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RESPONSE OF COWPEA TO FOLIAR SPRAY WITH SOME MICRONUTRIENTS (ZN, FE AND MN) AND IT'S REFLECT ON THE DRY SEED YIELD AND ITS COMPONENTS.

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ABSTRACT: *These field experiment werw carried out at Kaha Experimental Station, Qalubia Governorate during the two successive summer seasons of 2014 and 2015, to study the effect of foliar spray with some microelements, i.e. Fe, Zn and Mn at 150 and 200ppm for each on growth, seed yield and its components as well as on the chemical constituents of cowpea dry seeds (Vigna unguiculata L.) cv. Kafr El-Sheikh. The results indicated that, foliar spraying with mixture of some microelements i.e. Fe+ Zn + Mn at 150ppm for each significantly increased growth, seed yield and its chemical constituents such as carbohydrates, protein % and Fe, Zn , Mn in the dry seeds compared with the other treatments and the control. For that, it can be recommended that spraying cowpea plants with mixture of zinc, manganese and iron at the concentration of 150ppm from each gave the highest seed yield with best quality.*

Key words: *Cowpea, yield, quality, foliar application Fe, Mn and Zn.*

INTRODUCTION

Legumes are considered the most important source of food after the grain crops and one of the main sources for protein, starch, oil, vitamin, minerals and energy for human. Currently, it can be a good alternative for animal protein and due to its nutrition values as well as an economic importance. Cowpea (*Vigna unguiculata* L.) is commonly referred as a poor man's meat, it can be planted it for seeds which containing 18-32 % protein and nitrogen fixation ability. Cowpea seeds are a nutrition component in the human diet whereas, the protein in cowpea seeds is rich in lysine and tryptophan amino acids compared to cereals, (El -Hawary, 1999; Carvalho *et al.,* 2012 and Katoch, 2013).

Fertilizer is a vital input in agriculture to boost the crop yields. Among the methods of fertilizer application, foliar nutrition is recognized as an important method of fertilization and more faster for absorption, since foliar nutrients usually penetrate the leaf cuticle or stomata and enters the cells facilitating easy and rapid utilization of nutrients. Most of the plant nutrients are absorbed through the leaves and absorption become rapidly and nearly complete. Moreover, foliar feeding practice would be more useful in early maturing crops, which could be combined with regular plant protection programs. If foliar nutrition is applied, it reduces the cost of cultivation which inturn reduces the amount of fertilizer thereby reducing the costs of crop production. Supplementary foliar fertilization during crop growth can improve the mineral status of plants and increase the crop yield, (Elayaraja and Angayarkanni; 2005 and Rajesh and Paulpandi, 2013).

Several investigators reported that, Zn, Fe and Mn had an important role in plant growth, yield and its quality. Moreover, its consider limited factor for many crops as mentioned by many researchers. Regarding to role of zinc, it was found that, Zinc (Zn^{2+}) is important element for plant growth through several aspects, which consider a component and activator for several enzymes such as dehydrogenase, proteinase, peptidase and phosphohydrases which act the main role in metabolism processes of carbohydrates, protein and phosphate. Zn is directly involved in biosynthesis of growth regulators such as IAA hormone which induces cell division and cell elongation and it is consider one of the auxins, that will be stored in the plant organs especially in the seeds. Zn is important for Carbon fixed thus reflected on photosynthesis processes, uptake nitrogen, nitrogen metabolism, protein quality, carbon anhydrate activity. Also, Zn deficient reduces the rate of protein accumulation in plant and seeds, zinc also stimulates plant resistance to dry and hot weather, (Marschner, 1998; Gurmani *et al.,* 1988; Lincoln and Zeiger, 2002; Potarzycki and Grzebisz, 2009). Foliar application of Zinc at 0.5 and 0.4% increased pigeon pea and soybean seed yield respectively. Moreover, Concentrations of Zn, Fe, P and K increased in the plant leaves with increasing zinc concentration in foliar spray solution, (Osman *et al.,* 2000; Masood and Mishra, 2001; Nasri and Khalatbari 2011).

Concerning to the role of iron in plants, it can said that,Iron (Fe^{3+}) is the third most limiting nutrient for plant growth and metabolism. Iron is involved in chlorophyll synthesis and it is essential for the maintenance of chloroplast structure and function as well as Fe plays a significant role in basic biological processes such as photosynthesis, respiration, nitrogen fixation, uptake mechanisms, protein and DNA synthesis. It is also an active factor of many enzymes that are necessary for plant hormone synthesis such as ethylene, lipoxygenase and carboxalic-oxidase, In addition, it serves as a component of many enzymes such as cytochromes of the electron transport chain and it is thus required for a wide range of biological functions. (Jahanara *et al.*, 2013 and Gyana and Sahoo 2015).

