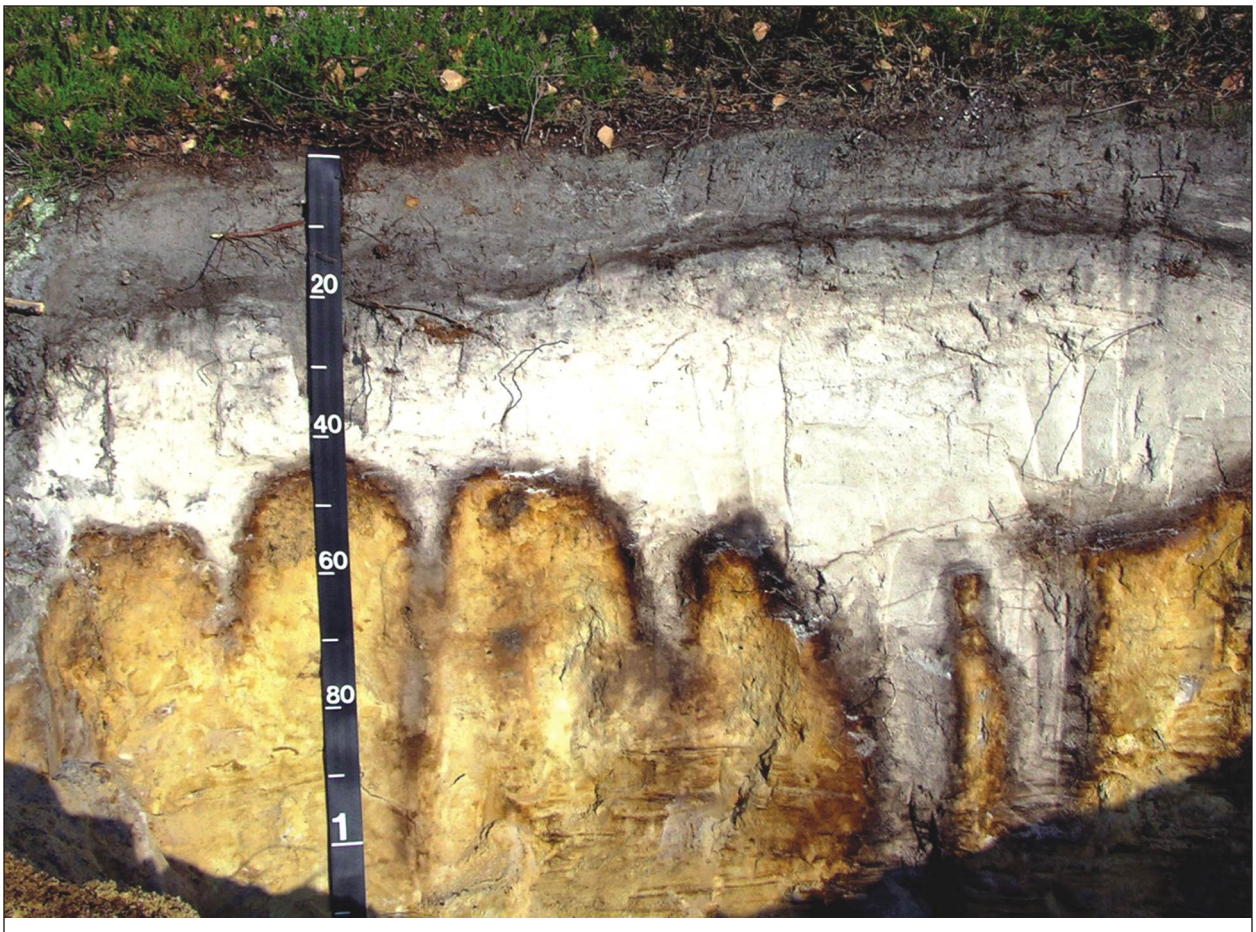

International Journal of Soil Science

ISSN 1816-4978

Academic Journals Inc.

www.academicjournals.com

International Journal of Soil Sciences 1 (1): 1-7, 2006
ISSN 1816-4978

Micronutrients and Zn Solubilizing Bacteria on Yield and Quality of Grapes Variety Thompson Seedless

