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# Efficacy of foliar application of ferrous and manganese sulfate on wet and dry biomass of tomato (*Lycopersicon esculentum*) in greenhouse

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## Abstract

In order to evaluate the efficacy of ferrous and manganese sulfate elements on yield and biomass of tomato in greenhouse conditions this research was performed in Yasuj during crop year of 2012-2013. An experiment was conducted as factorial on the basis of complete randomized block design with three replications. The factors of studied included ferrous sulfate, manganese sulfate, each at 3 levels (0, 3000 and 6000 ppm). Data were analyzed using SAS software and mean comparison of data was conducted through Duncan test and drawing graphs through Excel software. The analysis of data variance showed that the interaction of various levels of ferrous sulfate and manganese sulfate had significant effect on measured traits (Root fresh weight, shoot fresh weight, shoot dry weight and fruit fresh weight) Also, these increased compared with control. Based on the findings of this study, interaction of factors indicated the best results. The best treatments in present study were interaction of 6000 ppm of manganese sulfate with 6000 ppm of ferrous sulfate (Mn6 Fe6) which is recommended for growing greenhouse tomatoes.

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## Introduction

Tomato with Scientific name of *Lycopersicon esculentum* Mill Belongs to the Solanaceae family and is one of the important vegetables in the world (Shahedi *et al,* 2014). Tomato has the second largest cultivated area in the world after potatoes (Koul *et al,* 2014). Tomato is a tropical plant that needs 90- 120 days without freezing with an average high temperature of 16 degrees Celsius (Heuvelink, 2005). Tomato is one of the most important crops in China, America, India and Egypt, with more than 5 million hectares cultivated area (Peralta and spooner, 2001; Sartipnia *et al*, 2008).

Tomato is a rich source of carotenoids, vitamins A, B, C, and niacin (Raeisi *et al*, 2014; Farzaneh *et al*, 2010). In addition, tomato is a rich source of the lycopene antioxidant that plays an important role in the prevention of cancer (Hadi *et al,* 2014; Vahid *et al,* 2014). amount of available Fibro-protein in tomato is in high levels and low fat (Shahlaei *et al,* 2014), In addition, tomatoes are rich sources of minerals like potassium, magnesium, calcium, ferrous , etc. (Tijjani *et al,* 2014; Giovanelli and Paradiso, 2002).

According to the Food and Agriculture Organization of the United Nations (FAO) in 2010, Iran was known as the seventh producer of tomatoes (Anonymous, 2012). Tomato production in Iran, despite relative improvement in recent years, still does not enjoy well yield per unit area (Khavari Nejad *et al*, 2013). The qualitative and quantitative yield of tomato fruit is variable under various conditions, which is one of the most important challenges in this regard (Khazaei *et al,* 2013). Tomato cultivation area of Iran was estimated 130 thousand hectares in 2008 (Faizi *et al*, 2012).

Recently, much attention has been on greenhouse cultivation due to the important opportunities such as crop production throughout the year, saving in primary inputs such as fertilizer, land and labor per unit of production, supplying products with high quality and prices and reducing environmental pollutants (Masiha *et al*, 1999; Safarzadeh *et al*, 2010).

The main goal of vegetable planting scientists is to increase the amount of crop per unit area. One of the yield affecting factors, especially in controlled environment is to feed the plants with microelements (Tavasoli *et al*, 2010). The intake of microelements in countries with advanced agriculture is about 2- 4% of the total fertilizer consumption, but in Iran is only two grams per ton (Zarghamnejad, 2013). Microelements such as ferrous and manganese are important in plant biochemical reactions which can directly or indirectly increase the performance of crops. Optimal plant growth and maximum quality and quantity of the product require a sufficient and balanced amount of macro and micro nutrients in the soil (Zeidan *et al*, 2010; Khajevand, 2014).