Othman (2013) found that foliar application by Fe or Zn at 1% level showed significant effect on soybean protein content. In addition iron treatment has a greater effect on the nutrient uptake and protein percentage of seeds than other treatments.

Márquez-Quiroz1 *et al.,* (2015) reported that the mineral seed contents and yields in cowpea plants are most affected by Fe fertilizer applications, they also reported that ferrous sulfate at 25 µM L^{-1} and iron chelate at 100 µM L^{-1} significantly improved the Fe concentration in cowpea, beans and increased the seed yield over the control.

As for manganese effect on several crops , many investigators indicated that , Manganese (Mn^{2+}) is an essential element for plants, intervening in several metabolic processes, mainly in photosynthesis its involvement in the water-splitting system of photosystem II (PSII), which provides electrons whereas , it is very necessary for photosynthetic electron transport. Moreover, Mn play as an enzyme antioxidant and co-factor of various enzymes in plants such as Mn-superoxide dismutase, Mn-catalase, pyruvate carboxylase and phospho-enolpyruvate carboxykinase. Manganese also plays a role in ATP synthesis, biosynthesis of fatty acids, lipids and proteins. In addition, Manganese is also essential for the biosynthesis of chlorophyll (through the activation of specific enzymes), aromatic amino acids (tyrosine), secondary products, like lignin and flavonoids. It is also participates in the biosynthetic pathway of isoprenoids and assimilation of nitrate. Mn is involved in metabolic processes such as respiration, photosynthesis, synthesis of aminoacids and hormone activation. (Goussias *et a*l., 2002; Lidon *et al*., 2004; Ducic and Polle 2005; Millaleo1 *et al*., 2010)

Micronutrients have considerable significant effects, as limiting factors, on the productivity of cowpea. The importance of spraying microelements, Fe and Zn alone or in combination can be accounted by its essential role in respiration, their metabolism activation of the enzyme, photosynthesis, chloroplast formation, chlorophyll synthesis and natural hormone biosynthesis. Moreover, Zn + Fe increased cowpea dry matter, total yield/plant and number of pods/plant. These elements play vital roles in C_{O2} flowing out, vitamin A improvement and resistant system activities. So, deficiency of these nutrients can markedly reduce crop's yield, and even can cause ceasing plant growth. Mostly, amounts of iron and zinc in soil are more than in the plant needs but cannot readily be absorbed by the plants, either it is fixed with other or by high level of soil pH. Thus, it is better to be added it as foliar application, as it is more effective than adding it's as soil fertilization, (Narimani *et al*., 2010; Abou El-khair *et al.,* 2001).

The aim of this study is to investigate the effect of some micronutrients, i.e. Zn, Fe and Mn as a foliar application as single application or as a mixture between them on cowpea seed yield and its quality.

MATERIALS AND METHODS

The present investigation was conducted at Kaha Research Farm, Qaliobia, Horticulture Research Institute, Agriculture Research Center during the two successive summer seasons of 2014 and 2015 to study the effect of foliar spraying with Fe, Zn and Mn at 150 and 200ppm individual or mixture between them on growth, seed yield components, seeds quality and chemical constituents of cowpea seeds (Vigna unguiculata L.) cv. Kafr El-Sheikh. Sample of the soil at the depth of 50 cm from the soil surface was taken to determine the physical and chemical properties which determined according to (Black, 1965 and Page *et al.,* 1982), were shown in Table (1).

This Experiment Included 9 Treatments as Follows:-

1- Control (tap water). The control plant sprayed with tap water.
2- Spraying with Fe at150 ppm.
3- Spraying with Fe at 200 ppm.
4- Spraying with Mn at 150 ppm.
5- Spraying with Mn at 200 ppm.
6- Spraying with Zn at 150 ppm.
7- Spraying with Zn at 200 ppm.
8- Spraying with Mixture of Fe + Mn + Zn at 150 ppm.
9- Spraying with Mixture of Fe+Mn+Zn at 200 ppm.

The sources of microelements i.e., Fe, Mn and Zn were ferrous sulphate, manganese sulphate, zinc sulphate respectively. Seeds were sown in hills at10 April during both seasons at 15 cm apart between plants on one side of the ridge. The studied treatments were arranged in a randomized complete block design with three replicates. The experimental unit area was 10.5m^2 which contained 5 rows with 3.5m length and 60cm width for each. One row was left between each two experimental plots to avoid the overlapping.