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Abstract: Micronutrients disorders, which emanated from the adoption of intensive agriculture coupled with the use of high analysis NPK fertilizers and scarce use of organic manure and limited use of crop residues become dominant in grape growing tracts. The present energy crisis and rapidly increasing fertilizer price have necessitated the efficient utilization of micronutrients to achieve increased and sustainable productivity. Efficient micronutrient management embodies the use of effective micronutrient source and techniques on the time and mode of application to grape is necessary in this condition. A field experiment was conducted with Thompson seedless grapes with treatments involving micronutrients as soil application and foliar spray by adopting randomized block design with three replications. To arrive cost effective technology for correcting the micronutrients deficiencies for sustaining grapes yield with benefit: cost ratio, recommended doses of N, P and K fertilizers along with foliar sprays of $ZnSO_4$ (0.2%) + boric acid (0.2%) + $FeSO_4$ (0.2%) + $MnSO_4$ (0.2%) + $MgSO_4$ (0.5%) + $CaCl_2$ (0.5%) + KNO_3 (0.5%) + urea (1%) at blooming and 15 days after blooming stages was best. The quality of fruits such as juice content, TSS, titratable acidity, specific gravity, total sugar and TSS/acidity ratio were also higher in the above treatment.

Key words: Grapes, micronutrients, zinc solubilising bacteria, foliar spray

Introduction

Fruits are great bounty of nature and their importance in human diet. Grapes are an ancient crop which can be consumed as fresh, dried, juice and fermented wine and it belongs to some medicinal values. It is grown in an area of nine million ha in the world with the production of 6.52 million metric tonnes. In India, grapes are grown in area of nearly 0.4 lakhs ha with an annual production of 9.4 lakhs tonnes. Presently grapes cultivation is concentrated in the peninsular India accounting for 40% of total area and Thompson seedless is the ruling variety occupying 55% of area (Chadha, 2001). In Tamil Nadu, it is grown in an area of nearly 3480 ha, with an annual production of 0.68 lakh tonnes. Grape is grown in Punjab and Hariyana in the north and Karnataka and Tamil Nadu in the south (Samaddar, 2001). Normally four to five crops are being taken in two years in the selected districts of Theni, Dindigal, Madurai and Coimbatore through staggered pruning techniques. Despite the fact that micronutrients have got definite effect on the growth and quality, not much attention has been given so far to viticulture. Heavy cropping of grapes year after year in the same land has registered in a removal of large amounts of macro and micronutrients and the soil has

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become impoverished from plant food. This is particularly true for micronutrients, which are rarely applied to soil. The soil reserves are thus depleted which results in low yield with poor quality fruits. Ultimately cropping in such land becomes uneconomical, unless sufficient quantity of micronutrients are added to the soil or applied to the vines through foliar spray.

Appropriate diagnostic and recommendation tools based on soil and leaf analysis need to be developed and continuously upgraded to suit the ever changing requirements of fruit production so that hidden hunger as well as toxicity of nutrients are over come. Grapes is commercially one of the most important fruit crops in India and Viticulture is considered to be one of the cost remunerative farming enterprises (Chundawat, 1997) and nutrient management is the major important aspect of grapes cultivation. In India, no systematic experiments have been conducted to establish nutrient requirements and results have not been conclusive leading to arbitrary and speculative schedule. Recommendations made in old books on fruit culture are also at variance with one another. In any case manuring is the most important component and in Indian context this alone is estimated to comprise 40% of annual cost of grapes cultivation. Considerable variations in the level of fertilization exists in various region and with in region also variation exists. The fertilizer recommendations for grapes have not been based on well planned experimentation but adhoc and arbitrary.

Recommendation process based on experimental work is lacking. Concentrated efforts are required to achieve higher productivity hand in hand with sustainability. So that the activity of grapes production does not degrade soil health towards nutrient depletion or pollution and ecological balance are protected for posterity. A decline in the over all yield of Thompson seedless grape orchards with 7-10 years old plants had been observed due to some undetected nutrient deficiency and their yields are showing a downward trend despite the adequate uses of N, P and K fertilizers and organic manure. The objective of this study is the impact of mode of application of added nutrients including zinc solubilising microorganisms on nutrient status of soil, yield, quality of fruits and nutrient uptake of fruits in Thompson seedless grapes.

