Response of Wheat to Foliar Spray with Urea and Micronutrients

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Abstract Wheat (*Triticm aestivum* L.) plants were cultivated during two successive seasons (2007/2008 and 2008/2009). The experiments were conducting at Qualubia Governorate, Egypt. The purpose of this study was to investigate the influence of foliar spraying with urea (1%) and different treatment of micronutrients (Fe**,** Zn ,Mn) on growth and chemical constituents of wheat yield . Results showed that additional nitrogen foliar spray (1% urea) gave significant increase in 1000-grain weight, nitrogen concentration and uptake in both grain and straw and protein yield as compared with the control. Results also revealed that spraying wheat plant with (1% urea) showed marked increment in micronutrients concentration and uptake. Concerning the effect of spraying micronutrients foliar spray and the interaction, results showed positive marked effects on all the aforementioned parameters in addition to the significant increment of grain and straw yields. [Journal of American Science 2010;6(9):14-22]. (ISSN: 1545-1003).

Key Words: Wheat plant **–** foliar urea – micronutrients – yield – content - uptake

1. Introduction

Wheat (*Triticm aestivum* L.) considers one of the most important cereal crops in Egypt. The amount needed from it is greater than that locally produced. Therefore, increasing its productivity as well as cultivated area is highly recommended. Plants require specific amount of certain nutrients in specific form at appropriate time, for their growth and development (Sajid *et al*, 2008). It is well documented that the deficiency of micronutrients (Zn, Mn, Fe and Cu) in soils of arid and semi arid regions forms one of the major yield limiting factors and can greatly disturb plant yield and quality. In most of the cultivated areas in Egypt, deficits of micronutrients showed a pattern of Zn ≥ Mn > Fe > Cu (Fawzi and El Fouly, 1999). In such regions, soils are characterized with low organic matter, high pH and high $CaCO_3$ in some cases (El-Fouly, 1983; Amberger, 1991 and Malakouti, 2008). Under such conditions, soil application of micronutrients can be very expensive. Amal *et al*. (2006) reported that as macro and micro-nutrients added to the soil, their availability will be affected by the soil environmental factors. Foliar feeding technique, as a particular way to supply these nutrients could avoid these factors and results in rapid absorption. Foliar feeding of micronutrients generally is more effective and less costly (El-Fouly and El-Sayed, 1997). It is well known that soil application of NPK fertilizers may lead to some losses of these fertilizers. However, application of such macronutrients as foliar spray may decrease such losses. In this connection, El-Fouly and El-Sayed (1995) reported that N-losses from the

recommended N-dose for corn as a summer crop were 50% through leaching and/or denitrification. During the last decades, foliar feeding of nutrients has become an established procedure to increase yield and improve the quality of crop products (Romemheld and El-Fouly, 1999). This procedure can also improve nutrient utilization and lower environmental pollution through reducing the amount of fertilizers added to soil (Abou El-Nour, 2002). On the other hand, foliar feeding of a nutrient may actually promote root absorption of the same nutrient (Oosterhuis, 1998 and Soepardi, 1998) or other nutrients through improving root growth and increasing nutrients uptake (El-Fouly and El-Sayed, 1997). The reported experiment was undertaken to study the effect of foliar application of micronutrients and urea on yield and yield components of bread wheat crop to improve the nutritional status of plants.

2. Material and Methods

Two field trails on bread wheat (*Triticm aestivum*) cv. Giza 168 were preformed during the consecutive winter seasons of (2007/2008 and 2008/2009). In both seasons, the work was conducted on a clay soil located in Qualubia Governorate, Egypt.

Prior to any practices, a composite soil sample was taken from the soil surface (0-30 cm) of the experimental site, air dried, sieved by 2 mm sieve and

analyzed (table 1). The physical and chemical properties of soil were determined according to Chapman and Pratt (1961).The basic NPK fertilization was applied in the whole site as recommended (MoA, 1998). The rates were 75, 15 and 25 kg/fed. as N, P_2O_5 and K_2O in the form of ammonium sulphate (20.5% N), Calcium superphosphate (15.5% P_2O_5) and potassium sulphate (48-50% K_2O); respectively. The amount of calcium superphosphate was broadcasted during land preparation. The amount of ammonium sulphate was applied in three splits, 20% before sowing, 40% before the first irrigation (i.e. 30 days after sowing) and 40% before the second irrigation (i.e. 55 days after sowing). The amount of potassium sulphate was applied in two equal splits, the first at sowing and the second before the first irrigation. Sowing took place on mid-November each season.