Ferrous activates RNA synthesis enzymes and participates in the structure of the photosystem Company (Malakouti and Tehrani, 2005; Jamshidzadeh *et al*, 2014). Manganese has a key role in the formation of the chloroplast and plant enzyme systems and improves plant photosynthesis and crop production (Xue-Cheng *et al*, 2014). Manganese is an activator of many enzymes in human. Manganese plays a major role in the plant's participation in hybrid systems. Manganese plays an essential role in chlorophyll production and metabolism of nitrogen. Also, aqueous reactions of photosynthesis are effected by Manganese (Millaleo *et al.*, 2010; Xue-Cheng and Xiao, 2014).

In an experiment the effect of ferrous and manganese microelements on the quality and quantity of tomato were studied and it was observed that ferrous and manganese foliar application can increase fruit weight and yield (Elabdeen *et al*, 1982). In another experiment it was found that the dry matter and yield of tomato with foliar application of ferrous and Manganese significantly increases and the highest yield was observed in plants foliar sprayed twice with zinc, manganese, ferrous and copper (El-Lebodi *et al*, 1976). The application of manganese, zinc and ferrous microelements on foliar feeding of tomato plant in greenhouse conditions can increase the average fruit. Based on the Abedi Geshlagi and Tafazzoli study (2004) foliar application of ferrous sulfate and citric acid had effect on the qualitative and quantitative properties of tomato and increase the concentration of these elements in the plant.

The study of (Amir Hossein Khani *et al*, 2012) showed that the use of Manganese and Zinc increases the fruit dry weight and reduces the amount of manganese in the tomato culture medium; photosynthesis declines and consequently also fruit dry weight reduces but Manganese had no significant effect on the Tomato fruit size.The use of Manganese sulfate had no significant effect on fresh weight of fruit (Babaeian *et al*, 2011; Javanpour *et al*, 2005). Given the importance of microelements in farm lands, lacks and toxics caused by their imbalance in the plant; This study aimed to investigate the effects of various levels of foliar application of ferrous and manganese sulfate on the growth characteristics and yield components of tomato (*Lycopersicon esculentum*) in greenhouse condition.

## Materials and methods

*Plan Locality*

The study was carried out in experimental field of Islamic Azad University, Yasooj branch, Yasojj, Iran during crop year of 2012-2013 with (51° 35' longitude and 30° 45' latitude).

*Soil Analysis*

To identify quantitative and qualitative characteristics of soil, profiles were chosen from 0-30 cm soil depth and measures were taken to lab. Based on the obtained results, soil texture was Silt- loam and Lime (12.5%), Clay (22.9%), Silt (56.9%), Sand (20.2%), Nitrogen (0.12%), Organic carbon (1.22%), Potassium (5.6PPm), Phosphorus (5.5PPm), Humidity (58%), Ec (0.95 dc/m), PH (7.46), Ferrous (7.44 milligrams per kilogram), Zinc (0.22 ppm), Copper (4.1 mg per kg) and manganese (8.7 mg per kg) (Zarghamnejad, 2013).

*Method of Plan*

This study was conducted under greenhouse conditions in the form of completely randomized factorial experiment with 9 treatments and 3 replicates; treatment factors included ferrous sulfate at three levels (0, 3000 and 6000 ppm) and manganese sulfate at three levels (0, 3000 and 6000 ppm). A preliminary irrigation was conducted before planting. In this research, various foliar application levels of ferrous and manganese elements were added to pots after planting. Measured traits were (root fresh weight, shoot fresh weight, shoot dry weight and fruit fresh weight), respectively (Zarghamnejad, 2013).

*Statistical Analysis*

Finally, all data were analyzed by SAS software and Duncan test to compare the averages.

