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**ORIGINAL ARTICLE**

# Effects of Zn, Fe and their Combination Treatments on the growth and yield of tomato

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**ABSTRACT**

*The aim of this study was to evaluate the effects of the foliar application of zinc (50 and 100 mg/L) and iron (100 and 200 mg/L) and their combination on vegetative, reproductive growth, fruit quality and yield of tomato plants as a laid out in completely randomized block design with four replications. The results showed that high Zn (100 mg/L) and Fe (200 mg/L) and their combination significantly promoted vegetative and reproductive growth. Foliar application of Zn (100 mg/L) + Fe (200 mg/L) resulted in the maximum plant height (124.14 cm), branches per plant (8.36), flowers per cluster (18.14), fruits per cluster (8), fruits per plant (90.14), fruit weight (95.14 g), chlorophyll content (22.14 SPAD) and yield (25.14 t $ha^{-1}$). Fe and Zn alone or in combination had significant effect on leaves-NK content and nitrate reductase activity. The highest TSS (5.87 °Brix), TA (4 %), pH (2.61 %), fruit firmness (3.66 kg $cm^{-2}$) and fruit lycopene content (2.25 mg/100 g) were observed when tomato plants treated with 100 mg/L Zn+200 mg/L Fe, thus it was recommended to apply foliar application of Zn and Fe in order to improve growth, flower yield, quality and chemical constituents in tomato plants.*

**Keywords:** tomato, vegetative and reproductive growth, yield, Zn, Fe

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## INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) contains a large quantity water (%), calcium (%) and Niacin all of which have great importance in the metabolic activities of man. It's also a rich source of lycopene and vitamins. It is the largest vegetable crop after potato and sweet potato in the world but it tops the list of canned vegetables. Great efforts have recently been focused to produce a good appearance and quality tomato through the utilization of inexpensive and environmentally friendly resources.

Foliar spraying of microelements is very helpful when the roots cannot provide necessary nutrients [1]. According to Kołota and Osińska [2], foliar feeding is an effective method of supplying nutrients during the period of intensive plant growth when it can improve plants mineral status and increase crop yield. Narimani *et al.,* [3] reported that microelements foliar application improve the effectiveness of microelements. Zinc is an important micronutrient that is closely involved in the methabolism of RNA and ribosomal content in plant cells, also it leads to stimulate carbohydrates, proteins and the DNA formation. It is required for the synthesis of tryptophan, a precursor of IAA which acts as a growth promoting substance. Berglund [4] noted Zn foliar application particularly at vegetative growth stage increased soybean seed yield. Bozoglu *et al.,* [5] stated that foliar application of Zn could be implemented for higher yield and quality. Dixi and Gamdagin [6] claimed that a foliar spray application of Zn increased size, TSS and juice of oranges. Zn has also shown to have an important role in photosynthesis and related enzymes which is resulted in increasing sugar and decreasing acidity [7]. Iron (Fe) is another micronutrient that is a cofactor for approximately 140 enzymes that catalyze unique biochemical reactions. Hence, iron has many essential roles in plant growth and development including chlorophyll synthesis, thylakoid synthesis and chloroplast development. Iron plays an important role in tomato nutrition and fruit quality. This microelement significantly affects the quantity and quality of tomato yield in greenhouses cultivation with a limited volume of the growing medium [8]. Iron plays essential roles in the metabolism of chlorophylls. External application of Fe increased photosynthesis, net assimilation and relative growth in seawater-stressed rice [9]. Flower yield, essential oil percentage, and essential oil yield in chamomile increased by foliar application of iron and zinc compared with control. It seems that foliar application of iron and zinc can considerably improve flower yield and essential oil content of chamomile especially in calcareous soils [9]. However, iron is necessary for the biosynthesis of chlorophyll and cytochrome, which will lead to increased biosynthesis materials and growth.

