Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 2 (11) October 2013: 11-14

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com

ORIGINAL ARTICLE

Effect of Foliar Application of Iron and Zinc on Growth and Productivity of Cucumber

Mohsen Kazemi
Department of Horticultural Science, Faculty of Agricultural Science and Natural Resources, Science and Research Branch, Islamic Azad University, Tehran, Iran
Corresponding author: E-mail: kazemimohsen85@gmail.com

ABSTRACT
The aim of this study was to evaluate the effects of the foliar application of zinc (15, 30 and 50 mg/L) and iron (50 and 100 mg/L) and their combination on vegetative, reproductive growth, fruit quality and yield of cucumber plants as a factorial in completely randomized block design with four replications. Results indicated that different applied treatments significantly increased vegetative and reproductive growth, fruit quality of cucumber plants. Results indicated that Zn at 50 mg/L and Fe at 100 mg/L increased chlorophyll content and yield. The effect of Zn and Fe was promoting too, as 50 mg/L and at 100 mg/L of Zn and Fe led to significant increments of vegetative factors, chlorophyll and leaf NK content and fruit quality. However, the best results were found when Zn was applied accompanied by Fe.
Key words: Cucumber, Zn, Fe, Yield, Quality.

Received 10/08/2013 Accepted 17/09/2013

INTRODUCTION

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 main composition of ribosome and is essential for their development. Amino acids accumulated in plant tissues and protein synthesis decline by zinc deficit .Zn is known to have an important role either as a metal component of enzymes or as a functional, structural or regulatory cofactor of a large number of enzymes [4]. Zinc also plays an important role in the production of biomass [5]. Furthermore, zinc may be required for chlorophyll production, pollen function and fertilisation [6]. Another element that is iron is necessary to chlorophyll synthesis and its critical element in electron transport chain in photosystems. 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 [7]. Iron plays essential roles in the metabolism of chlorophylls. External application of Fe increased photosynthesis, net assimilation and relative growth in seawater-stressed rice [8]. The aim of the present study was to test the effects of foliar spraying of Zn and Fe alone or in combination on the growth, yield, fruit quality of cucumber fruit.

MATERIALS AND METHODS

In order to determine, the effect of different levels of Iron and Zinc used in spraying solution on the yield and quality of cucumber during 2013-2014 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•kg-1 of P, and K, respectively. Seeds of cucumber cultivar Mostar were sown in January and were transplanted during March. All foliar spraying was carried out early in the morning. 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. Total nitrogen of the sample was determined by Kjeldahl method [9]. For determination of K contents of leaf, plant samples were air-dried and were then ground. K was determined after dry digestion of dry and sub-samples in a HCL preparation. Potassium was determined by flame photometry. The total yield for each treatment was calculated by weighing the fruit picked in each treatment and converting the weight to yield (kg/plant). 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. Total soluble solids were determined on a portable refractometer 300003 (Sper Scientific Ltd., Scottsdale, Ariz.) standardized with distilled water. 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. The experimental design was a complete randomized blocks with four replications for each treatment.. 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

