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RESPONSE OF ONION TO FOLIAR APPLICATION OF SOME MICRONUTRIENTS

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Abstract

A field experiment was conducted at the Agricultural Research Station, Sids, Beni Sweif governorte during two successive seasons (1995-1996 and 1996-1997) to study the effect of foliar spray of Fe, Mn, Zn or Cu applied as sulphate and B applied as borax on onion yield (*Allium cepa* L.) and its chemical components.

Results showed that the highest dry yield was obtained by foliar application of Zn SO_4 followed by the application of borax. Increment percentages were 9.7%, 2.2%, 23.6% and 11.5% for the first growing season and 0.0%, 5.6%, 27.8% and 27.8% and 18.5% for the second growing season over the control for Fe, Mn, Zn and B treatments, respectively. On the other hand, copper treatment resulted in slight, but not significant yield decrease.

Foliar spray treatments did not increase micronutrients concentrations except spraying with Zn SO_4 which increased Zn to its highest concentration and content. Significant correlation coefficients between P and Zn (-0.792*), Fe and Zn (+0.734*), Fe and Cu (-0.828*) Mn and Fe (-0.801*) and Mn and Cu (-0.809*) were recorded.

INTRODUCTION

Onion (*Allium cepa* L.) is one of the most important vegetable crops in Egypt. It is the most important cash crop after rice. Increasing its yield with consequent economic return is the major concern of the farmers.

The goal of successful fertilization strategies is to supply the growing crop with its need of nutrients at suitable time, place and dose. Micronutrients needs for several crops are a few hundred grams per feddan represents only a very small amount of the total quantities in soils. However, different soil factors, especially pH, free calcium carbonate content and environmental conditions of aridity and drought reduce the availability and result in insufficiency of micronutrients. Sillanpaa (1982) reported that iron deficiency in semiarid regions is very acute, but concerning the impact on yield zinc deficiency ranks higher.

The reaction of soluble micronutrients compounds applied to the soil proceeds rapidly and convert them into relatively unavailable forms. Therefore, foliar spray with soluble salts or chelates is more efficient and very common, especially for vegetable crops. Amberger (1979) summarized the advantages of foliar spray in low application rate, uniform distribution, immidiate response and the suspect deficiencies can be easily diagnosed. The disadvantages can be summarized in the insufficient leaf surface with respect to demand, leaf burn as a result of salt concentration and little residual effect.

Foliar spray of micronutrients was performed with a reasonable success in Egypt since the 60's on several crops in the Nile Valley, the Nile Delta and the adjacent new reclaimed soils (Baza *et al.*, 1988; Amin *et al.*, 1988a; Amin *et al.*, 1988b, Badr *et al.*, 1991; Abu Grab *et al.*, 1993; El-Hawwary *et al.*, 1933 and El-Melegy *et al.*, 1997).

Therefore, a field experiment was conducted during two successive seasons in Sids Experimental Station, Beni Sweif governorate, to study the efficiency of some micronutrients applied by foliar spray on yield and chemical constituents of onion crop.

MATERIALS AND METHODS

A field experiment was conducted at Sids Agricultural Research Station, Beni Sweif governorate, during the two growing seasons of 1995-1996 and 1996-1997 to study the response of onion (*Allium cepa* L.) cv. Compest 16 to foliar spray of Fe, Mn, Zn or Cu applied as sulphate salts and B applied as borax for two times. The first spray tooks place two weeks after transplanting and the second one, two weeks later. The design is a complete randomized with four replicates.

Nursery bed was prepared and planted with onion seeds and fertilized with 15 kg P_2O_5/fed. as superphosphate (15.5% P_2O_5), 24 kg K_2O/fed. as potassium sulphate (48% K_2O) and 60 Kg N/fed. as ammonium nitrate (33.5% N). The main field was prepared and divided into plots (2.0 X 3.5 m^2) with five rows each of 50 cm in width. Surface soil samples (0-30 cm) representing the experimental sites were analyzed for some physical and chemical properties according to the methods reported by Jackson (1973) and Lindsay and Norvell (1969) and the data are shown in Table 1. Onion seedlings were transplanted to the main field fertilized with basic application of 22.5 kg P_2O_5/fed. as superphosphate (15.5% P_2O_5) and 24 kg K_2O/fed. as potassium sulphate (48% K_2O). Nitrogen fertilizer was applied in two equal doses just before the first and the second irrigation at the rate of 120 kg N/fed. as ammonium nitrate (33.5% N).