Table (1): Chemical and Physiological Analysis.

Seasons	Texture class	O.M.%	pH	E.C. (m.mohs/(cm)	Available (ppm)		
					Fe	Zn	Mn
2014	clay	2.01	8.39	0.32	6.9	1.2	3.4
2015	clay	1.80	8.33	0.3.6	7.0	1.3	2.1

Plants were sprayed three times at 25, 45 and 65 days after sowing. Each experimental unit received 2 liter solutions of each concentration using spreading agent (Super film at 1cm/L.) to improve adherence of the spray to the plant foliage for increasing absorption by the plants (Mortvedt *et al.,* 1991). The untreated plants (check) were sprayed with tap water and spreading agent. The normal agricultural practices of cowpea production were followed according to the recommendations of Ministry of Agriculture.

Data Recorded:-

1- Vegetative growth characteristics:

Plant height (cm), number of branches and fresh weight per plant were measured in five plants chosen randomly from each plot at flowering stages, (leaves, stems and branches) were dried at 70 C^{o} till constant weight and then dry weight/plant was evaluated.

2- Dry seed yield and its components:

At harvesting time, a random samples of 5 plants from one row of each experimental plot were taken to evaluate dry seed yield and its components; number of seeds /pod, number of pods/plant, dry seed yield/plant, seed index (100-seed weight (g). Moreover, total dry seed yield per plot were evaluated as (kg/plot) and then calculated as kg /feddan. Shell out% of dry pods was calculated using the following equation:

$$\text{Shell out \%} = \frac{\text{Weight of dry seeds}}{\text{Weight of dry pods}} \times 100$$

3- Chemical constituents of cowpea dry seeds as the folowing:

Crude protein was calculated based on total N concentration according to (A.O.A.C, 1990). Total Carbohydrates were determined colorimetrically using the method described in A.O.A.C. Microelements; Iron, manganese and zinc were determined by atomic absorption spectrophotometer (FAAS Perkin Elmer HGA 4000 Programs) as described by Evenhuis and Dewaard (1980).

4- Seed germination tests:

Three random samples (100 seeds each) were used from each treatment for calculating the following records; germination percentage (%), germination rate and sprout length (cm). Germination rate was calculated according to the following equation;

Germination rate=

$$\frac{(G1\ xN1)+(G2 \times N2) + \ldots\ldots..(Gn \times Nn)}{G1 + G2 + \ldots\ldots\ldots\ldots\ldots\ldots Gn}$$

Where: G = Number of germinated seeds in certain day, N = Number of this certain day.

100 seeds were distributed on watered sheets of filtrated papers and incubated at 25C^{0} for 14 day. Sprout length was taken after germination beginning for 2 day intervals until finishing the incubation period (14 days).

5- Statistical Analysis:

The obtained data were subjected to statistical analysis as technique of randomized block design with three replicates in both growing seasons. All data were subjected to the analysis of variance according to (Gomez and Gomez, 1984), and L.S.D values were used for comparison.

RESULTS AND DISCUSSIONS

1- Vegetative growth characters:

Data in (Table 2) showed the effect of spraying cowpea plants with some microelements i.e. Fe, Zn and Mn at 150 and 200 ppm for on vegetative growth. It is obvious in such data that vegetative growth was promoted with all microelements used as compared to the control; plant height, No. of branches/plant, fresh and dry weight/plant were increased significantly with adding Fe at 150 ppm individual and the most increment was obtained by adding the mixture of Fe + Mn + Zn at the rate of 150 ppm. This trend was clear in the both seasons.