Vegetative factors, chlorophyll and leaf NP content

Our results showed that application of Zn and Fe either alone or combination significantly influenced plant height, dry weight and number of leaves per plant (Table 1). The highest rates of these variables were found at 50 mg/L Zn +100 mg/L Fe . Application of higher concentrations of this factors decreased plant height and dry weight as other treatments (Table 1). It is evident that increase in Zn (from 15 to 50 mg/L) and Fe concentration (from 50 to 100 mg/L) increased plant height and dry weight (Table 1). Fe and Zn either alone or combination significantly affected chlorophyll and leaf NK content (Table 1). The highest chlorophyll was obtained at 15 mg/L Zn +50 mg/L Fe. Results indicated a reduced in chlorophyll and leaf NK content as Zn and Fe concentration increased. K and N content was maximum in treatment 15 mg/L Zn +50 mg/L Fe (Table 1). This was in agreement with Berglund [10] and Huda *et al.,* [11] who demonstrated that adding Zn and Fe, increased leaf surface, vegetative growth, net photosynthetic rate and chlorophyll content of plants. Iron deficiency in plants causes chlorosis, decreases in vegetative growth, reduced net photosynthetic rate and chlorophyll content of plants. Goos and Johanson [12] showed that two foliar applications of Fe-EDDHA increased seed yield of three soybean genotypes. Fe deficiency decrease in the amounts of chlorophylls with the appearance of leaf chlorosis, the visible symptom in orange trees [13]. Suryanarayana and Rao [14] 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) resulted in increased in plant height. Jana and Kabir [15] reported the effect of foliar application of micronutrients on growth of French bean. They found that, iron along with other micronutrients at 0.1 ppm concentration recorded highest plant height and number of branches. Zinc is a component of carbonic anhydrase, as well as several dehydrogenases and auxin production which in turn enhance plant growth. However, iron is necessary for the biosynthesis of chlorophyll and cytochrome, leading to increase in the biosynthesis of materials and growth. Application of Zn or Fe has been reported significant positive effects, in most cases, on growth measurements and chemical composition of cumin[16], sunflower [17] and and rice [18]. Similar upon results, micronutrient fertilizing decreased P and N content in leaves. These results were inconsistent with that obtained from Movchan and Sobornikova [19]. 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, mean fruit weight, fruit length and fruit diameter per plant

In general, application of Zn and Fe combination produced significantly higher yield and fruit weight of plant compared to control and other treatments. Fruit length and fruit diameter per plant increased when cucumber treated with 50 mg/ L Zn+ 100 mg/ L Fe. On the other hand tomato treated with 50 mg/ L Zn+ 100 mg/ L Fe produced the maximum yield (6.12 kg/plant) and fruit weight (g). Also, Zn at 50 mg/L and Fe at 100 mg/L could alone, increased the yield (5.56, 5.45 kg/plant) and fruit weight (92.12, 91.56 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 fruit length and fruit diameter. Fruit length and fruit diameter increased when plants were treated with 50 mg/ L Zn+ 100 mg/ L Fe, Abdollahi *et al.,* [20] reported similar results for 'Selva' strawberries. Resembling results were obtained by Prasad *et al.,* [21-22]. 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.,* [23] 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 [24]. Growth of the receptacle is controlled primarily by auxin, which is synthesized in achenes [25]; 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 [26]. Zaiter *et al.,* [27] 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 (3.12 %) content was attained in fruits treated with foliar application of 50 mg/L Zn+100 mg/L Fe and the lowest was achieved in control (Table 1). Also highest pH was attained in fruits treated with 200 mg/L foliar Fe. Increase in Zn and Fe concentration significantly increased TSS content when accompanied by Zn and Fe alone or in combination, and the highest and lowest values of this parameter were found at 50 mg/L Zn+100 mg/L Fe and control, respectively (Table 1). It is well known that Fe plays a key role in carbohydrate metabolism and fruit quality [28]. Zn and Fe did affect the pH, TSS, TA and vitamin C of fruits. El-Shazly *et al.,* [29] have also reported that apple fruits treated with Fe had increased TA, TSS and Vitamin C content at the end of storage. Malawadi *et al.,* [30] 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.,* [31], who reported treatment with Fe along with Zn significantly increased the vitamin C, TSS and TA content. Application of zinc sulfate can increase TSS in fruit of guava [32]. Since zinc has an important role in photosynthesis and enzymes responsible for plant metabolism, the increased TSS could be attributed to $ZnSO_4$. Singh [33] mentioned that micro nutrient had effect on fruit quality of grapes, T.S.S and quality of fruit. Moustafa *et al*., [34] 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 cucumber to increase weight fruit, total soluble solids and yield, which helps to obtain higher marketable fruit yield with yield and other quality parameters.

Table 1- Effect of foliar spraying of Zn and Fe on growth, yield and quality of cucumber plants during 2012 and 2013 seasons.