## MATERIALS AND METHODS

In order to determine, the effect of different levels of Fe and Zn used in spraying solution on the yield and quality of tomato during 2012-2013 growth seasons in Ilam (Elevation 1339 m, Latitude East 33.638, Longitude North 46.431), Iran. The soil of the experimental field was silty loam in texture with a pH of 7, containing total N (2.5%), total C (1%), a C/N ratio of 0.46, 75, 107 $mg \cdot kg^{-1}$ of P, and K, respectively, and with an EC of 0.071 $ds \cdot cm^{-1}$. Seeds of tomato cultivar Tivi F1 were sown in the month of January and were transplanted during the month of March. There were 3 ridges in 1 subplot and 10 plants in each ridge. Row-to-row distance and plant-to-plant distance was 75 cm and 30 cm, respectively. Fe (100 and 200 mg $l^{-1}$) and Zn (50 and 100 mg $l^{-1}$), alone or in combination, were applied as foliar spray 30 days after transplanting and when the fruits were berry-sized. A back-held spray pump was used for foliar application of the chemicals. After each treatment, the pump was washed thoroughly. A teaspoon of commercial washing powder was added as a wetting agent. Distilled water containing a comparable amount of wetting agent was sprayed on the plants in the controlled treatment. All foliar spraying was carried out early in the morning. The following characteristics were recorded, plant height, number of fruits per cluster, total yield, mean fruit weight, soluble solid content, total titrable acid, vitamine C, total N and P in leaves. Plant height was determined for 5 plants in the middle row in each treatment after the first picking. For this purpose, the plant height from the soil line to the top was determined with a measuring tape and averaged to represent corresponding treatments. The number of branches was counted for the middle ridge in each treatment at the first picking and the average number of branches per plant was calculated. Total N and P of the sample was determined by Kjeldahl method [10]. Lycopene in fruits was estimated as described by Sadasivam and Manikam [11]. The number of flower clusters per plant, number of fruits per cluster, and number of fruits per plant were determined for 5 plants in the middle row of the plot. For this purpose, the number of flower clusters per plant, number of fruits per cluster, and number of fruits per plant were counted and divided by the total number of plants. Nitrate Reductase Activity (NRA) was determined by the method of Silveira *et al.,* [12]. Leaf disc from the second youngest fully expanded leaves (200 mg fresh mass) were infiltrated twice for two minutes with 5 ml of reaction mixture containing 100 mmol/l Potassium Phosphate buffer (pH 7.5) ; 25 mmol/l KNO3 ; and 1% isopropanol. The reaction mixture was incubated at 35°C for 30 minutes in the dark. NR activity was estimated from the amount of $NO^{2-}$ formed during the incubation period and released from the leaf discs to the medium after boiling for 5 minutes. Aliquots were mixed with 2 ml of (1:1) 1% sulfanilamide in 2.4 mol /l HCl ; 0.02% N-1-naphtyl-ethylenediamine and the absorbance was taken at 540 nm. The total yield for each treatment was calculated by weighing the fruit picked in each plot and converting the weight to yield per hectare. The average fruit weight was estimated by weighing 10 fruits in each treatment, with the help of an electronic balance measuring in grams to the third decimal place, and then converting to average fruit weight. Sub-samples (10 g) were pressed through cheese cloth to extract the juice. Total soluble solids were determined on a portable refractometer (Sper Scientific Ltd., Scottsdale, Ariz.) standardized with distilled water. Total titrable acid and vitamin C was measured by NaOH (0.1 M) titration and indophenol's method according to Horvitz *et al.,* [13]. Blossom end rot incidence (%) was estimated by counting the total number of fruits and fruits showing symptoms of blossom end rot in each plot. The blossom end rot incidence is expressed as a percentage of total fruits. The fruit firmness was recorded with the help of a pressure meter (OSK 10576 CO., Japan). For this purpose, 5 fruits from each treatment were taken and penetration force was measured by gently inserting the probe into the equatorial region of the fruit. The readings for all 5 fruits were averaged to represent the corresponding treatments. During the trial three plants per experimental unit were sampled and fruit numbers and weight were determined. Photosynthetic pigments chlorophyll was determined using chlorophyll meter (SPAD-502, Minolta Co. Japan), which is presented by SPAD value. Average of 3 measurements from different spots of a single leave was considered.

### Statistical Analysis

The experiment was laid out in randomized complete block design with 4 replications, each consisting of 3 pots with each pot containing one plant. Data were analyzed by SPSS 16 software and and comparing averages was done by Duncan's test and a probability value of %5.