These results may be due to the effect of these microelements on plant physiological processes, Fe which plays a prominent role in several vital processes in plant such as photosynthesis, respiration, nitrogen fixation, uptake mechanisms, protein and DNA synthesis consequently affecting plant growth (Jahanara et *al.,* 2013 and Gyana and Sahoo 2015). Zn is important for C_{14} fixed in the primary photosynthetic process (Lincoln and Zeiger 2002). Zn there by it may increase photosynthetic efficiency which was reflected as stimulative effect on plant vegetative growth and also zinc is a one of the most important component in several kinds of enzymes such as dehydrogenase, proteinase, peptidase and phosphohydrases (metabolism of carbohydrates, protein and phosphate) and Zn is known to stimulate plant resistance to dry and hot weather (Marschner, 1998). Zn is also well known to be directly involved in biosynthesis of IAA hormone. On the other point manganese (Mn) is involved in the evolution of O_2 in photosynthesis. It is also a component of several enzyme systems. It has also important role function in chloroplast as a part of electron-transfer (oxidation-reduction) reactions and electron transport system. Moreover, Mn participates in the biosynthetic pathway of isoprenoids and assimilation of nitrate (Ducic and Polle 2005; Millaleo1 *et al.,* 2010). The obtained results are in agreement with those reported by (Gad and Kandil, 2013; Eisa and Ali, 2014 on cowpea and El-Mansi *et al.,* 2005 on pea) they illustrated that, spraying plants with mixtures of (Fe, Zn, Mn, Mo and B) at different concentrations increased vegetative growth characters compared with the control. Nevertheless, Faizus and Rahman, 2012 and Inayat *et al.,* 2014 showed that a significant difference was observed in common bean (*Phaseolus vulgaris* L.) vegetate growth when plants were sprayed it with zn alone. Moreover, the increments in plant height and No. of branches/plant were recorded with foliar spray by mixture form (B + Mo + Zn).

Table (2): Vegetative growth characteristics of cowpea as affected by foliar application with some microelements in the seasons of 2014 and 2015.

Treatments	1st season				2nd season			
	Plant height (cm)	No. of branches / plant	Fresh weight (g/plant	Dry weight (g/plant	Plant height (cm)	No. of branches / plant	Fresh weight (g/plant	Dry weight (g/plant
Control	56.50	5.50	149.24	26.30	63.30	7.70	153.60	27.04
Fe at 150ppm	75.00	7.00	314.90	40.90	82.70	8.00	320.00	42.39
Fe at 200ppm	73.20	7.00	264.70	31.30	81.28	7.60	308.12	33.15
Mn at 150ppm	66.10	6.50	236.90	29.60	70.00	7.00	250.52	32.20
Mn at 200ppm	63.40	6.20	197.70	28.70	65.30	6.10	220.86	29.61
Zn at 150ppm	67.60	6.60	297.60	30.90	69.30	7.20	313.00	32.31
Zn at 200ppm	64.20	6.50	254.80	31.20	65.40	7.20	293.14	32.00
Fe + Mn + Zn at 150ppm	78.63	7.20	350.55	46.50	84.05	8.00	390.44	48.22
Fe + Mn + Zn at 200ppm	75.50	7.00	310.70	42.40	81.82	7.81	324.17	44.76
LSD	5.57	0.86	38.24	6.92	4.43	0.63	32.56	6.34

2- Dry seed yield and its components:

Data in (Table 3) illustrated the effect of spraying cowpea plants with some microelements; i.e. Fe, Zn, and Mn at 150 or 200ppm on seed yield and its components i.e. number of seeds/pod, umber of pods/plant, seeds weight/pod, seed index, shell out and seed yield/plant as well as seed yield/fed. It can be concluded that, yield and its components were significantly increased by spraying plants with Zn at 150 ppm individually or spraying the mixture of the three microelements i.e. Fe, Zn and Mn used in this study at 150 ppm compared with the control (tap water) or the other tested treatments, in other meaning it can said that, the favorable treatments that produced the superior seed yield either per plant or per feddan were spraying the cowpea plants with the mixture of Fe + Mn + Zn at 150ppm then, the treatment of foliar spray with zn alone at 150ppm. This increment was clear during the two both seasons. The increment in total seed yield may be directly due to the increment in vegetative growth (Table 2). Also these increases might be due to the favorable role of the tested micronutrients in pigments formation, photosynthesis activation and carbohydrates assimilation consequently reflected on the seed production (Bhuiyan *et al.,* 2008). The results are in conformity with those obtained by (Gad and Kandil, 2013; Eisa and Ali 2014 on cow pea, El-Mansi *et al.,* 2005 and El-Sayed *et al.,* 2012 on pea) they illustrated that spraying the plants with mixtures of (Fe, Zn, Mn, Mo and B) at different concentrations gave the highest 1000 seed wt. and increased dry seeds/plant as well as/fed compared with the control. In some studies which carried out by (Faizus and Rahman, 2012; Inayat *et al.,* 2014 and Sedighe and kavoos, 2015) on common bean, the results indicated that foliar application which include zinc alone or combined with B and Mo recorded the maximum number of pods/plant, seeds/pods, seed index and dry seed yield/fed in the both seasons.

Table (3): Dry seed yield and its components of cowpea as affected by foliar application with some microelements in the seasons of 2014 and 2015.