Table 1 Some characteristics of the experimental site (Qualubia Governorate) in two seasons

Physical properties	1st season (2006/2007)			2nd season(2008/2009)		
	Sand %	**Silt %**	**Clay %**	**Sand %**	**Silt %**	**Clay %**
	14.1	**28.9**	**57.0**	**13.2**	**27.8**	**59.0**
Texture		**Clay**			**Clay**	
Chemical properties	**Value**					
pH	**8.20**			**7.97**		
EC dS/m	**0.66**			**0.59**		
% Calcium Carbonate	**2.80**			**3.11**		
% Organic matter	**1.40**			**1.60**		
Available elements (ppm)						
N	**106**			**110**		
P	**2.11**			**2.15**		
K	**26.3**			**25.4**		
Ca	**196.1**			**220.2**		
Mg	**55.2**			**60.4**		
Fe	**9.40**			**8.90**		
Mn	**6.50**			**7.20**		
Zn	**1.10**			**0.90**		
Cu	**1.30**			**1.50**		

Treatments and experimental design

The experiment includes two nitrogen and eight micronutrient treatments which were as the following:-

I- Nitrogen Treatments:

- Spraying plants with tap-water (Control)
- Spraying plants with 1% urea

Treatments applied twice, the first at 45 days after sowing (i.e. during tillering stage), followed by the second at 15 days later (i.e. before heading stage).

II- Micronutrient treatments:

- Spraying plants with tap-water (Control)
- Spraying plants with 1.6 kg Fe SO_4 (Fe)
- Spraying plants with 0.72 kg Zn SO_4 (Zn)
- Spraying plants with 2.4 kg Mn SO_4 (Mn)
- Spraying plants with (Fe + Mn)
- Spraying plants with (Fe + Zn)
- Spraying plants with (Zn + Mn)
- Spraying plants with (Fe + Zn + Mn)

Micronutrient treatments were applied after 45 days after sowing. Treatments were carried out using tap-water (250 l/fed./spray). Treatments were arranged as split plots in a randomized complete block design (RCBD), where, nitrogen treatments occupied the main blocks and micronutrient treatments were allocated at random in the sub-blocks (Snedecor and Cochran, 1967), with three replicates ; each of 18 m^2 (3 x 6m).

Plant samples and analysis

After complete maturity, the plant were harvested and separated into grain and straw. Production were recorded and prepared for analysis. Samples were digested with acid mixture. Total N was determined according to the method described by Cottonie *et al* (1982). Zinc, manganese, iron content were determined using atomic absorption spectrophotometer to method described by Cottonie *et al* (1982)

Parameters measured

1. Grain yield ton/fed.
2. Straw yield ton/fed.
3. 1000 grain weight g
4. Biological yield ton/fed.

Statistical analysis

Obtained results were subjected to statistical analysis of variance according to the method described by Snedecor and Cochran (1980) and the combined analysis of the two seasons calculated according to the method of Stell and Torrie (1980).

3. Results

Effect of foliar urea and micronutrients fertilizers on yield

Grain yield

It is quite clear from the data presented in table 2 that additional nitrogen foliar spray (1% urea) increased grain yield by 4%, but the resulted increment did not reach to the level of significance. While, spraying wheat plants with micronutrients either as a single nutrient or as the possible combinations markedly increased grain yield. The increment ranged between 24-38% as compared with control treatment. The lowest increment (24%) resulted from spraying Fe +Zn and the highest increment value (38%) was obtained from spraying Fe + Zn +Mn. It is also noticed that spraying wheat plants with Mn + Fe gave nearly the same highest grain yield.

Concerning the interaction effect between spraying additional nitrogen and micronutrients, results revealed marked positive effect. Spraying manganese in combination with spraying 1% urea gave the highest grain yield (2.98 ton/fed.) as compared with the other treatments.