Materials and Methods

To study the influence of mineral nutrition on the yield and quality of Thompson seedless grape, the experiments were carried out during two seasons of summer (Feb- May 2002) and winter (June-October 2002) in a farmer's vineyard located at Odaipatty of Uthamapalayam Taluk, Theni district, Tamil Nadu. The field is situated at 9° N latitude and 77°E longitude with an altitude of 392.71 m above mean sea level. The mean annual rainfall was 672 mm, with the mean annual maximum and minimum temperature of 32.6 and 25.6°C, respectively. The mean relative humidity was 68%. The experimental field soil belongs to the order Inceptisol.
Treatment details were show as:

T_1 : Control (with out fertilizer)
T_2 : Recommended dose (400 g N, 240 g P_2O_5 and 1200 g K_2O $Vine^{-1}$)
T_3 : T_2 + $ZnSO_4$ 10 g $vine^{-1}$ (Soil application)
T_4 : T_2 + $ZnSO_4$ 10 g $vine^{-1}$+ Zn Solubilizing Bacteria (Soil application)
T_5 : T_2 + $ZnSO_4$ 10 g $vine^{-1}$+ Borax 4 g (Soil application)
T_6 : T_2 + $ZnSO_4$ (0.2%) + Urea (1%)
T_7 : T_2 + $ZnSO_4$ (0.3%) + Urea (1%)
T_8 : T_2 + $ZnSO_4$ (0.4%) + Urea (1%)
T_9 : T_2 + $ZnSO_4$ (0.2%) + Boric acid (0.2%) + Urea (1%)

T_{10} : T_2 + $ZnSO_4$ (0.2%) + Boric acid (0.2%) + $FeSO_4$ (0.2%) + $MnSO_4$ (0.2%) + $MgSO_4$ (0.5%) + Urea (1%)

T_{11} : T_2 + $ZnSO_4$ (0.2%) + Boric acid (0.2%) + $FeSO_4$ (0.2%) + $MnSO_4$ (0.2%) + $MgSO_4$ (0.5%) + $CaCl_2$ (0.5%) + KNO_3 (0.5%) + Urea (1%)

T_{12} : Farmer's practice (150 g N, 200 g P_2O_5 and 400 g K_2O $Vine^{-1}$, 100 kg ground nut cake ha^{-1}, 150 kg neem cake ha^{-1} and 10 kg FYM $vine^{-1}$)

The treatments were tried in grape vines aged about nine years old by adopting a Randomised Block Design (RBD) with three replications during two seasons of summer and winter. There were four grape vines allotted per treatment. The recommended full dose of N in the form of urea, P_2O_5 in the form of SSP and half of the dose of K_2O in the form of MOP were incorporated in the soil of the respective plots at the time of pruning. The $ZnSO_4$ (10 g $vine^{-1}$) and Borax (4 g $vine^{-1}$) were also applied as basal as per treatment schedule. The Zinc Solubilising Bacteria (*Pseudomonas fluorescens*) obtained from Department of Microbiology, Agricultural College and Research Institute, Madurai and FYM 50 kg $vine^{-1}$ were applied one week before basal fertilizer application. The remaining half of the dose K in the form of MOP was applied at 1 m away encircling the vine and covered with soil at 60 days after pruning. The stipulated concentrations of mineral nutrients were sprayed using hand-operated sprayer during morning hours between 7 to 8 am to the respective vines both at blooming and 15 days after blooming stages of growth. Normal packages of practices of cultural operations for Thompson seedless grapes variety were followed.

Initial surface soil samples (0-15 cm) were collected and analysed for its properties. The surface soil samples were also collected from the grapevine trunk at three stages of grape growth viz., full bloom, 15 days after full bloom and post harvest stages. The collected soil samples were dried separately under shade, ground using wooden mallet and sieved through a 2 mm polyethylene sieve and used for analysis. The leaf petioles opposite to flower cluster were collected separately at three stages of grape growth viz., full bloom, 15 days after full bloom and at fruit harvest stages of both two seasons. The petiole samples were washed with acidified distilled water (0.1 N HCl) and then with deionised water. Then the samples were separately dried in the shade and oven at 60°C for 3 h. The dried petiole samples were used for analysis of N, P, K, Ca, B, Cu, Fe, Mn and Zn.

Results and Discussion

The analysis of initial soil, showed that soil is sandy clay loam in texture. The soil was free from salinity (EC 0.08 dS m^{-1}) and soil reaction was found to be alkaline (pH 7.7). The CEC of experimental soil was found to be medium (14.10 c mol (P^+) kg^{-1}). The physical properties of soil were found to be medium in both pore space (52.3%) and water holding capacity (42.8%) and high in volume expansion (39.5%). The chemical analysis of soil indicated that the initial fertility of soil in terms of available N was medium and available P, K and organic carbon contents were found to be high. Regarding micronutrients the soil was deficient in hot water B and DTPA Zn.