Foliar spray solution of Fe, Mn or Zn were used as sulphate salt with the concentration of 3.0 g/L., while the concentration of $CuSO_4$ was 1 g/L. Boron was used as borax, $Na_2B_4O_7$ with the concentration of 0.7 g/L. Triton B (1% concentration) was used as adhesive or sticking agent and the volume of spray solution was about 400 L./fed. for each treatment.

At harvest, bulbs weight (fresh and dry) were recorded as ton/fed. Samples of bulbs were wet ashed and N, P, K, Fe, Mn, Zn and Cu were determined according to the methods reported by Chapman and Pratt (1961). Boron was determined after dry ashing of bulb samples using Curcumin method as described by Dible *et al.* (1954). Data were subjected to statistical analysis according to Steel and Torrie (1980).

Table 1. Analyses of soil samples taken from the experimental sites.

	1st season	2nd season
Textural class	Clay loam	Clay loam
$CaCO_3$ (%)	3.40	2.38
Organic matter (%)	1.38	1.70
pH (soil paste)	8.01	8.23
E.C. (dS/m) soil paste	0.26	0.90
Soluble Anions (meq/L).		
HCo^{-}_{3}	1.40	1.50
Cl^{-}	3.50	3.50
SO^{--}_{4}	5.70	5.05
Soluble Cations (meq/L.)		
Ca^{++}	3.10	2.80
Mg^{++}	3.90	3.50
Na^{+}	3.40	3.50
K^{+}	0.20	0.15
Available nutreinents (ppm)		
N	60.00	23.00
P	11.00	5.00
K	490.00	350.00
Fe	17.50	12.80
Mn	5.60	3.20
Zn	0.80	0.90
Cu	0.90	0.70
B	1.30	1.80

RESULTS AND DISCUSSION

1. Onion yield:

Data presented in Table 2 showed that onion yield (fresh and dry) as affected by foliar spray with different micronutrients. Fresh and dry yield of onion follow the same general trend in the two seasons. In general, yield of the 1st season was higher than of the 2nd season by 45% in average. This is probably due to the difference in fertility status of the two experimental sites as shown in Table 1.

Yield of onion significantly increased with foliar spray of Zn as $ZnSO_4$ during the two seasons, where increment percentages on dry hasis were 23.6% and 27.8%, respectively. On the other hand, foliar spray with B as borax or Mn as $MnSO_4$ solutions increased onion yield insignificantly and increment percentages reached 11.5% and 18.5% for B treatment and 2.2% and 5.6% for Mn treatment for the two seasons, respectively. However, when $FeSO_4$ was sprayed, onion yield increased only in the 1st season insignificantly by about 9.7%, while in the 2nd season this treatment caused a slight decrease in onion yield by about 2.8%. When $CuSO_4$ was sprayed, onion yield decreased by about 7.0% and 6.5% for the two seasons, respectively.

Examination of the obtained data revealed that foliar spray of micronutrients solutions for two times showed an appreciable effect on onion yield especially spraying of $ZnSO_4$ or borax solutions. These data could be explained on the basis of soil analysis of experimental sites which showed that available Zn extracted by DTPA + $CaCl_2$ method (Lindsay and Norvell, 1969) reached 0.80 and 0.90 ppm which is considered on the border of deficiency, as the critical level reported lies between 0.5-1.0 ppm. Therefore, the application of $ZnSO_4$ through foliar spray method was effective. The soil analysis for B status of the two experimental sites was 1.30 and 1.80 ppm. This level is considered higher than the critical level reported (0.1 - 0.7 ppm). However, foliar spray with borax showed somewhat promising results. As for Fe, Mn and Cu status of the two sites, soil analysis showed that the concentration of these nutrients exceeded the critical levels reported. This is possibly the reason why these treatments were not effective.

2. Chemical contituents of onion bulbs

Nitrogen percentages of onion bulbs during the two seasons (Table 2) showed a similar general trend where Zn, Fe or B foliar spray treatments as well as Mn treat-

Table 2. Means of fresh and dry yield of onion bulbs and their N, P, K, Fe, Mn, Zn, Cu, B concentrtions as affected by foliar application of some micronutrients.