Treatments (mmolL-1)	Plant height (cm)	Dry weight of leaves (g)	Number of leaves per plant	Chlorophyll (SPAD)	Fruit length (cm)	Mean fruit weight (g)	Fruit diameter (cm)	Total yield (kg/Plant)	N(%)	K(%)	TSS (%)
Control	167.55c	2.45c	18.87c	14.12bc	15b	75.23c	1.89c	2.76c	2bc	1.32c	1.67c
15 mg/ L Zn	189.11b	3b	20.12b	23.11a	19.56a	80.76bc	2.78ab	4.11b	2.98a	3.01a	2.3b
30 mg/ L Zn	190b	3.11b	21.13b	18.12b	16.12b	81bc	2.34b	4.32b	2bc	2.34b	2.54ab
50 mg/ L Zn	205.98ab	4.19ab	29.56ab	15bc	15.5b	92.12ab	2.3b	5.56ab	2.13bc	2bc	3a
50 mg/ L Fe	190.56b	3.2b	23.14b	22a	20.13a	80.67bc	2.81ab	4.13b	3a	2.89a	2.29b
100 mg/ L Fe	205.1ab	4.14ab	28.96ab	14.13bc	15.12b	91.56ab	2.13b	5.45ab	2bc	2.45b	2.89a
15 mg/ L Zn+ 50 mg/ L Fe	190.11b	3b	23.23b	24.12a	15b	85.34b	3.31a	4.01b	3.11a	3a	2.33b
15 mg/ L Zn+ 100 mg/ L Fe	193.43b	3.11b	23.78b	17.98b	14.65b	85b	2.4b	4.32b	2.5b	2bc	2.3b
30 mg/ L Zn+ 50 mg/ L Fe	194.67b	3.98ab	24.12b	16.13bc	13.12bc	85.87b	2.32b	4.56b	2.16bc	2.01bc	2.3b
30 mg/ L Zn+ 100 mg/ L Fe	194.9b	4.1ab	24b	16bc	13bc	86.34b	2.3b	5.34ab	2.18bc	1.98bc	2.25b
50 mg/ L Zn+ 50 mg/ L Fe	200.45ab	4.12ab	24.14b	15.78bc	12.58bc	87.34b	2.3b	5.5ab	2.01bc	1.96bc	2.34b
50 mg/ L Zn+ 100 mg/ L Fe	209.32a	5.05a	31.12a	15.69bc	12.6bc	98.56a	2.34b	6.12a	2.04bc	1.89bc	3.12a

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, M.M., 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. Grotz, N., Guerinot, M. L. (2006). Molecular aspects of Cu, Fe and Zn homeostasis in plants. Biochim. Biophys. Acta., 1763: 595–608.
5. Cakmak, I. (2008). Enrichment of cereal grains with zinc: Agronomic or genetic biofortification Plant Soil., 302: 1-17.