Effect of Added Nutrients on Yield of Fruits

The data of mean yield of fruits in both the seasons showed that among the treatments tried, the treatment received recommended fertilizer schedule of N, P and K and foliar application of

Table 1: Effect of added nutrients on yield of Thompson seedless

	Fresh Fruit yield (t ha^{-1})		
Treatments	S 1	S 2	Mean
T_1	9.00	7.50	8.29
T_2	16.20	16.90	16.55
T_3	17.20	18.30	17.75
T_4	19.70	21.00	20.33
T_5	17.60	18.60	18.10
T_6	19.80	20.60	20.20
T_7	20.00	20.80	20.40
T_8	20.20	20.90	20.55
T_9	9.00	7.50	8.29
T_{10}	16.20	16.90	16.55
T_{11}	17.20	18.30	17.75
T_{12}	19.70	21.00	20.33
Mean	17.60	18.60	18.10
	S	T	S×T
SEd	0.11	0.28	0.39
CD (p = 0.05)	0.23	0.56	0.78

Table 2: Effect of added nutrients on physico chemical characteristics of fruits

	Bunch wt. (g)			No. of berries $bunch^{-1}$			No. of shoot berries $bunch^{-1}$		
Treatments	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean
T_1	327.27	300.00	313.64	142.29	121.38	131.84	22.0	22.6	22.3
T_2	457.95	464.60	461.28	186.91	192.30	189.61	18.4	16.0	17.2
T_3	468.02	489.63	478.33	187.20	193.21	190.21	16.3	14.5	15.4
T_4	527.09	560.00	543.55	210.83	215.32	213.08	14.4	13.2	13.8
T_5	478.91	499.32	489.12	191.56	196.32	193.94	15.6	14.0	14.8
T_6	559.71	572.22	565.97	220.13	224.12	222.13	13.4	13.1	13.3
T_7	568.64	573.79	571.22	227.45	230.45	228.95	12.1	13.0	12.6
T_8	567.01	574.57	570.79	226.80	229.33	228.01	11.6	12.9	12.3
T_9	574.64	580.82	577.73	229.85	233.35	231.60	10.9	12.8	11.9
T_{10}	583.85	601.36	592.61	233.54	237.42	235.48	10.6	11.0	10.8
T_{11}	590.00	621.62	605.31	235.76	241.60	238.68	10.1	10.2	10.2
T_{12}	412.81	445.07	428.94	164.80	170.80	167.80	23.3	18.3	20.8
Mean	509.66	528.58	519.12	204.76	207.06	205.91	15.7	14.3	15.0
	S	T	S×T	S	T	S×T	T	S	S×T
SEd	2.90	7.10	10.04	1.53	3.74	5.29	0.3	0.1	0.4
CD (p = 0.05)	5.83	14.29	20.21	3.07	7.52	NS	0.6	0.2	0.8

$ZnSO_4$ (0.2%) + boric acid (0.2%) + $FeSO_4$ (0.2%) + $MnSO_4$ (0.2%) + $MgSO_4$ (0.5%) + $CaCl_2$ (0.5%) + KNO_3 (0.5%) + urea (1%) at both blooming and 15 days after blooming stages gave the highest yield of fruits compared to the yield of fruits due to other treatments including the growers practice and application of recommended N, P and K (Table 1). Dariuszwietlik (2002) reported that there is an evidence of strong relationship between Zn nutrition and yield of fruits. It was also seen that it would also be possible to improve yield of fruits by soil application of $ZnSO_4$ (10 g $vine^{-1}$) and ZSB (2 kg ha^{-1}) or foliar feeding of $ZnSO_4$ (0.2%) at twice besides soil application of recommended fertilizer schedule of N, P and K. The finding necessitates the importance of foliar fertilization to improve the yield of. The foliar spraying of Zn must be repeated at frequent intervals due to poor mobility of foliar absorbed Zn from spray to non-sprayed new leaves. Subbiah and Peter (1993) observed that foliar application KNO_3 (0.5%) had beneficial effect to improve yield of fruits in mandarin orange. Shikhamany *et al.* (1985) reported that bloom time petiole Mg content was found

Table 3: Effect of added nutrients on titratable acidity, TSS and Juice content of berries