## RESULTS AND DISCUSSION

### Plant height, Chlorophyll, N and P Content and Number of Branches per Plant

Table 1, indicates the effect of Zn, Fe and their combination on plant height, chlorophyll content, and number of branches. Zn at 100 mg/L and Fe at 200 of mg/L increased plant height, chlorophyll content and number of branches per plant in tomato. The maximum plant height (124.14 cm) and number of branches per plant (8.36) was recorded with 100 mg/L Zn+200 mg/L Fe application (Table 1). The maximum amount of P and N was in control plants (Table 1). Zn and Fe alone or in combination significantly decreased the P and N content of tomato leaves. As it has been indicated in table 1, Zn, Fe and their combination had increased effects on plant height, chlorophyll content, and number of branches. This was in agreement with Berglund [4] and Huda *et al.,* [14] who demonstrated that by adding Zn and Fe, leaf surface, vegetative growth, net photosynthetic rate and chlorophyll content of plants increased. Iron deficiency in plants causes chlorosis, decreases in vegetative growth, reduced net photosynthetic rate and chlorophyll content of plants. Goos and Johnson [15] showed that two foliar applications of Fe-EDDHA increased seed yield of three soybean genotypes. Fe deficiency leads to decrease in the amounts of chlorophylls with the appearance of leaf chlorosis, which is the visible symptom in orange trees [16]. Suryanarayana and Rao [17] studied the effect of foliar application of iron on growth of Okra. They reported that, application of iron along with Zn in a chelated form (Agromin) will resulted in increased plant height. Zinc is a component of carbonic anhydrase, as well as several dehydrogenases and auxin production which in turn will enhance plant growth. However, iron is necessary for the biosynthesis of chlorophyll and cytochrome, that it increases the biosynthesis of materials and growth. Application of Zn or Fe has been reported significant positive effects, in most cases, such as on growth measurements and chemical composition of cumin [18], sunflower [19] and rice [20]. Upon Similar results, micronutrient fertilizing decreased P and N content in leaves. These results were inconsistent with that was obtained from Movchan and Sobornikova [21]. The highest phosphorous content was related to control treatment. Zinc decreases phosphorous content because there is competitive effect between phosphorous and zinc in uptake of ions

**Yield and Reproductive Growth**

In general, application of Zn and Fe combination produced significantly higher yield, fruit weight, fruits per plant, flowers per cluster and fruits per cluster of plant compared to control and other treatments. Number of fruit weight, fruits per plant, flowers per cluster and fruits per cluster increased when tomato treated with 100 mg/L Zn+200 mg/L Fe. On the other hand tomato treated with 100 mg/L Zn+200 mg/L Fe produced the maximum yield (25.14 t $ha^{-1}$) and fruit weight (95.14 g). Also, Zn at 100 mg/L and Fe at 200 mg/L could alone, increased the yield (23.5, 22.14 t $ha^{-1}$) and fruit weight (93, 93.14 g) in comparison to control, respectively ($p \leq 0.05$). As it has been indicated in table ,Zn, Fe and their combination had increasing effects on fruits per cluster, flowers per cluster, fruits per plant, fruit weight and yield. Fruits per cluster, flowers per cluster, fruits per plant, fruit weight and yield increased when plants were treated with 100 mg/L Zn+200 mg/L Fe , Abdollahi *et al.,* [22] reported similar results for 'Selva' strawberries. Resembling results were obtained by Prasad *et al.,* [23-24]. They observed that application of iron in combination with Zn at 0.1 ppm recorded maximum number of pods per plant, length of pod and pod yield. Tamilselvi *et al.,* [25] reported that foliar application of iron combined with other micronutrients (Zn, Cu, Mn, B and Mo) significantly increased the number of fruits per plant, fruit setting percentage, single fruit weight, yield per plant of tomato and seed yield of tomato. Positive effect of $ZnSO_4$ on fruit number is well documented [26]. Growth of the receptacle is controlled primarily by auxin, which is synthesized in achenes [27]; Therefore $ZnSO_4$ is applied to rise fruit number, size and quality. Iron improves photosynthesis, yield and assimilates transportation to sinks and finally increases seed yield [28]. Zaiter *et al.,* [29] showed that foliar feeding of iron chelate increased the Performance by increasing the number of fruits in strawberry. Irons have a positive effect on the synthesis and activity of chlorophylls; thereby it increases the Photosynthesis. Ability to photosynthesize and produce more food increases the generative power; whereby the tree can hold more fruits.