Treatment	Yield (ton/fed)		Macronutrients (%)			Macronutrients (ppm)				
	Fresh	Dry	N	P	K	Fe	Mn	Zn	Cu	B
			1995-1996 season							
Control	10.50	0.971	0.70	0.21	0.91	85.6	84.4	29.4	19.5	45.0
Fe	10.68	1.065	0.85	0.19	0.91	85.9	77.4	27.0	20.0	44.8
Mn	10.44	0.992	0.76	0.19	0.94	83.1	83.3	24.0	19.8	46.7
Zn	11.70	1.200	0.86	0.16	0.96	84.8	85.2	45.0	19.5	44.0
Cu	10.08	0.903	0.66	0.19	0.88	85.2	77.9	29.9	19.8	42.7
B	11.10	1.083	0.75	0.20	0.93	106.7	86.0	26.1	19.0	44.2
L.S.D. (0.05)	0.99	0.126								
			1996-1997 season							
Control	6.84	0.648	0.79	0.21	0.96	85.5	86.4	27.7	25.5	54.7
Fe	6.60	0.640	0.81	0.23	0.94	82.5	90.3	25.7	24.7	51.7
Mn	6.96	0.684	0.74	0.24	0.95	83.6	90.5	26.6	25.4	54.4
Zn	7.38	0.828	0.85	0.23	0.96	86.7	89.5	45.5	25.9	54.0
Cu	6.48	0.606	0.72	0.23	0.94	85.5	92.7	26.4	26.0	50.5
B	6.96	0.768	0.80	0.23	0.91	82.8	148.0	25.8	26.5	52.0
L.S.D. (0.05)	0.46	0.170								

ment in the 1st season increased N percentages. However, foliar spray with Cu during the 1st season and Mn & Cu during the 2nd season decreased N percentages below that of control treatments. As for N content, (Table 3) data revealed that during the 1st season, all foliar spray treatments increased N content of onion bulbs except when Cu was sprayed where N content decreased to the lowest N content recorded. However, during the 2nd season, all foliar spray treatments decreased the N content of onion bulbs except Zn and B treatments where N contents were of the highet values in this experiment.

Phosphorus percentages (Table 2) of onion bulbs in the 1st season showed a decrease below that of the control treatment with all foliar spray treatments and the decrease took the descending order of B, Fe, Cu, Mn and Zn, respectively. Simple correlation coefficient verified this feature where a significant negative correlation coefficient (-0.792*) was recorded between P and Zn. In the 2nd season. P percentages showed a quite different trend, where all micronutrients treatments showed a stimulating effect on P percentages and the trend took the ascending order of B, Fe, Zn, Cu and Mn, respectively. P content of onion bulbs of 1st season (Table 3) decreased by all foliar treatments except for B and Fe treatments. On the contrary, in the 2nd season all foliar treatments increased P content of onion bulbs, and Zn treatment showed the highest effect followed by B, Mn, Fe and Cu treatments, respecttively.

Potassium percentages (Table 2) of onion bulbs during the 1st season increased by Zn, Mn or B foliar spray treatments, while Cu and Fe caused a decreae in K percentages. However, in the 2nd season all foliar treatments decreased K percentages below that of the control. K content of onion bulbs increased in all treatments in the 1st season, except when Cu was sprayed where K was of the least content (Table 3). K content of onion bulbs of the 2nd season showed a stimulating effects when plants were sprayed with Zn, B or Mn, respectively. However K content decreased by Cu or Fe foliar spray treatments.

Foliar spray treatments did not increase micronutrients concentrations (Table 2) except when spraying with $ZnSO_4$ which highly increased Zn concentration. Thorne (1957) in his discussion of Zn deficiency and its control, concluded that the satisfactory performance of $ZnSO_4$ sprays in comparison of applications of Zn chelates suggested that the need for Zn chelates in sprays is not critical as for Fe chelates.

Iron concentration (Table 2) was not affected much by foliar spray of different micronutrients, except when spraying with B in the 1st season and Zn in the 2nd season where Fe concentration increased. A significant positive correlation coefficient (0.734*) was found between Fe and Zn in the 2nd season. Fe content (Table 3) took a similar general trend as dry onion bulbs yield.