## Results and discussion

*Root Fresh Weight*

The results of ANOVA showed that various levels of ferrous fertilizer had a significant effect on the root fresh weight at ($P \leq 0.01$) (Table 1); mean comparison of the data showed the highest root fresh weight (56.28 g) in the control treatment (Mn0 Fe0) significantly was different from the mean obtained levels of ferrous sulfate (Table 2). Based on the results of ANOVA, different levels of manganese sulfate had no significant effect on the yield of tomato root at ($P \leq 0.01$) (Table 1).The mean comparison of data showed that the highest root fresh weight (21.38) was in control treatment (Mn0 Fe0) but had no significant difference with respect to different levels of manganese sulfate and all were in a class (Table 3).

The results of ANOVA showed that the interaction of ferrous and manganese fertilizer factors had a significant effect on root fresh weight at ($P \leq 0.01$) (Table 1). Based on the results of the mean comparison the highest root fresh weight (44.47 g) was observed in 6000ppm ferrous treatment without Manganese (Mn0 Fe6) the lowest root fresh weight (32.2) was observed in the control treatment (no Fe and Mn) (Table 4).

*Shoot fresh weight*

The results of ANOVA showed that ferrous sulfate had a significant effect on the shoot fresh weight at (P≤0.01) (Table1). Based on the results obtained from the mean comparison of the data the highest shoot fresh weight (308.25g) was in Fe6 treatment (6000 ppm ferrous) which had a significant difference with other treatments (Table 2).

**Table 1.** The results of ANOVA, the effect of ferrous sulfate and Manganese sulfate factors on on wet and dry biomass.

| Treatments | Df | Roots Fresh Weight | Shoot Fresh Weight | Shoot Dry Weight | Fruit Fresh Weight |
|---|---|---|---|---|---|
| Manganese sulfate | 2 | 43.69** | 18004.35** | 2870.00** | 3.07** |
| Ferrous sulfate | 2 | 54.28** | 12584.66** | 10235.48** | 14.16** |
| Manganese sulfate × Ferrous sulfate | 4 | 31.12** | 4254.99** | 193.61** | 385.0** |
| Error | 27 | 1.064 | 9.9 | 8.72 | 0.034 |
| Coefficient of Variation | | 5.97 | 22.37 | 17.33 | 1.027 |

** :Significant at % 1

*: Significant at the 5% level.

NS: no significant.

Based on the ANOVA results Manganese sulfate had a significant effect on the shoot fresh weight at (P≤0.01) (Table 1).The results of the mean data comparison showed that maximum shoot fresh weight (307.66 g) was in Mn6 treatment (6000 ppm Manganese) (Table 3). (Ziaeyan and Rajaie, 2009; Orhue and Nwaoguala, 2010; Jafari jood *et al*, 2013) also reported the results similar to our study.

**Table 2.** The mean comparison of the effect of ferrous factor on wet and dry biomass.

| Characteristics | Fe0 (Not applicable) | Fe3 (3000 ppm) | Fe6 (6000 ppm) |
|---|---|---|---|
| Fresh weight of roots | 56.28 a | 39.07 b | 40.38 b |
| Shoot fresh weight | 243.86 b | 270.017 b | 308.25 a |
| Shoot dry weight | 86.08 c | 112.24 b | 144.39 a |
| Fruit Fresh Weight | 3.27 c | 3.9 b | 5.39 a |

Means that contain at least one letter in common are not significantly different.

Based on the results of the mean-square comparison the highest shoot fresh weight (352.6 g) was observed in 6000 ppm ferrous treatment with 3000 ppm manganese (Mn3 Fe6) and the lowest shoot fresh weight (215.22 g) was observed in the control treatment (Mn0 Fe 0) (Table 4).

*dry weight*

The results of ANOVA showed that ferrous sulfate had a significant effect on the shoot dry weight at (P≤0.01) (Table 1). Based on the results obtained from the mean comparison of the data the highest shoot dry weight (144.39 g) was in Fe6 treatment (6000 ppm ferrous) (Table 2).