	Titratable acidity (g L^{-1})			TSS (%)			Juice content (%)		
Treatments	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean
T_1	0.891	0.910	0.900	14.30	13.60	13.95	68.30	67.10	67.70
T_2	0.843	0.830	0.840	16.20	16.50	16.35	71.20	71.40	71.30
T_3	0.805	0.790	0.797	17.90	18.20	18.05	73.10	73.50	73.3
T_4	0.789	0.760	0.770	18.40	18.70	18.55	73.70	74.20	73.95
T_5	0.792	0.780	0.786	18.10	18.40	18.25	73.30	73.80	73.55
T_6	0.784	0.770	0.771	18.30	18.60	18.45	74.30	74.70	74.50
T_7	0.776	0.760	0.763	18.20	18.70	18.45	74.20	74.70	74.45
T_8	0.778	0.760	0.770	18.20	18.60	18.40	74.20	74.80	74.50
T_9	0.710	0.700	0.705	18.90	19.20	19.05	75.40	76.10	75.75
T_{10}	0.703	0.690	0.700	19.10	19.40	19.25	76.00	76.50	76.25
T_{11}	0.692	0.680	0.690	19.30	19.70	19.50	76.50	77.20	76.85
T_{12}	0.854	0.840	0.847	15.80	16.00	15.90	70.30	70.60	70.45
Mean	0.784	0.770	0.777	17.72	17.96	17.84	73.37	73.70	73.54
	S	T	S×T	S	T	S×T	S	T	S×T
SEd	0.005	0.014	0.020	0.13	0.33	0.46	0.54	1.33	1.88
CD (p = 0.05)	0.012	0.029	NS	NS	0.66	NS	NS	2.67	NS

Table 4: Effect of added nutrients on TSS/acidity ratio, specific gravity of berries and total sugar

	TSS/acidity ratio			Specific gravity of berries (g cc^{-1})			Total sugar (%)		
Treatments	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean
T_1	16.05	14.95	15.47	1.23	1.18	1.21	9.15	9.08	9.12
T_2	19.22	19.87	19.55	1.14	1.13	1.14	10.50	11.02	10.75
T_3	22.24	23.04	22.62	1.08	1.06	1.07	11.23	11.50	11.37
T_4	23.32	24.60	23.96	1.05	1.03	1.04	12.22	12.48	12.35
T_5	22.85	23.59	23.22	1.07	1.05	1.06	11.36	11.50	11.43
T_6	23.34	24.16	23.74	1.05	1.03	1.04	11.56	11.78	11.67
T_7	23.45	24.60	24.03	1.05	1.02	1.04	11.67	11.86	11.78
T_8	23.39	24.61	23.99	1.05	1.03	1.04	11.73	11.96	11.85
T_9	26.62	27.43	26.81	1.04	1.02	1.03	11.91	12.10	12.03
T_{10}	27.17	28.12	27.64	1.03	1.02	1.03	12.21	12.70	12.45
T_{11}	27.89	28.97	28.43	1.02	1.01	1.02	12.62	12.98	12.80
T_{12}	18.50	19.05	18.77	1.18	1.12	1.15	10.02	10.40	10.21
Mean	22.84	23.58	23.19	1.08	1.05	1.07	11.34	11.61	11.48
	S	T	S×T	S	T	S×T	S	T	S×T
SEd	0.21	0.41	0.56	0.01	0.02	0.03	0.32	0.77	1.09
CD (p = 0.05)	0.43	0.82	NS	0.02	0.04	NS	NS	1.56	NS

to determine the enhancement of yield of fruits in Thompson seedless. Also, inclusion of Zn solubilizing bacteria with $ZnSO_4$ showed specific effect on nutrient, growth parameters and consequently on yield. So by using ZSB that has the ability to produce gluconic acid can be successfully used as bio inoculant to supply the Zn source by dissolving the insoluble Zn compounds present in the soil. This helps to get the Zn supply to the plant on a sustainable basis and increase the yield (Saravanan *et al*., 2003).

The reason for the enhancement of fruit yield due to the treatments set of above mentioned foliar feeding of nutrients twice in a season and at definite physiological stages might have maintained the critical levels of required nutrients in the leaf petiole throughout the growth periods and in turn might have influenced the growth parameters and ultimately resulted in enhanced yield of fruits. The increased yield of fruits due to above mentioned treatment of foliar feeding of fertilizers can also be evidenced from the correlation studies made between fruit yield and nutrient content in leaf

petiole, nutrient available in soil and micronutrients content and uptake by fruit pulp. In addition to this, the net profit and benefit: cost ratios were found to be the highest due to the mentioned treatment of foliar feeding of fertilizers.