6. Kaya, C., Higgs, D. (2002). Response of tomato (Lycopersicon esculentum L.) cultivars to foliar application of zinc when grown in sand culture at low zinc. *Sci. Hortic*., 93:53-64.
7. 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.
8. Mousavi, S.R. (2011). Zinc in crop production and interaction with phosphorus. *Australian Journal of Basic and Applied Sciences.*, 5: 1503-1509.
9. Kacar, B. (1972). Bitki ve topragin kimyasal analizleri. II. Bitki analizleri. Ankara Univ. Ziraat Fak., Ankara, Turkey; Yayin., 453.
10. Berglund, D.R. (2002) Soybean Production Field Guide for North Dakota and Northwestern Minnesota. Published in cooperative and with support from the North Dakota Soybean Council, 136p.
11. Huda, K.M.K., Bhuiyan, M.S.R., Zeba, N., Banu, S.A., 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.
12. Goos, R.J., Johanson, B.E. (2000). A comparison of three methods for reducing iron-deficiency chlorosis in soybean. Agron. J., 92: 1135- 1139.
13. Pestana, M., David, M., deVarennes, A., Abadı´a, J. & Faria, E. A. (2001). Responses of 'Newhall' orange tree stoir on defi-ciency inhydroponics: effects on leaf chlorophyll, photosynthetic efficiency and root ferricchelate reductase activity. *Journal of Plant Nutrtion*., 24:1609–20.
14. Suryanarayana, V., & Rao, S.K.V. (1981). Effect of growth regulators and nutrient sprays on the yield of okra. *Veg. Sci*., 8 : 12-13.
15. Jana, B.K., & Jahangir, K. (1987). Influence of micronutrients on growth and yield of French bean Cv. Contender under polyhouse conditions. Veg. Sci., 14 (2) : 124-127.
16. El-Sawi, S. A., & Mohamed, M.A. (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.
17. Mirzapour, M. H., & Khoshgoftar, A. H. (2006). Zinc application effects on yield and seed oil content of sunflower grown on a saline calcareous soil. *J. Plant Nutr*., 29:1719-1727.
18. Wissuwa, M., Ismail, A. M., & Graham R.D., (2008). Rice grain zinc concentrations as affected by genotype native soil-zinc availability, and zinc fertilization. *Plant Soil*., 306:37-48.
19. Movchan, V. G., & Sobonikova, I. G. (1972). Zinc fertilizers and the Uptake of Mineral Nutrients by Vinges Growing on the Southern Chenozem." Agrokhimiya., 43(5):123-130.
20. Abdollahi, M., Eshghi, S., Tafazoli, E. (2010). Interaction of Paclobutrazol, Boron and Zinc on Vegetative Growth, Yield and Fruit Quality of Strawberry (*Fragaria × Ananassa* Duch. cv. Selva). *Journal. Biology. Environ. Sci*., 4(11): 67-75.
21. Prasad, B., Singh, A.P., Sinha, M.K. (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.
22. Prasad, R., Sakal, R. (1991). Availability of iron in calcareous soil in relation to soil properties. J. Ind. Soc. Soil Sci., 39 : 658-661.
23. 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.
24. Chaplin, M.H.(1980). Westwood MN.Relationship of Nutritional Factors to Fruit set. J. Plant Nutr., 2: 477-505.
25. Archbold, D.D., Dennis, F.G. (1984). Quantification of free ABA and conjugated IAA in strawberry achene and receptacle tissue during fruit development. J. Amer. Soc. Hort. Sci., 109:330-335.
26. Alvarez-Fernandez, A., Abadia, J., Abadia, A. (2006).Iron deficiency, fruit yield and quality. In: Barton LL, Abadia J (eds) Iron nutrition in plants and rizospheric microorganisms. Springer, Dordrecht, The Netherlands.pp 85–101, ISBN-10 1-4020-4742-8.
27. Zaiter, H.Z., Saad, I., Nimah, M.(1993).Yield of iron-sprayed strawberry cultivars grownon high pH calcareous soil.*Journal of Plan Nutr*., 16: 281-296
28. Dongre SM, Mahorkar VK, Joshi PS, Deo DD.Effect of micronutrients sprayon yield and quality of chilli (Capsicum annuum L.). var. Jayanti. *Agric. Sci. Digest*, 2000. 20 (2) : 106-107.
29. El-Shazly, S.M., Abdel Naseer, G., Harhash, M.M. (2000). Physiological and biochemical indices in Washington novel orange trees as influenced by iron foliar application. *Alexandria J. Agric. Res*., 45 (1) : 287-306.
30. Malawadi, M.N., Shashidhara, G.B., Palled, Y.B. (2004). Effect of secondary and micronutrients on yield, nutrient uptake and quality of chilli. Karnataka *J. Agric. Sci.,* 17 (3): 553-556.
31. Mishra, L.N., Singh, S.K., Sharma, H.C., Goswami, A.M., Bhana, Pratap. (2003). Effect of micronutrients and rootstocks on fruit yield and quality of kinnow under high density planting. *Ind. J. Hort*., 60 (2) : 131-134.
32. Dobroluybsikii, O.K., Strakhov, V.G., Tanurkov, G.R. (1982). Effect of microfertilizers on yield and quality of grape in Ukrainian south. Vitis.,20: 183 (Abst.).
33. Singh, C., Sharma, V.P., Usha, K., Sagar, V.R.(2002). Effect of macro and micronutrients on physico-chemical characters of grape cv. Perlette. *Ind. J. Hort*., 59 (3) : 258-260
34. Moustafa, A., Elshazly, A.S.A., Eissa, A.M., Zahran, M.A.(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.

How to cite this article

Mohsen Kazemi. Effect of Foliar Application of Iron and Zinc on Growth and Productivity of Cucumber. Bull. Env. Pharmacol. Life Sci., Vol 2 (11) October 2013: 11-14