**Table 3.** The mean comparison of the effect of Manganese factor on growth characteristics and yield components.

| Measured Characteristics | Mn0 (Not applicable) | Mn3 (3000 ppm) | Mn6 (6000 ppm) |
|---|---|---|---|
| Fresh weight of roots | 38.21 a | 34.86 a | 34.95 a |
| Shoot fresh weight | 231.68 b | 282.78 a | 307.66 a |
| Shoot dry weight | 96.48 b | 121.47 a | 124.77 a |
| Fruit Fresh Weight | 3.72 b | 4.125 ab | 4.72 a |

Means that contain at least one letter in common are not significantly different..

Based on the ANOVA results Manganese sulfate had a significant effect on the shoot dry weight at ($P \leq 0.01$) (Table 1). The results similar to this research was reported on other plants by (Ziaeyan and Rajaie, 2009; Orhue and Nwaoguala, 2010; Jafari jood *et al,* 2013). The result of mean comparison showed that the highest shoot dry weight (124.77 g) was in Mn6 treatment (6000 ppm Manganese) (Table 3).

Based on the results of the ANOVA table the interaction of ferrous and manganese fertilizer factors had a significant effect on shoot dry weight at ($P \leq 0.01$) (Table 1). The result similar to this research was reported by (el-lebodi *et al*, 1976).

**Table 4.** The mean interaction comparison in different levels of manganese sulfate and ferrous sulfate factors on growth characteristics and yield components of tomato.

| Measured Characteristics | Mn0 Fe0 | Mn0Fe3 | Mn0 Fe6 | Mn3 Fe0 | Mn3Fe3 | Mn3Fe6 | Mn6 Fe0 | Mn6Fe3 | Mn6Fe6 |
|---|---|---|---|---|---|---|---|---|---|
| Root fresh weight (g) | 32.2 e | 37.59 cd | 44.47 a | 26.45 f | 40.92 b | 37.2 d | 27.025 f | 38.35 cd | 39.47 bc |
| Shoot fresh weight (g) | 231.85 e | 215.22 g | 247.97 d | 221.57 f | 274.15 c | 352.6 a | 278.15 c | 320.67 b | 324.15 b |
| Shoot dry weight (g) | 86.4 d | 90.2 d | 112.85 d | 85.90 d | 107.98 d | 170.52a | 85.95d | 138.55 c | 149.80 b |
| Fruit Fresh weight (kg) | 2.7 f | 3.5 d | 4.9 b | 2.92 e | 3.92 c | 3.82 b | 3.9 e | 4.2 b | 5.74 a |

Means that contain at least one letter in common are not significantly different.

The highest shoot dry weight (170.52 g) was observed in 6000 ppm ferrous treatment with 3000 ppm manganese (Mn3 Fe6) and the lowest shoot dry weight (85.90 g) was observed in the control treatment (Mn3 Fe 0) (Table 4). The results of mean comparison based on Duncan multiple range tests showed that different levels of manganese sulfate and ferrous sulfate factors lonely had no significant effect on shoot dry weight compared to control groups.

*Fruit Fresh Weight*

Based on the ANOVA results various levels of ferrous sulfate had a significant effect on fruit fresh weight at ($P \leq 0.01$) (table 1) which was confirmed with the results of (Bose and Tripathi, 1996). Maximum fresh weight of tomato (5.39 g) was in 6000 ppm ferrous treatment (Table 2).

The results of ANOVA showed that various levels of manganese sulfate had a significant effect on the fresh weight of tomato fruits at ($P \leq 0.01$). Based on the study of Amir Hossein Khani *et al*, (2012) by reducing the amount of manganese in the culture medium of tomato, photosynthesis declines and consequently the fruit fresh weight reduces and these results were confirmed with the results obtained in the present study. Also the findings of this research were confirmed with previous studies by (Babaeian *et al*, 2011), (Javanpour *et al*, 2005) and (el-lebodi *et al*, 1976). The highest fresh fruit weight (4.72 mg) was observed in 6000 ppm manganese treatment (Table 3).