Treatments	1st season						2nd season					
	No. of pods/ plant	No. of seeds/ pod	Seed index	Seed wt. (g/pod)	Dry seed wt. (g/plant	Dry seed yield (kg/fed)	No. of pods/ plant	No. of seeds/ pod	Seed index	Seed wt. (g/pod)	Dry seed wt. (g/plant)	Dry seed yield (kg/fed)
Control	15.75	7.72	16.66	2.38	21.51	732.93	16.09	8.70	20.49	2.68	21.92	780.60
Fe at 150ppm	27.50	8.90	17.97	2.75	22.82	758.77	27.65	9.57	19.04	3.05	23.68	820.97
Fe at 200ppm	25.78	8.65	17.28	2.49	22.17	749.60	26.22	9.41	18.08	2.77	22.79	793.73
Mn at 150ppm	28.13	10.30	25.20	2.82	24.09	791.67	28.77	10.37	25.71	3.14	24.73	837.00
Mn at 200ppm	27.83	9.10	18.08	2.62	23.26	775.30	28.04	10.07	20.25	2.85	23.94	798.33
Zn at 150ppm	36.25	10.78	27.31	3.28	26.41	880.60	37.09	11.16	30.14	3.50	26.84	931.43
Zn at 200ppm	28.19	9.70	26.65	3.11	23.75	803.73	29.09	10.72	26.91	3.19	24.25	864.07
Fe + Mn + Zn at 150ppm	42.00	12.40	30.11	3.53	29.16	893.60	44.07	12.94	32.33	3.95	29.88	951.07
Fe + Mn + Zn at 200ppm	29.92	10.88	28.71	3.37	25.95	841.13	32.00	11.60	30.83	3.70	27.17	915.83
LSD	4.92	1.15	4.09	0.63	3.13	107.30	4.97	1.08	3.68	0.71	2.72	100.19

3- Chemical constituents in cowpea dry seeds:

Data in Table (4) clearly indicated that spraying some microelements, i.e. Fe, Zn, and Mn greatly improved the chemical composition. i.e., protein, carbohydrates, Fe, Zn and Mn percentage in cowpea dry seeds as a reflection of spraying the plants with all tested microelements compared with the control in both seasons. The best value for protein, carbohydrates and Fe content in dry seeds were obtained by spraying the plants with Fe at 150 ppm individually or mixture of all microelements (Fe, Zn and Mn) at 150 ppm compared with the control (tap water) or with the other tested treatments. Whereas, the best results for Zn% was indicated from using Zn at 150 ppm individually or spraying the mixture of all microelements (Fe, Zn and Mn) at 150 ppm. On the other hand, the highest values of Mn was obtained by foliar spray with Mn at 150 ppm individually or spraying the mixture of all microelements (Fe, Zn and Mn) at 150 ppm. All the above mentioned concentrations gave significant increase than the control. The positive effect of micronutrients on dry seeds chemical contents may be due to their involvement in one or more of important biological functions such as synthesis of chlorophyll, electron transport system, oxidation-reduction reactions, protein synthesis and degradation, (Dwivedi, 1991; Nofal *et al.,* 1998 and Radwan and Tawfik, 2004). Moreover, Zinc (Zn) is necessary for plant growth as an activator of several enzymes and it is directly involved in the biosynthesis of growth regulators such as auxin, which promotes production of more plant cells and biomass that will be stored in the plant organs especially in seeds (Marschner, 1995). These results are in harmony with those reported by (Mohammad *et al.,* 2011 on *Phaseolous Vulgaris* and Othman 2013 on cowpea) , they reported that foliar application by Fe or Zn at 1% level on nutrient concentration produced the high values from contents of protein and carbohydrate in the seed. They added also that, iron treatment has a greater effect on the nutrient uptake and protein percentage in seeds than the other treatments. Also, Eisa and Ali (2014) working on cowpea and mentioned that Fe, Zn, Mn, Mo and B contents in seeds were increased with spraying the plants by all the concentrations of Fe, Zn, Mn, and B as compared to the control.

4- Seed germination tests:

Data represented in Table (5) showed that, it obtained significant increases in seed germination tests, i. e. percentage of germination, germination rate and sprout length were obtained by spraying cowpea plants with the all tested treatments compared with the control (tap water). Whereas, the greatest values were obtained by spraying cowpea plants with Fe at 150 ppm individual or by mixing Fe, Mn and Zn at 150 or 200 ppm compared with the other treatments or the control. This trend was true in the both seasons.

Table (4): Protein, Carbohydrates, Fe, Mn and Zn percentages in cowpea seeds as affected by foliar application with some microelements in the both seasons of 2014 and 2015.