***Fruit quality***

The highest percentage of TSS (5.87 °Brix), TA (4 %) and vitamin C (15.34) content was attained in fruits treated with foliar application of 100 mg/L Zn+200 mg/L Fe and the lowest was achieved in control (Table 2). Also highest pH was attained in fruits treated with 200 mg/L foliar Fe. Increase in Zn and Fe concentration significantly increased fruit firmness and Fruit lycopene content when accompanied by Zn and Fe alone or in combination, and the highest and lowest values of this parameter were found at 100 mg/L Zn+200 mg/L Fe and control, respectively (Table 2). The interaction effect between Zn and Fe foliar application with 100 mg/L Zn+200 mg/L Fe concentrations gave the lowest of Blossom end rot (6 %) and highest of nitrate reductase activity (6.14) as compared with either individual foliar application or control plants. According to the results (Table 2), Zn and Fe had affect the pH, TSS, TA and vitamin C of fruits and their increased by Zn and Fe treatments. The pH of juice was significantly affected by Fe and Zn applications, increased Fe and Zn levels resulted in higher titratable acidity content, total soluble solids, vitamin C, average fruit weight and pH of fruit juice. It is well known that Fe plays a key role in carbohydrate metabolism and fruit quality [30]. Zn and Fe did affect the pH, TSS, TA and vitamin C of fruits. Vitamin C, pH, TSS and titratable acidity (TA) of fruits treated with higher 100 mg/L Zn+200 mg/L Fe concentrations was higher than control fruits. El-Shazly *et al.,* [31] have also reported that apple fruits treated with Fe had increased TA, TSS and Vitamin C content at the end of storage. Our results showed that Zn and Fe had significant effect on maintaining higher content of vitamin C in tomato fruits. Sourour [32] have also reported that fruits treated with Fe were observed with maximum vitamin C content. The application of 150 ppm Zn and Fe effectively increased antioxidant compounds, ascorbic acid content and TSS [33]. Malawadi *et al.,* [34] observed that, application of iron increased ascorbic acid content and TSS and TA in Chilli. Our results are in agreement with those of Mishra *et al.,* [35], who reported treatment with Fe along with Zn significantly increased the vitamin C, TSS and TA content. Dixi and Gamdagin [6] claimed that a foliar spray application of $ZnSO_4$ increased size, TSS and juice of oranges. Zinc has also shown to have an important role in photosynthesis and related enzymes, which will lead to increasing sugar and decreasing acidity [7]. Application of zinc sulfate can increase TSS in fruit of guava [36]. Since zinc has an important role in photosynthesis and enzymes responsible for plant metabolism, the increased TSS could be attributed to $ZnSO_4$. Rath *et al.,* [37] reported foliar application of zinc sulfate (0.8 %) increased vitamin C. Singh [38] mentioned that micro nutrient had effect on fruit quality of grapes, T.S.S and quality of fruit. Moustafa *et al*., [39] noticed that an application of ZnSO4 increased weight and number of raceme, T.S.S and the juice content of grapevine. In conclusions the present study revealed that sequential pre-harvest foliar application of Zn and Fe is quite useful in tomato to increase number of flowers, weight fruit, total soluble solids, titratable acidity, ascorbic acid content, which helps to obtain higher marketable fruit yield with better firmness and other quality parameters.