Straw yield

Data presented in table 2 show that no marked effect on straw yield of bread wheat due to spraying additional nitrogen. However, spraying micronutrients as a single nutrient did not affect significantly wheat straw yield as compared with control treatment except in case of spraying plants with zinc. On the other hand, the possible combinations of these three nutrients significantly increased wheat straw yield. Moreover, marked interaction positive effect on straw yield was obtained. Spraying additional nitrogen or not in combination with spraying mixture of Fe, Zn and Mn showed the highest straw yield as compared with the other interaction treatments.

1000 grain weight

Table 2 shows the effect of additional nitrogen and micronutrients foliar spray as well as their interaction on 1000-grain weight in grams. Results revealed that the thousand-grain weight significantly increased by 4% due to the additional nitrogen foliar spray. On the other hand, marked increments in this parameter were observed due to micronutrient treatments. The highest increment (16%) was obtained when plants sprayed with micronutrients mixture (Fe + Zn + Mn) as compared with control treatment.

Table 2 Effect of additional nitrogen (NFS) and micronutrients foliar spray (MN) as well as their interaction on wheat grain and straw yields and 1000-grain weight (average of two seasons).

	Grain yield ton/fed.			Straw yield ton/fed.			1000 grain weight g		
Treatments	Control (without)	N FS (With)	Mean	Control (without)	N FS (With)	Mean	Control (without)	N FS (With)	Mean
Control	1.98	2.01	2.00	4.22	4.45	4.34	40.79	42.16	41.48
Fe	2.31	2.64	2.48	4.40	4.80	4.60	43.32	45.02	44.17
Mn	2.34	2.98	2.66	4.33	4.70	4.52	45.17	47.33	46.25
Zn	2.42	2.85	2.64	4.43	5.10	4.77	45.36	47.80	46.58
Fe+Mn	2.65	2.80	2.73	5.70	5.46	5.58	46.07	48.10	47.09
Fe+Zn	2.32	2.60	2.46	4.36	5.53	4.95	43.60	45.72	44.66
Mn+Zn	2.44	2.61	2.53	5.61	5.63	5.62	44.38	46.10	45.24
Fe+Mn+Zn	2.60	2.89	2.75	5.81	5.81	5.81	46.93	49.00	47.97
X	2.57	2.67		4.86	5.21		44.45	46.40	
LSD 5%									
N			n.s.			n.s.			1.19
MN*			0.18			0.49			3.85
N X MN			0.26			0.69			5.45

NFS: nitrogen fertilizer spray.

The other micronutrient treatments gave also marked increases in 1000-grain weight ranged from 6 to 14%

by Fe foliar spray and Fe + Mn treatment, respectively. The interaction effect between the additional nitrogen and micronutrient foliar spray treatments found to have significant positive effect on 1000-grain weight. Spraying wheat plants with 1% urea in combination with micronutrient mixture (Fe + Zn + Mn) showed the highest 1000-grain weight (49.00 g) and the lowest value (40.79 g) was obtained from control plants.

Biological yield ton/fed.

Data illustrated in Fig. 1 show that significant increase in biological yield of bread wheat was recorded due to spraying the plants with the additional N (1%urea). The recorded increment reached to 9% as compared with control plants.

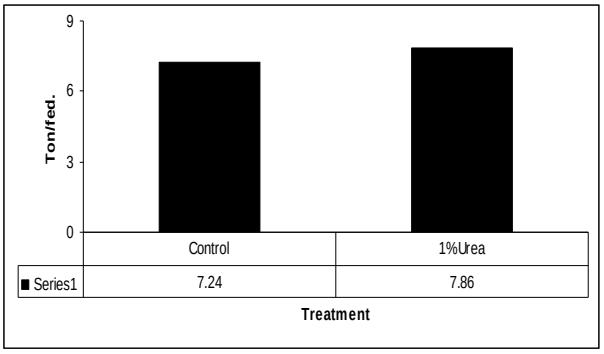

Fig. 1: Effect of additional nitrogen foliar spray (1% urea) on biological yield ton/fed. of bread wheat.