Treatments	1st season					2nd season				
	Protien	Charboh-ydrate	Fe	Mn	Zn	Protien	Charboh-ydrate	Fe	Mn	Zn
Control	15.17	24.69	6.06	3.38	3.87	15.63	25.12	6.12	3.42	4.12
Fe at 150ppm	22.49	34.30	6.09	3.45	4.06	22.84	34.89	6.12	3.47	4.10
Fe at 200ppm	21.16	33.29	6.10	3.47	4.00	21.67	33.61	6.14	3.48	4.08
Mn at 150ppm	16.59	26.95	6.15	3.76	4.10	17.00	27.33	6.18	3.45	4.71
Mn at 200ppm	15.79	27.27	6.13	3.42	4.54	16.23	27.78	6.16	3.42	4.58
Zn at 150ppm	18.27	30.73	6.19	3.42	4.60	18.77	31.16	6.23	3.73	4.32
Zn at 200ppm	18.05	28.19	6.16	3.68	4.02	18.53	28.86	6.17	3.72	4.25
Fe + Mn +Zn at 150ppm	23.20	36.17	6.52	4.23	4.82	23.89	36.85	6.54	4.46	4.86
Fe + Mn +Zn at 200ppm	19.48	33.90	6.40	4.04	4.64	19.73	34.29	6.45	4.14	4.66
LSD	1.00	0.69	0.16	0.30	0.56	0.91	0.56	0.14	0.25	0.52

Table (5): Germination percentage (%), germination rate and sprout length of cowpea seeds as affected by foliar application with some microelements in the both seasons of 2014 and 2015.

Treatments	1st season			2nd season		
	Germination (%)	Germination rate (day)	Seedling length (cm)	Germination %	Germination rate (day)	Seedling length (cm)
Control	82.67	1.86	29.83	89.00	1.94	31.66
Fe at 150ppm	93.33	2.04	32.90	94.00	1.94	32.27
Fe at 200ppm	97.33	2.100	35.80	98.00	2.12	35.07
Mn at 150ppm	94.67	2.17	31.72	96.00	2.16	34.40
Mn at 200ppm	88.00	2.08	32.55	88.67	2.02	32.90
Zn at 150ppm	92.00	1.94	31.67	92.33	2.080	32.13
Zn at 200ppm	92.00	2.16	34.80	93.33	1.940	33.37
Fe + Mn +Zn at 150ppm	98.00	1.43	37.63	98.67	1.487	35.30
Fe + Mn +Zn at 200ppm	95.33	1.68	37.70	96.00	1.700	34.27
LSD	6.51	3.50	0.22	6.26	5.53	0.08

CONCLUSION

It can be concluded that foliar spraying cowpea plants with some micronutrients, i.e. mixture of (Fe+ Mn + Zn) at 150 ppm enhanced the plant height, number of branches/plant, number of pods/plant, number of seeds/pod as well as seed weight/plant yield as well as total seed yield per fed. Thus, it can be recommend by using foliar application with some micronutrients; (Fe+ Mn + Zn) at 150ppm to obtain the highest cowpea seed yield with best quality.

REFERENCES

Abou El-khair, E. E., I. A. S. Al-Esaily and N. M. El-Sarkassy (2001). Physiological response of garlic plant grown in sandy soil to foliar spray with iron, zinc and manganese either individual or in mixture form. Minufiya J. Agric. Res., 36(2): 409-426.

A. O. A. C. (1990). Official Method of Analysis 10th Association of Official Analytical Chemists. Inc. USA.Horneck, D. A. and D.

Bhuiyan, M. M. H., M. M. Rahman, F. Afroze, G. N. C. Sutradhar and M. S. I. Bhutyan (2008). Effect of Response of phosphorus, molybdenum and rhizobium inoculation on growth and nodulation on mung bean. J. Soil and Nature. 2(2):25-30.

Black, C. A. (1965). Methods of soil analysis part I- physical and mineralogical properties. A. S. A. Madison Wise., USA.

Carvalho, A. F. U., N. M. de Sousa, D. F. Farias, L. C. B. da Rocha-Bezerra and R. M. P. da Silva (2012). Nutritional ranking of 30 brazilian genotypes of cowpeas including determination of antioxidant capacity and vitamins. J. Food Compos Anal: 81-88.

Ducic, T and A. Polle (2005). Transport and detoxification of manganese and copper in plants. Braz. J. Plant Physiol. :103-112.

Dwivedi, G. K. (1991). Mode of application of micronutrients to sweet potato in acid soil of Garhwal Himalaya. Indian J. Hort. 48: 258 - 263.