Table 1. Influence of Zn and Fe application on vegetative and reproductive growth of tomato plants.

| Treatments | Fruits per cluster | Number of branches | Flowers per cluster | Plant height (cm) | Yield (t ha$^{-1}$) | Fruits per plant | Fruit weight (g) | Chlorophyll (SPAD) |
|---|---|---|---|---|---|---|---|---|
| Control | 4.3c | 4.12c | 9.14c | 82.17c | 14.36c | 68.12c | 78.36c | 14.2c |
| 50 mg l$^{-1}$ Zn | 5b | 6.68ab | 12b | 90.35bc | 17.13b | 76.18b | 84.17b | 17.18b |
| 100 mg l$^{-1}$ Zn | 7.69a | 7.5a | 17.5a | 120.2a | 23.5a | 88.3a | 93a | 21.14a |
| 100 mg l$^{-1}$ Fe | 5.7b | 6.7ab | 12.14b | 90bc | 17.15b | 77.14b | 86.14b | 18b |
| 200 mg l$^{-1}$ Fe | 7.56a | 7.69a | 16.14a | 122.14a | 22.14a | 87.17a | 93.14a | 20.1a |
| 50 mg l$^{-1}$ Zn+100 mg l$^{-1}$ Fe | 6.14ab | 6b | 14.36ab | 96.14b | 19.39ab | 77.94b | 89.25ab | 17.96b |
| 50 mg l$^{-1}$ Zn+200 mg l$^{-1}$ Fe | 6ab | 6.15b | 14.5ab | 96.27b | 19.86ab | 78.6b | 90ab | 18b |
| 100 mg l$^{-1}$ Zn+100 mg l$^{-1}$ Fe | 6.21ab | 6.35b | 14.7ab | 97.11b | 20.14ab | 79.14b | 90.11ab | 18.14b |
| 100 mg l$^{-1}$ Zn+200 mg l$^{-1}$ Fe | 8a | 8.36a | 18.14a | 124.14a | 25.14a | 90.14a | 95.14a | 22.14a |

Means followed by same letter are not significantly different at 5% probability using Duncan's test.

Table 2. Effect of PBZ and K application on yield and quality of tomato.

| Treatments | TSS (°Brix) | vitamin C (mg. 100 g fresh fruit-1) | TA (%) | PH (%) | Fruit firmness (kg cm$^{-2}$) | Fruit lycopene content (mg/100 g) | Nitrate reductase activity µmole NO2-(g. f.w.hr)-1 | Blossom end rot (%) | P (%) | N (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| Control | 2c | 9.14c | 2.47c | 1.17c | 1.94c | 1acd | 2.17c | 15a | 2.5a | 2.01a |
| 50 mg l$^{-1}$ Zn | 2.89b | 11.37b | 3b | 1.79bc | 2.38bc | 1.86ac | 3.08b | 10b | 1.23b | 1.38b |
| 100 mg l$^{-1}$ Zn | 5.09a | 14.7a | 3.74a | 2.38a | 3.38a | 1.23b | 5.91a | 5.9c | 1.2b | 1.31b |
| 100 mg l$^{-1}$ Fe | 3.11b | 11.87b | 3.03b | 1.7bc | 2.3bc | 1.2b | 3.12b | 10.11b | 1.14b | 1.33b |
| 200 mg l$^{-1}$ Fe | 5a | 14.87a | 3.94a | 2.69a | 3.4a | 1.8ac | 6a | 6c | 1.34b | 1.04b |
| 50 mg l$^{-1}$ Zn+100 mg l$^{-1}$ Fe | 3.87ab | 12b | 3b | 2.1b | 3b | 1.63ab | 3.89ab | 8.67bc | 1.5b | 1.74b |
| 50 mg l$^{-1}$ Zn+200 mg l$^{-1}$ Fe | 4ab | 12.06b | 3.08b | 2.04b | 3.01b | 2.13a | 4ab | 8bc | 1.3b | 1.6b |
| 100 mg l$^{-1}$ Zn+100 mg l$^{-1}$ Fe | 4.12ab | 12.14b | 3.14b | 2b | 3b | 1.2b | 4.15ab | 8.14bc | 1.52b | 1.59b |
| 100 mg l$^{-1}$ Zn+200 mg l$^{-1}$ Fe | 5.87a | 15.34a | 4a | 2.61a | 3.66a | 2.25a | 6.14a | 6.17c | 1.54b | 1.1b |

Means followed by same letter are not significantly different at 5% probability using Duncan's test.