Spraying bread wheat with iron, zinc and manganese individually or in combination Fig. 2 resulted in marked increments in biological yield. Biological yield increases ranged between 12 and 35% over control treatment. The lowest increment (12%) resulted from spraying plants with iron, whereas, the highest (35%) was obtained from spraying the plants with the mixture of the three nutrients (Fe + Zn + Mn).

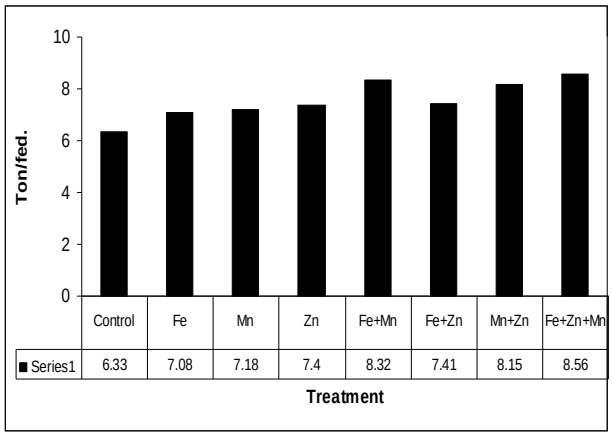

Fig. 2: Effect of micronutrients foliar spray on biological yield ton/fed. of bread wheat.

Concerning the interaction effect between spraying plants with additional N and micronutrients, data revealed that spraying wheat plants with 1% urea and micronutrient mixture of the three nutrients (Fe + Zn + Mn) gave the highest biological yield as compared with the other interaction treatments (Fig. 3).

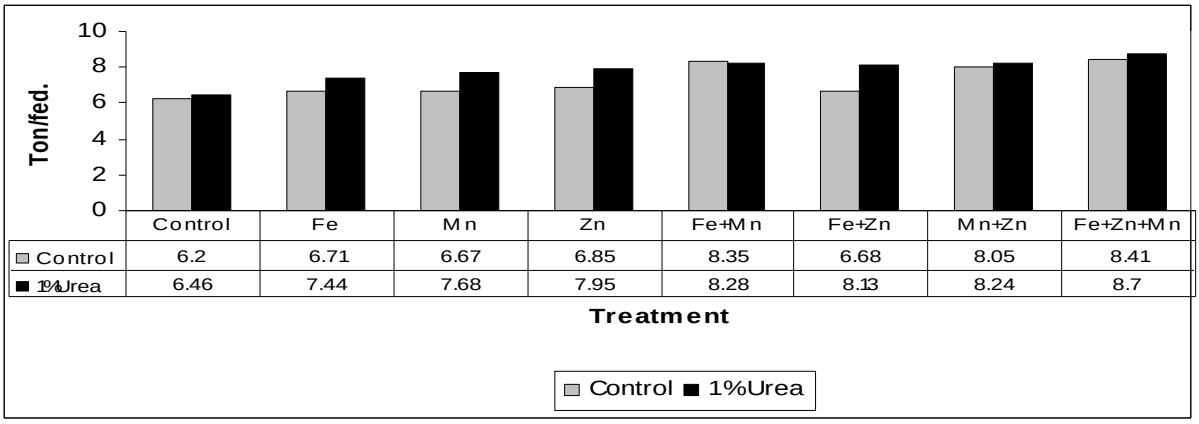

Fig. 3: Effect of interaction effect between spraying bread wheat with 1%urea and micronutrients on biological yield ton/fed.

Effect of foliar urea and micronutrients fertilizers on chemical composition:

Grain nitrogen content and uptake

Data in table 3 revealed that spraying wheat plants with 1% urea increased nitrogen concentration as well as protein percentage of grains by 23% as

compared with control plants. However, spraying plants with micro-nutrients either as a single nutrient or as possible combinations increased grain nitrogen concentration and consequently, protein percentage as compared with control plants. The highest values were obtained from plants sprayed with Zn + Mn, where the increment reached to 27% over control plants. The interaction between spraying plants with 1% urea and micronutrients showed also marked positive effect in increasing nitrogen and protein percentage in wheat grains. The highest value resulted from spraying plants with 1% urea in combination with spraying either Mn alone or Mn + Zn (2.44% N and 15.25 % protein).