Eisa, G. S. A and T. B. Ali (2014). Impact spraying of some microelements on growth, yield, nitrogenase activity and anatomical features of cowpea plants .World J. of Agric. Sci. 10 (2):57-67

Elayaraja, D. and A. Angayarkanni (2005). Effect of foliar nutrition on the nodulation and yield of rice fallow blackgram. J. Andhra Agric., 52: 602-604

El-Hawary, N. A. (1999). Effect of a new macro-micronutrients formulation on the yield production of some field and vegetable crops. J. Agric. Sci. Mansoura Univ. 24: 5175-5186.

El-Mansi, A. A., H. M. Arisha, A. I. EL-Kassas and E. M. E. Nour (2005). Effect of iron, molybdenum and boron and their spray methods on pea plants under sandy soil conditions 1. Morphological characters, photosynthetic pigments, dry weight and activity. The 6th Arabian Conference for Horticulture, Ismailia, Egypt. pp: 325-339.

El-Sayed, H. E. A., E. A. Amen, A. H. El-Morsy and M. H. Tolba (2012). Effects of foliar spraying with microelements and different fertilizer sources on quality and yield of *Pisum sativum,* L. plant .International Research Journal of Agric. Sci. and Soil Sci. 2:017-024.

Evenhuis, B. and T. W. Dewaard (1980). Principles and Practices in Plant Analysis. FAO Soils Bull. 38:152-165.

Faizus, and S. Rahman (2012). Effects of zinc and nitrogen fertilizer and their application method on yield and yield components of *Phaseolus vulgaris* L. http://dx.doi.org/10.4236/as.2012 3 (1):9-13.

Gad, N. and H. Kandil (2013). Evaluate the effect of molybdenum and different nitrogen levels on cowpea *Vigna* *anguiculata*. J. Apple. Sci. Res, 9(3):1490-1497.

Gomez, K. A. and A. A. Gomez (1984). Statistical procedures for the agricultural researches. John Wiley and Son, Inc. New York.

Goussias, C., A. Boussac and W. Rutherford (2002). Photosystem II and photosynthetic oxidation of water: an overview. Phil. Trans. R. Soc. Lond. B 357, 1369-1381.

Gurmani, A. H., B. H. Shahani, S. Khan and M. A. Khan (1988). Effect of various micronutrients (Zn, Cu, Fe, Mn) on the yield of paddy. Sarhad J. and Agric, 4: 515-520.

Gyana, R. R and S. Sahoo (2015). Role of iron in plant growth and metabolism. Ravi.Agric. Sci. (3):1-24.

Inayat, U., A. R. Afzal, I. Zafar, I. F. S. Salma, S. M. Shafiu and M. Afzal (2014). Response of common bean *Phaseolus vulgaris* to basal applied and foliar feeding of different nutrients application. J. Agric. & Environ. Sci., 14(9):851-854.

Jahanara, F. S. M. Sadeghi and M. Ashouri (2013). Effect of nano-iron (Fe) fertilization and rhizobium leguminosarum on the qualitative and quantitative traits of *Phaseolus vulgaris* L. genotypes. Intl. J. Agri. Crop Sci. 5:572-578.

Katoch, R. (2013). Nutritional potential of rice bean *Vigna umbellata* an underutilized legume. J. Food Sci.:8-16.

Lidon, F. C., M. Barreiro and J. Ramalho (2004). Manganese accumulation in rice: in implications for photosynthetic functioning. J. Plant Soil. 1611:235-44.

Lincoln, T and E. Zeiger (2002). Plant physiology, publisher, sinauer associates; 3 edition. Pb. 690.

Márquez-Quiroz, C., E. C. Lázaro, R. O. Osorio and E. S. Chávez (2015). Bofortification of cowpea beans with iron: iron´s influence on mineral content and yield. J. Soil Sci. Plant Nutr. 15(4):839-847

Marschner, H (1995). Mineral nutrition of higher plants. 2nd edition, academic press, London, 645 pp.

Marschner, H (1998). Mineral nutrition of higher plants. 2nd ed. academic press, Harcourt Brace and Company, Publisher London, San Diego, New York Boston, Sydney, Tokyo, Toronto, 864 pp.

Masood Ali and J. P. Mishra (2001). Effect of foliar nutrition of boron and molybdenum on chickpea. Indian, J. Pulses Res., 14(1):41-43.