Based on the ANOVA results, the interaction of ferrous and manganese factors had a significant effect on fruit fresh weight at ($P \leq 0.01$) (Table1). Based on the table of mean data comparison the maximum fruit fresh weight (74.5 g) was observed in 6000 ppm ferrous treatment with 6000 ppm manganese treatment (Mn6 Fe6); also the lowest fruit fresh weight (72.2g) was in the control treatment (Mn0 Fe0) (Table 4).

**Conclusion**

The results of present study showed that the use of ferrous and manganese sulfate can increase the yield and biomass of tomato. This can be due to the effect of manganese on increasing the concentration of chlorophyll in the leaves which consequently increases photosynthesis and eventually increases the fresh weight of fruit. Increasing the ferrous sulfate as an activator of enzymes associated with photosynthesis can exacerbate this process. According to the findings of present research, the interaction of factors leads to the best results. The interaction of 6000 ppm manganese sulfate with

6000 ppm ferrous sulfate treatment (Mn6 Fe6) was the best treatment which is recommended for growing greenhouse tomatoes (Zargham Nejad, 2013).

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**References**

**Abedi Geshlagi A, Tafazzoli A.** 2004. The effect of foliar sprays of ferrous sulfate and citric acid on qualitative and quantitative characteristics of tomato cultivars Urbana .Journal of Agricultural Science and Natural Resources **4,** 71-79. (In persian).

**Al-Suhaiban NA.** 2009. Influence of Early Water Deficit on Seed Yield and Quality of Faba Bean under Arid Environment of Saudi Arabia. American Eurasian Journal of Agriculture & Environment Sciences **5(5),** 649-654.

**Amiri Hossein khani M, Alishah Aratboni H, Nouri H, Tavassoli A.** 2012. Investigation of different levels micro nutrients on tomato in hydroponic culture system. Annals of Biological Research **3(11),** 5409-5412.

**Anonymous.** 2012. Agricultural data FAOSTAT. Food and Agriculture Organization of the United Nations (FAO). Available: accessed 7 March, 2012. http://faostat.fao.org/site/339/default.aspx

**Babaeian M, Tavassoli A, Ghanbari A, Esmaeilian Y, Fahimifard M.** 2011. Effects of foliar micronutrient application on osmotic adjustments, grain yield and yield components in sunflower (Alstar cultivar) under water stress at three stages. African Journal Agricaltural Reserch **6(5),** 1204-1208.

**Bose US, Tripathi SK.** 1996. Effect of micronutrients on growth, yield and quality of tomato cv. Pusa Ruby. Crop Research **12,** 61-64.

**Elabdeen AZ, Metwally AM.** 1982. Effect of foliar spraying with Mn, Fe, Zn and Cu on the quality of tomato and pepper. Agriculture Research Review **60,** 143-164.

**El-Lebodi A, El-Gala AM, Sakr AA.** 1976. Growth and nutritional status of tomato subjected to foliar spray with certain nutrient solution. Agriculture Research Review. **54,** 109-127.

**Faizi H, Rezvani Moghadam P, Sahabi H, Amir Moradi SH.** 2012. Stimulating seed germination and growth of tomato seedling using a magnetic field and seed soaking. Horticultural Science **3(26),** 349-343 (In persian).

**Farzaneh N, Golchin A, Hashemi Majd K.** 2010. The effect of nitrogen and boron on growth, yield and nutrient concentration of tomato Science and Technology of Greenhouse Culture **2,** 28-19. (In persian).

