

Table 6 Effect of Effect of multi- nutrients application on the post- harvest micronutrients status in the soil (mg kg⁻¹)

Treatment details	DTPA Micronutrients (mg kg ⁻¹)			
	Zn	Fe	Mn	Cu
Recommended NPK(RDF)	1.00	5.54	2.06	3.59
25 kg ZnSO ₄ +50 kg FeSO ₄ +10 kg borax	1.78	6.90	3.04	4.54
0.1% Boric acid+ 0.2% ZnSO ₄ +1.0% Urea FS	1.08	5.67	2.33	4.64
0.1 % Boric acid+ 0.2% ZnSO ₄ +0.5% FeSO ₄ FS	1.60	5.61	2.18	3.81
1%DAP+1%Urea+0.5%K ₂ SO ₄ FS	1.09	5.78	2.73	4.21
0.5%CaNO ₃ +0.5%MgSO ₄ +0.5%K ₂ SO ₄ FS	1.12	5.94	2.84	4.11
0.1 % Boric acid+ 0.2% ZnSO ₄ +0.5% FeSO ₄ +1%DAP+1%Urea+0.5%K ₂ SO ₄ FS	1.33	6.44	3.42	3.95
0.1 % Boric acid+ 0.2% ZnSO ₄ +0.5% FeSO ₄ +0.5%CaNO ₃ +0.5%MgSO ₄ +0.5%K ₂ SO ₄ FS	1.19	6.49	3.99	4.82
25 kg ZnSO ₄ +50 kg FeSO ₄ +10 kg borax +0.1 % Boric acid+ 0.2% ZnSO ₄ +0.5% FeSO ₄ FS	2.43	6.68	3.55	5.29
25 kg ZnSO ₄ +50 kg FeSO ₄ +10 kg borax +0.5%CaNO ₃ +0.5%MgSO ₄ +0.5%K ₂ SO ₄ FS	2.61	7.24	4.56	6.31
SEd	1.33	0.94	1.52	1.03
CD (P=0.05)	2.83	1.97	3.19	2.16

*FS - Foliar spray during flowering and early berry formation stage

* RDF is common to all the treatments

The variations in concentrations of DTPA micronutrients could be attributed to the nature and behavior of the elements in the soil itself. The use of organic manures and micronutrient fertilizer might have contributed to micronutrient availability. Combined application of soil + foliar spraying of micronutrients, sustained the availability in soil when compared to NPK control. Many of the grape soils shared higher availability of DTPA Mn and Zn while, DTPA Cu and Fe were observed in medium and higher ranges (Kondi et al., 2018).

Conclusion

Nutrient management, water, and vineyard maintenance play a major role in sustained yield and soil fertility in a continuous cycle system of grape cultivation. To assess the effect of the integrated supply of major, secondary, and micronutrients application through the soil and foliar spray on various growth, yield, and quality attributes, a current field experiment was conducted at 8 years old orchard of panneer variety during the summer season of 2017 at Theethipalayam village of Coimbatore district. The effect of soil and foliar application of secondary and micronutrients showed that foliar spraying of secondary nutrients (Ca, Mg) and micronutrients (Zn, Fe, B) along with basal recommended NPK increased the yield and yield attributes of grapes. Basal application of 100% RDF (200:160:1200 g/vine in two splits) + 25 kg ZnSO₄+50 kg FeSO₄+10 kg borax along with foliar spraying of 0.5% CaNO₃+0.5% MgSO₄+0.5% K₂SO₄ registered higher fruit yield and bunch weight. Further, higher juice content and TSS was also recorded with the combined soil application of RDF (200: 160:1200 g/vine in two splits) + 25 kg

ZnSO₄+50 kg FeSO₄+10 kg borax along with foliar spraying of 0.5% CaNO₃ + 0.5% MgSO₄ + 0.5% K₂SO₄ twice during flowering and early berry formation stage.

From the above experiment, it can be concluded that soil and foliar application of multi-nutrients have a stimulatory effect on the various yield and quality parameters of grape, this showed that basal application of 100% RDF (200:160:1200 NPK g/vine in two splits) + 25 kg ZnSO₄+50 kg FeSO₄+10 kg borax along with foliar spraying of 0.5% CaNO₃+0.5% MgSO₄+0.5% K₂SO₄ was found effective in increasing the grape yield and quality.

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Conflict of interest

The authors declare that they have no conflict of interest

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