Millaleol, R., M. Reyes-Díaz, A .G. Ivanov, M. L. Mora and M. Alberdi (2010). Manganese as essential and toxic element for plants, transport, accumulation and resistance mechanisms. J. Soil Sci. Plant Nutr. 10:476-494

Mohammad, N., M. Khalatbari and H. A. Farahani (2011). Zn foliar application Influence on quality and quantity features in *Phaseolous Vulgaris* under different levels of N and K Fertilizers. Adv. Environ. Biol. 5:839-846.

Mortvedt, J. J., F. R. Cox, L. M. Shuman and R. M. Welch (1991). Micronutrients in agriculture, 2nd ed. Published by Soil Soc. Amer. Inc. Madison, Wisconsin, USA, 760 pp.

Narimani, H., M. M. Rahimi, A. Ahmadikhan and B. Vaezi (2010). Study on the effects of foliar spray of micronutrient on yield and yield components of durum wheat. Appl. Sci. Res. 2:168-176.

Nasri, M. and M. Khalatbari (2011). Effect of different nitrogen, potassium and zinc fertilizer on quantities and qualities characteristic of green beans. Eco-physiological Crop Journal. 3(1): 82-93.

Nofal, O. A., M. F. El-Masri and A. A. El-Saed (1998). Response of some potato cultivars growth on alluvial soil to micronutrients foliar spray. J. Agric. Sci. Mansoura Univ. 23 (8):4121–4133

Othman, H. S. (2013). Effect of foliar fertilization of Fe, B and Zn on nutrient concentration and seed protein of Cowpea "Vigna Unguiculata. J. Agric. Veterin. Sci. 6(3):42-46.

Osman, A. S., Y. M .Y. Abido and S. M. M. Allam (2000). Response of soybean to phosphorus and zinc fertilizer under irrigation regime. Ann. Agric. Sci. 45(1): 229-238.

Page, A. L., R. H. Miller and D. R. Keeney (1982). Methods of soil analysis. Part (II) chemical and microbiological properties. A. S. A. Madison Wisc., USA.

Potarzycki, J. and W. Grzebisz (2009). Effect of zinc foliar application on grain yield of maize and its yielding components. Plant Soil Environ, 55(12):519-527.

Radwan, E. A. and A. A. Tawfik (2004). Effect of sulphur, manganese and zinc on growth, yield and quality of potato (*Solanum tuberoium*, L) J. Agric. Sci. Mansoura Univ. 29 (3):1423-1431.

Rajesh, N. and V. K. Paulpandi (2013). Review of foliar nutrition in red-gram enhancing the growth and yield characters. Amer. Int. J. Res. Appl & Natu. Sci., 13: 9-14.

Sedighe, N. S. and K. Kavoos (2015). Effect of zinc sulfate and iron sulfate fertilizers on some morphological characteristic of *Phaseolus vulgaris* Bull. Env. Pharmacol. Life Sci. 4 (2):74-78.

استجابه اللوبيا للرش الورقي بالعناصر الصغري (الزنك والحديد والمنجنيز) وانعكاس ذلك علي المحصول البذري ومكوناته

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الملخص العربي

اجريت هذه التجربه الحقليه بمزرعه بحوث الخضر بقها – محافظه القليوبيه التابعه لمعهد بحوث البساتين– مركز البحوث الزراعيه خلال موسمين صيفين 2014 و 2015 بهدف دراسة تاثير الرش ببعض العناصر الصغري ممثله في الحديد – الزنك و المنجنيز بتركيزى 150 و 200 جزء في المليون سواء منفرده أو مخلوطا فيما بينهما علي النمو والمحصول البذري ومكوناته لنباتات اللوبيا صنف كفر الشيخ وقد اوضحت النتائج ان الرش الورقي بمخلوط من العناصر الصغري (الحديد – الزنك والمنجنيز بتركيز 150 جزء في المليون) ادت الي زياده معنويه في كل من صفات النمو والمحصول البذري ومكوناته وكذلك المحتوي الكيميائي لبذور اللوبيا مثل البروتين و الكربوهيدرات وكذلك محتواها من عناصر الزنك و الحديد والمنجنيز ولذلك يوصى لانتاج محصول مرتفع من بذور اللوبيا بمواصفات جيده ان يتم الرش الورقى لنباتات اللوبيا بمخلوط من العناصر الصغرى الزنك و الحديد والمنجنيز بتركيز 150 جزء فى المليون من كل منهما وكانت هذه الزياده واضحه خلال موسمي الدراسه مقارنه بمعامله الكنترول (بدون رش عناصر صغرى) او مقارنه بالمعاملات الاخري.

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