**Giovanelli G, Paradiso A.** 2002. Stability of dried and intermediate moisture tomato pulp during storage. Journal of Agricultural and Food Chemistry, **50(25),** 7277-7281. http://dx.doi.org/10.1021/jf025595r

**Hadi F, Ayaz M, Sartaj A, Shafiq M, Rizwan U, Jan AA.** 2014. Comparative effect of polyethylene glycol and mannitol induced drought on growth (in vitro) of canola (Brassica napus), cauliflower (Brassica oleracea) and tomato (Lycopersicon esculentum) seedlings. International Journal of Biosciences **4(9),** 34-41. http://dx.doi.org/10.12692/ijb/4.9.34-41

**Heuvelink E.** 2005. Tomatoes. CABI international publishing. 339 p. http://dx.doi.org/10.1079/9780851993966.0000

**Jafari jood S, Shiranirad AH, Daneshian J, Rokhzadi A.** 2013. Effects of nitrogen application and spraying of boron and manganese on growth

traits of two potato cultivars. International Journal of Biosciences **3(9),** 298-303.
http://dx.doi.org/10.12692/ijb/3.9.298-303

**Jamshidzadeh MA, Mobasser HR, Ganjali HR.** 2014. Effect of times and foliar concentration of iron on grain yield, diameter of cob, Plant height and dry weight of corn. International Journal of Biosciences, **5(2),** 139-143.
http://dx.doi.org/10.12692/ijb/5.2.139-143

**Javanpour-Haravi R, Babalar M, Kashi A, Mirabdolbaghi M, Asgari M.** 2004. Effect of several types of substrates in hydroponic nutrient solution and the characteristics and quality of greenhouse tomatoes Hmra' cultivar. Iranian Journal Agricaltural Science **36(4),** 939-946.

**Khajevand A, Nashaei Moghadam M, Musavi AA, salehizarkhuni RA.** 2014. The Effects of Copper, Magnesium and Manganese on Yield and Yield Components of Rice (Variety of Shirudi). Advance Environmental Biology **8(9),** 902-904.

**Khavari Nezhad R, Najafi F, Asemani F.** 2013. Effect of aluminum chloride and Indoleacetic Acid on some physiological properties of) Lycopersicon *esculentum* L).Ecophysiology of research (plant science research) **32(4),** 53-64. (In Persian).

**Khazaei H, Zare Feizabadi A.** 2013. Investigating the tomato fruit yield and quality in one and multi-step manual harvesting, Journal of seed and plant crops. **29 (2),** 249-235. (Lycopersicon esculentum L.) Physiological of tomato plant, Ecophysiological researches in Iran. **4 (32),** 64-53. (In persian).

**Kobraee S, shamsi K, Mohammad saeed V.** 2013. Response of soybean yield to manganese foliar application under short-term drought stress. International Journal of Biosciences **3(2),** 132-140.
http://dx.doi.org/10.12692/ijb/3.2.132-140

**Koul B, Srivastava S, Amla DV, Sanyal I.** 2014, Establishment and optimization of Agrobacterium-mediated transformation and regeneration of tomato (Solanum lycopersicum L.). International Journal of Biosciences **4(10),** 51-69.
http://dx.doi.org/10.12692/ijb/4.10.51-69

**Malakouti M, Tehrani M.** 2005. Micronutrien role in increasing yield and improving the quality agricultural products. 1st ed. Tarbiat Modarres Press **46,** 1200- 1250

**Masiha SM, Karimayi S, Moghadam M.** 1999.Comparing the effect of three nutrient solutions on growth and nitrogen, phosphorous, potassium concentrations in lettuce using hydroponics. Seed and Plant Journal **4,** 389-375 (In persian).

**Millaleo R, Reyes-Díaz M, Ivanov AG, Mora ML, Alberdi M.** 2010. Manganese as essential and toxic element for plants: transport, accumulation and resistance mechanisms. Journal of soil science and plant nutrition. **10(4),** 476–494.
http://dx.doi.org/10.4067/s07189516201000020000 8

**Orhue ER, Nwaoguala CNC.** 2010. The effect of manganese on early growth of fluted pumpkin (Telfairia occidentalis Hook F) in an ultisol. Agro-Science **9(3),** 154-160.
http://dx.doi.org/10.4314/as.v9i3.65749