 

## REFERENCES


1. Kinaci E, Gulmezoglu N.(2007).Grain yield and yield components of triticale upon application of different foliar fertilizers. Interciencia, **32(9)**: 624-628.
2. Kołota E, Osińska M. (2001).Efficiency of foliar nutrition of field vegetables grown at different nitrogen rates. Acta Hort, **563**: 87–91.
3. Narimani H, Rahimi MM, Ahmadikhah A, Vaezi B . (2010). Study on the effects of foliar spray of micronutrient on yield and yield components of durum wheat. Arch. Appl. Sci. Res, **2 (6)**:168-176
4. Berglund DR . (2002).Soybean Production Field Guide for North Dakota and Northwestern Minnesota. Published in cooperative and with support from the North Dakota Soybean Council, 136p.
5. Bozoglu H, Ozcelik H, Mut Z, Pesken E. (2007).Response of chickpea (Cicer arientinum L.) to Zink and molybdenum fertilization. Bangladesh J Bot, **36(2)**:145-149.
6. Dixi CX, Gamdagin R (1978). Effect of foliar application of zinc and iron chlorsis and yield of Kinnow. Pro. Hort. Sci, **10 (1)**: 13- 19.
7. Abedy A .( 2001).Effects of zinc sulfate and citric acid spray on fruit characteristics of tomato cultivar 'Urbana'. MSc. Thesis, Shiraz University.
8. Chohura P, Kolota E, Komosa A. (2009). Effect of Fertilization with Fe Chelates on the State of Iron Nutrition of Greenhouse Tomato. J. Elementol, **14(4)**: 657-664.
9. Mousavi SR. (2011). Zinc in crop production and interaction with phosphorus. Australian Journal of Basic and Applied Sciences, **5**: 1503-1509.
10. Kacar B. Bitki ve topragin kimyasal analizleri. II. Bitki analizleri. Ankara Univ. Ziraat Fak., Ankara, Turkey; Yayin. 453. 1972.
11. Sadasivam S, Manickam A. Biochemical Methods for Agricultural Sciences, Wiley Eastern Limited, New Delhi; 1992.
12. Silveira JAG, Matos JCS, Ceccato VM, Sampaio AH, Costa RCL, Viégas RA. (1998). Induction of nitrate reductase activity and nitrogen fixation in two Phaseolus species in relation to exogenous nitrate level. Physiol Mol Bio Plants, 4:181-188.
13. Horvitz W, Chic Hilo P, Reynolds H. Official methods of analysis of the association of official analytical chemists. Eleventh edition, P.O. Box. 540. Benjamin Franklin Station. Washington DC 20044. 1970.
14. Huda KMK, Bhuiyan MSR, Zeba N, Banu SA, Mahmud F, Khatun A . (2009).Effect of FeSO4 and pH on shoot regeneration from the cotyledonary explants of Tossa Jute. Plant Omics J, 2(5): 190-196.
15. Goos RJ, Johanson BE . (2000). A comparison of three methods for reducing iron-deficiency chlorosis in soybean. Agron. J, 92: 1135- 1139
16. Pestana M, David M, deVarennes A, Abadı´a J, Faria EA. (2001). Responses of 'Newhall' orange tree stoir on deficiency inhydroponics: effects on leaf chlorophyll, photosynthetic efficiency and root ferricchelate reductase activity. Journal of Plant Nutrtion, 24:1609–20.
17. Suryanarayana V, Rao SKV. (1981). Effect of growth regulators and nutrient sprays on the yield of okra. Veg. Sci, 8 : 12-13.
18. El-Sawi SA, Mohamed MA. (2002). Cumin herb as a new source of essential oils and its response to foliar spray with some micro-elements. Food Chem, 77:75-80.
19. Mirzapour MH, Khoshgoftar AH. (2006). Zinc application effects on yield and seed oil content of sunflower grown on a saline calcareous soil. J. Plant Nutr, 29:1719-1727.
20. Wissuwa M, Ismail AM, Graham RD.(2008). Rice grain zinc concentrations as affected by genotype native soil-zinc availability, and zinc fertilization. Plant Soil, 306:37-48.
21. Movchan VG, Sobonikova IG. (1972). Zinc fertilizers and the Uptake of Mineral Nutrients by Vinges Growing on the Southern Chenozem." Agrokhimiya, 43(5):123-130.
22. Abdollahi M, Eshghi S, Tafazoli E. (2010). Interaction of Paclobutrazol, Boron and Zinc on
23. Vegetative Growth, Yield and Fruit Quality of Strawberry (Fragaria × Ananassa Duch. cv.Selva). Journal. Biology. Environ. Sci, 4(11): 67-75.
24. Prasad B, Singh AP, Sinha MK. (1984). Effect of poultry manure as a source of zinc, iron and as complexing agents on Zn and Fe availability and crop field in calcareous soil. J. Ind. Soc. Soil Sci, 32 : 519-521.
25. Prasad R, Sakal R. (1991).Availability of iron in calcareous soil in relation to soil properties. J. Ind. Soc. Soil Sci, 39 : 658-661.
26. Tamilselvi, P., Vijayakumar, R.M. and Nainar, P. (2002).Studies on the effect of foliar application of micronutrients on growth and yield of tomato (Lycopersicon esculentum Mill). Cv. PKM-1. South Ind. Hort., 53 (1-6) : 46-51.
27. Chaplin MH, Westwood MN. (1980). Relationship of Nutritional Factors to Fruit set. J. Plant Nutr, 2: 477-505.
28. Archbold DD, Dennis FG.Quantification of free ABA and conjugated IAA in strawberry achene and receptacle tissue during fruit development. J. Amer. Soc. Hort. Sci, 1984.109:330-335.
29. Alvarez-Fernandez A, Abadia J, Abadia A,.Iron deficiency, fruit yield and quality. In: Barton LL, Abadia J (eds) Iron nutrition in plants and rizospheric microorganisms. Springer, Dordrecht, The Netherlands, 2006.pp 85–101, ISBN-10 1-4020-4742-8.
30. Zaiter HZ, Saad I, Nimah M. (1993).Yield of iron-sprayed strawberry cultivars grownon high pH calcareous soil.Journal of Plan Nutr, 16: 281-296.
31. Dongre SM, Mahorkar VK, Joshi PS, Deo DD. (2000).Effect of micronutrients spray on yield and quality of chilli (Capsicum annuum L.). var. Jayanti. Agric. Sci. Digest, 20 (2) : 106-107.