Manganese concentration (Table 2) was not affected by Mn foliar spraying; however, when Fe or Cu sulphate solutions were sprayed, Mn concentration decreased to its lowest concentration, suggesting an interaction between Mn and Fe and Mn and Cu. A simple correlation coefficient verified these features where a significant negative correlation coefficients (-0.801* and -0.809*) were found between Mn and Fe and Mn and Cu in the 1st season. Mn content of onion bulbs during the tow seasons (Table 3) took a similar general trend as dry bulbs yield.

Zinc concentration (Table 2) increased to its highest when $ZnSO_4$ was sprayed. Zn concentration decreased with Mn spraying in the 1st season, while during the 2nd season spraying with Fe decreased Zn concentration to its least concentration. The correlation coefficient of Fe and Zn was 0.734*. Zn content (Table 3) of onion bulbs took the similar trend as for bulbs dry weights.

Cupper concentration (Table 2) of the 2nd season of onion bulbs was higher than Cu concentration of onion bulbs of the 1st season. Foliar spraying with B in the 1st season and Fe or Mn in the 2nd season decreased Cu concentration to its lowest concentration. Cu content (Table 3) showed a general trend as in onion bulbs dry weights.

Boron concentration (Table 2) showed the same trend for the two seasons where spraying $CuSO_4$ decreased B concentration to its lowest concentration. Slight antagonistic effects were noticed when $ZnSO_4$ was sprayed. Boron content (Table 3) was not different in onion bulbs during the two seasons. Results of Baza *et al.* (1988) pointed out to such mutual effects especially when one or more of micronutrients was on the threshold of deficiency.

The obtained results showed that for onion cultivated in Middle Egypt Region, foliar spray of Zn as $ZnSO_4$ and B as borax could be useful for increasing onion yield.

Table 3. Means of macro and micronutrient contents of onion bulbs as affected by foliar application of some micronutrients.

Treatment	Macronutrients (%)			Macronutrients (ppm)				
	N	P	K	Fe	Mn	Zn	Cu	B
1995-1996 season								
Control	6.816	2.007	8.863	83.15	81.91	28.54	18.90	43.65
Fe	9.048	2.053	9.700	91.49	82.38	28.77	21.27	47.67
Mn	7.572	1.897	9.332	82.42	82.64	23.78	19.60	46.30
Zn	10.344	1.969	11.609	101.75	102.29	53.99	23.44	52.86
Cu	6.000	1.693	7.981	76.92	70.33	27.01	17.84	38.52
B	8.130	2.122	10.019	115.59	93.11	28.28	20.56	47.86
L.S.D. (0.05)	3.814	N.S.	2.993	7.97	19.14	12.73	3.35	8.91
1996-1997 season								
Control	5.130	1.372	6.224	55.41	55.99	17.96	16.53	35.46
Fe	5.100	1.448	5.912	52.00	56.89	16.19	15.55	32.58
Mn	5.052	1.633	6.506	57.16	61.93	18.22	17.35	37.21
Zn	7.014	1.916	7.925	71.81	74.11	37.66	21.45	44.73
Cu	4.386	1.411	5.685	51.82	56.17	16.00	15.77	30.58
B	6.138	1.761	6.965	63.56	113.66	19.83	20.38	39.92
L.S.D. (0.05)	1.988	N.S.	1.274	18.35	22.31	15.83	4.48	9.01

REFERENCES

1. Abu-Grab, O.S., E.A. El-Kabbany and S.H.H. Kandeel. 1993. Effect of some micronutrients on growth, seed yield, photosynthetic pigments and mineral content of onion. Egypt. J. Appl. Sci. 8 (12): 98-105.

2. Amberger, A. 1979. Foliar application of microntrients, uptake and incorporation. Proc. 2nd Workshop "Micronutrients and Plant Nutrition". NRC, The Acadamy of Scientific Research and Technology in collaboration with the German Culture Institute, Mariut, Egypt. PP 47-60.

3. Amin, M.A.A., M.S.M. Baza, and M.E. Ali. 1988a. Effect of soil application of Fe-EDTA and spraying with some micronutrient solutions on growth, mineral composition and yield of soybean. Annals Agric. Sci., Moshtohor, 26 (2): 1365-1382.

4. Amin, M.A.A., M.S.M. Baza, and F.H. El-Gendy. 1988b. Effects of the number of sprays of some micronutrients on the growth, yield and mineral composition of Broad bean plants. Annals Agric. Sci., Moshtohor, 26 (3): 2007-2021.