**Peralta IE, Spooner DM.** 2001. Granule-Bound Starch Synthase (GBSSI) Gene Phylogeny of Wild Tomatoes (Solanum L. Section Lycopersicon [Mill.] Wettst. Subsection Lycopersicon). American Journal of Botany Systematic Botany Monographs **88(10),** 1888
http://dx.doi.org/10.2307/3558365

**Raeisi M, Babaie Z, Palashi M.** 2014. Effect of chemical fertilizers and bio-stimulators containing amino acid on quality and quantitative and qualitative characteristics of tomato (Lycopersicum esculentum) var. Cal.j. International Journal of Biosciences **4(1),** 425-431.
http://dx.doi.org/10.12692/ijb/4.1.425-431

**Riki GH, Mobasser HR, Ganjali HR.** 2014. Effect of iron and manganese foliar spraying on some quantitative characteristics of canola. International Journal of Biosciences **5(1),** 61-68.
http://dx.doi.org/10.12692/ijb/5.1.61-68

**Safarzadeh Shirazi S, Ronaghi AM, Gholami AS, Zahedifar M.** 2010. Effects of salinity and nitrogen on tomato quality and microelements concentration in hydroponic culture, Science and Technology of Greenhouse Culture **3,** 21-11. (In Persian).

**Sartipnia N, Khavari-Nejhad RA, Babaeizad V, Nejad-Sattari T, Najafi F.** 2013. Effect of Piriformospora indica on antioxidant enzymes activity of tomato (Lycopersicon esculentum Mill) under lead stress. International Journal of Biosciences **3(12),** 55-64.
http://dx.doi.org/10.12692/ijb/3.12.55-64

**Shahedi A, Torabi S, Khosroshahli M.** 2014. Efficiacy of SCoT and ISSR marekers in assesment of tomato Lycopersicum esculentum Mill genetic diversity. International Journal of Biosciences **5(2),** 14-22.
http://dx.doi.org/10.12692/ijb/5.2.14-22

**Tavassoli A, Ghanbari A, Ahmadian A.** 2010. Effects of feeding manganese and zinc on fruit yield and nutrient concentration in greenhouse tomato and hydroponic culture, Science and Technology of Greenhouse Culture, 6-1(In persian).

**Tijjani A, Adebitan SA, Gurama AU, Haruna SG, Safiya T.** 2014. Effect of some selected plant extracts on Aspergillusflavus A CAUSAL agent of fruit rot disease of tomato (Solanum lycopersicum ) in Bauchi State **4(12),** 244-252.
http://dx.doi.org/10.12692/ijb/4.12.244-252

**Vahid A, Hadi F, Jan AA.** In vitro assessment of tomato (Lycopersicon esculentum) and Cauliflower (Brassica oleracea) seedlings growth and proline production under salt stress, International Journal of Biosciences **4(9),** 109-115.
http://dx.doi.org/10.12692/ijb/4.9.109-115

**Zhang Y, Hu CX, Ling Tan O, Song Zheng C, Gui HP, Zeng WN, Sun XC, Zhao XH.** 2014. Plant nutrition status, yield and quality of satsuma mandarin (Citrus unshiu Marc.) under soil application of Fe-EDDHA and combination with zinc and manganese in calcareous soil, Scientia Horticulturae **174,** 46-53.
http://dx.doi.org/10.1016/j.scienta.2014.05.005

**Zargham Nejad ZH.** 2013. The effect of various ferrous sulfate and manganese sulfate factors on the growth and yield of tomato (Solanum Lycopersicum) in greenhouse conditions, Master's thesis. Islamic Azad University Yasuj Branch. (In persian).

**Zeidan MS, Mohamed MF, Hamouda HA.** 2010. Effect of foliar fertilization of Fe, Mn and Zn on wheat yield and quality in low sandy soils fertility World Journal of Agricultural Science **6(6),** 696-69.

**Ziaeyan AH, Rajaie M.** 2009. Combined effect of zinc and boron on yield and nutrients accumulation in corn. International Journal of Plant Production **3 (3),** 35-44.