32. El-Shazly SM, Abdel Naseer G, Harhash MM. (2000). Physiological and biochemical indices in Washington novel orange trees as influenced by iron foliar application. Alexandria J. Agric. Res, 45 (1) : 287-306.
33. Sourour MM. (2000).Effect of foliar application of some micronutrient forms on growth, yield, fruit quality and leaf mineral composition of Valencia orange trees grown in north Sinia. Alexandria J. Agric. Res, 45 (1): 269-285.
34. Singh B. (2002). Effects of macro and micro nutrient spray on fruit yield and quality of grapes (Visit vinifera L.) cv. Perlette. Acta. Hort, 594: 197-202.
35. Malawadi MN, Shashidhara GB, Palled YB. (2004).Effect of secondary and micronutrients on yield, nutrient uptake and quality of chilli. Karnataka J. Agric. Sci, 17 (3): 553-556.
36. Mishra LN, Singh SK, Sharma HC, Goswami AM, Bhana P. (2003).Effect of micronutrients and rootstocks on fruit yield and quality of kinnow under high density planting. Ind. J. Hort, 60 (2) : 131-134.
37. Dobroluybsikii OK, Strakhov VG, Tanurkov GR. (1982).Effect of microfertilizers on yield and quality of grape in Ukrainian south. Vitis, 20: 183 (Abst.).
38. Rath S, Singh RL, Singh B, Singh DB. (1980). Effect of boron and zinc sprays on physio-chemical composition of mango fruits. Punjab Hort. J, 20: 33- 35. (Abstract).
39. Singh C, Sharma VP, Usha K, Sagar VR. (2002). Effect of macro and micronutrients on physico-chemical characters of grape cv. Perlette. Ind. J. Hort, 59 (3) : 258-260.
40. Moustafa A, Elshazly ASA, Eissa AM, Zahran MA. (1986). Effect of foliar applications of chelated Fe, Zn and Mn on leaf mineral content, yield and fruit quality of Roumi Red grape-vines. Annals of Agricultural Sciences, 31: 623- 635.

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