5. Badr, M.M.A., M.A.M. Hassan, and Nadia O. Monged. 1991. Effect of nitrogen application and micronutrients on the yield and chemical contents of wheat plants. Zagazing J. Agric. Res. 18 (5): 1661-1668.

6. Baza, M.S.M., M.A.A. Amin, and M.E. Ali. 1988. Effect of soil applied Fe-EDTA in combination with foliar spray of some micronutrients on growth and mineral composition of corn plants. Annals Agric. Sci., Moshtohor, 26 (1): 637-648.

7. Chapman, D.H., and D.F. Pratt. 1961. Methods of Analysis for Soils, Plants and Water. Univ. of California Division of Agric. Sci.

8. Dible, W.T., E. Troug and K.C. Berger. 1954. Boron determination in soil and plant. Anal. Chem., 26 (1): 418-421.

9. El-Hawwary, N.A., M.A. Nofal, K.M. Kalil, and A.H. Firgany. 1993. Response of cotton and onion plants under intercropping system to foliar application of some micronutrient fertilizer. J. Agric. Sci. Mansoura Univ. 18 (10) : 3102-3110.

10. El-Melegy, M.A., M.M. A. Badr, and S.M.M. Allam. 1997. Respónse of chickpea plant to foliar application of some micronutrients and rhizobia inoculation. Al-Azhar J. Agric. Res. 25 (1): 240-249.

11. Jackson, M.L. 1973. Soil Chemical Analysis. Printice Hall of India Ltd. New Delhi.

12. Lindsay, W.L., and W.A. Norvell. 1969. A micronutrient soil test for Zn, Fe, Mn and Cu. Agron. Abst. pp. 84.

13. Sillanpaa, M. 1982. Micronutrients and the nutrient status of soil. A global study. FAO Soil Bull. 48, FAO, Róma, Italy.

14. Steel, R.G.D., and H. Torrie. 1980. Principles and procedures of statistics. Mc Grew Hill Book Co., New York.

15. Thorne, D.W. 1957. Zinc deficiency and its control. Adv. Agron. 9 (1): 31-65.

أستجابة محصول البصل للرش الورقى ببعض العناصر الصغرى

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أقيمت تجربة حقلية بمحطة البحوث الزراعية بسدس، محافظة بنى سويف خلال موسمى ١٩٩٥ – ١٩٩٦ ، ١٩٩٦ – ١٩٩٧ وذلك لدراسة تأثير الرش الورقى بكل من الحديد، المنجنيز ، الزنك، النحاس فى الصورة المعدنية كبريتات وكذا الرش بالبورون فى صورة بوراكس، على محصول البصل والمحتوى الكيماوى له، وأشارت النتائج المتحصل عليها الى ماياتى:-

كان أعلى محصول تحصل عليه عند الرش بكبريتات الزنك يليها معاملة الرش بالبوراكس.

أدت معاملة الرش بكبريتات الحديدوز الى زيادة محصول البصل زيادة غير معنوية خلال الموسم الأول فقط، وكانت نسبة الزيادة فى المحصول ٩,٧٪ بينما أدت نفس المعاملة الى أنخفاض طفيف فى المحصول فى الموسم الثانى.

أدت معاملة الرش بكبريتات المنجنيز الى زيادة غير معنوية فى محصول البصل خلال الموسمين حيث كانت النسبة المئوية للزيادة ٢,٢ ٪ ، ٥,٦٪ على الترتيب.

أدت معاملة الرش بكبريتات النحاس على خفض المحصول خلال الموسمين.

لم تؤدى كل معاملات الرش الى زيادة تركيز العنصر المرشوش فيماعدا معاملة الرش بكبريتات الزنك حيث عملت على زيادة تركيز الزنك الى أعلى تركيز له.

ظهرت بعض التأثيرات المتبادلة للعناصر المختلفة حيث تحصل على معاملات أرتباط مؤكدة بين الفسفور x الزنك (*– ٠,٧٩٢) الحديد x الزنك (*٠,٧٣٤) الحديد x النحاس (*–٠,٨٢٨) والمنجنيز x الحديد (*–٠,٨٠١) وكذا المنجنيز x النحاس (*–٠,٨٠٩).