Effect of Added Nutrients on Physico Chemical Characteristics of Grape Berries

It is interesting to note that, the treatment (recommended fertilizer schedule of N, P and K with $ZnSO_4$ (0.2%) + boric acid (0.2%) + $FeSO_4$ (0.2%) + $MnSO_4$ (0.2%) + $MgSO_4$ (0.5%) + $CaCl_2$ (0.5%) + KNO_3 (0.5%) + urea (1%) foliar sprays at both blooming and 15 days after blooming stages) which had profound influence on the enhancement of yield of fruits also registered significantly the highest bunch weight, number of berries $bunch^{-1}$ and the lowest number of shot berries $bunch^{-1}$ (Table 2). The reason might be due to the maintenance of required amount of micronutrients content in leaf petiole which in turn might have promoted higher synthesis of metabolites resulted in a improvement of biometrics of berries. The results are in conformity with those of Senthil Kumar (2001) and Sidhu *et al.* (2002) in grapes. The better availability and absorption of nutrients with the foliar applied fertilizer nutrients might have caused significant increase in the fruit yield attributing parameters of grapes. In general the above findings clearly showed that in addition to recommended N, P and K fertilizers application besides secondary and micronutrients through foliage to improve physico chemical characteristics of grape berries in the Thompson seedless variety.

Effect of Added Nutrients on Quality of Fruits

The quality characteristics of grape berries such as the juice content, TSS, titratable acidity, specific gravity, total sugar and TSS/acidity ratio were found to be enhanced by the treatment (recommended fertilizer schedule of N, P and K along with $ZnSO_4$ (0.2%) + boric acid (0.2%) + $FeSO_4$ (0.2%) + $MnSO_4$ (0.2%) + $MgSO_4$ (0.5%) + $CaCl_2$ (0.5%) + KNO_3 (0.5%) + urea (1%) at both blooming and 15 days after blooming stages) which is responsible for the highest production of fruits (Table 3 and 4). But the pH of juice was not altered by the above mentioned treatment. The reason for increased fruit quality parameters like juice content, TSS, total sugar and TSS / acidity ratio might be due to the favourable effect of added nutrients through foliage on the translocation of sugars in the fruits. The results are in agreement witht hose of and Balakrishnan *et al.* (1996) and Senthil Kumar (2001) in grapes and Subbiah and Peter (1993) in mandarin orange. The discussion showed that in addition to soil application of recommended doses of N, P and K, foliar feeding of deficient nutrients (B and Zn) partially mobile micronutrients (Zn, Mn and Fe) and immobile secondary nutrients like Ca ($CaCl_2$) and macro nutrient like K (KNO_3) were found to be necessary to obtain top quality fruits.

References

Balakrishnan, K., K. Venkatesan and S. Sambandamurthi, 1996. Effect of foliar application of Zn, Fe, Mn and B on yield and quality of pomegranate. The Orissa J. Hortic., 24:33-35.

Chadha, K.L., 2001. Hand Book of Horticulture. Indian Council of Agricultural Research, New Delhi.

Chundawat, 1997. Nutrient management in fruit crops. Agrotech Publishing Academy. Udaipur.

Dariuszwietlik, 2002. Zinc nutrition of fruit crops. Hortic. Technol., 12: 45-49.

Samaddar, H.N., 2001. Commercial Production of Horticultural Crops. Naya Udyog Publishers. Kolkata.

Saravanan, V.S., S.R. Subramoniam and S.A. Raj, 2003. Assessing *in vitro* solubilization potential of different zinc solubilizing bacterial (ZSB) isolates. Brazilian J. Microbiol., 34: 121-125.

Senthil, K.P.S., 2001. Micronutrient management for sustainable production in major grape and turmeric growing areas of Tamil Nadu. Ph.D Thesis, Tamil Nadu Agricultural University, Coimbatore.

Shikhamany, S.D., Chadha, K.L. and R.Chittiraichelvan, 1985. Determination of critical levels of petioles nutrient content for Thompson seedless grapes. Indian J. Hortic., 42: 8-11.

Sidhu, A.S., N.S. Tomer, B.S. Chahil and J.S. Brar, 2002. Effect of N, P and K on physiochemical, characteristics of grapes (*Vitis vinifera* L.) during development. Haryana J. Hortic. Sci., 31: 19-22.

Subbiah, K. and G.B.V. Peter, 1993. Effect of foliar applied potassium and calcium nitrates on yield and quality of mandarin orange. Golden Jubilee Symposium on Horticultural Research-Changing Scenario, Bangalore, pp: 122.