Data recorded in table 3 showed that spraying wheat plants with 1% urea resulted in increasing grain nitrogen uptake by about 39% as compared with the untreated plants. Meanwhile, spraying plants with the different micronutrient treatments resulted in marked increases in grain nitrogen uptake. The increments ranged between 50 – 73 % in comparison with control plants. The highest value was obtained as a result of spraying plants with Fe + Zn + Mn (60.32 kg/fed.) while, the lowest value was due to spraying the plants with Fe as a single micronutrient.

The interaction between spraying plants with 1% urea and micronutrients showed positive effect in increasing grain- nitrogen uptake. Spraying wheat plants with 1% urea in combination with spraying the plants with Mn gave the highest grain-nitrogen uptake (72.71 kg/fed.).

Table 3: Effect of spraying bread wheat either with 1% urea or micronutrients as well as their interaction on nitrogen concentration and uptake, protein percentage and protein yield of wheat grain

Treatment	N concentration (%)			N uptake kg/fed.			Protein concentration (%)			Protein yield kg/fed.		
	control	NFS	X	control	NFS	X	control	NFS	X	control	NFS	X
Control	1.64	1.86	1.75	32.47	37.39	34.93	10.25	11.63	10.94	203.0	233.8	218.2
Fe	1.88	2.32	2.10	43.43	61.25	52.34	11.75	14.50	13.13	271.4	382.8	327.1
Mn	1.82	2.44	2.13	42.59	72.71	57.65	11.38	15.25	13.32	266.3	354.5	360.4
Zn	1.98	2.35	2.17	47.92	66.98	57.45	12.38	14.69	13.54	299.6	416.7	359.2
Fe+Mn	1.80	2.31	2.06	47.70	64.68	56.19	11.25	14.44	12.85	298.1	404.3	351.2
Fe+Zn	1.98	2.40	2.19	45.94	62.40	54.17	12.38	15.00	13.69	287.2	390.0	338.6
Zn +Mn	2.01	2.44	2.23	49.04	63.68	56.36	12.56	15.25	13.91	306.5	398.0	352.2
Fe+Mn+Zn	1.95	2.42	2.19	50.70	69.94	60.32	12.19	15.13	13.66	316.7	337.3	377.1
X	1.88	2.32		44.97	62.38		11.77	14.49		281.1	389.9	

Grain- protein yield kg/fed

Remarkable increases in protein yield kg/fed. due to spraying wheat plants with 1% urea were noticed (table 3). The increment reached to 39% over control treatment. Remarkable increases were also obtained due to spraying the plants with the different micronutrient treatments. The highest protein yield (377.1 kg/fed.) resulted from spraying plants with Fe + Zn + Mn, while, the lowest (327.1 kg/fed.) was obtained from spraying plants with Fe. Concerning the interaction between spraying wheat plants with 1% urea and micronutrients, data in table 3 showed remarkable differences. Spraying plants with 1% urea in combination with Zn gave the highest protein yield in comparison with the other combinations.

Straw nitrogen content and uptake

Data in table 4 reveal that spraying wheat plants with 1% urea increased straw –N concentration by 14% over control plants. However, spraying plants with micronutrients individually or in combination resulted in increments in straw-N concentration. The increments ranged between 6- 26% by Fe and Fe + Zn; respectively.

Combination between spraying wheat plants with 1% urea and Fe +Zn showed the highest straw-N concentration.

It is also noticed from the data presented in table 4 that spraying plants with 1% urea gave 20 %

increase over control treatment in straw-N uptake. However, spraying plants with micronutrients showed 14 - 66% increase over control treatment in N uptake measured in wheat straw by spraying plants with Fe and Fe + Mn + Zn; respectively.

Table 4: Effect of additional nitrogen and micronutrients foliar spray as well as their interaction on nitrogen concentration and uptake of wheat straw

Treatment	N concentration (%)			N uptake kg/fed.		
	control	NFS	X	control	NFS	X
Control	**0.43**	**0.51**	**0.47**	**18.15**	**22.69**	**20.43**
Fe	**0.48**	**0.53**	**0.50**	**21.12**	**25.44**	**23.28**
Mn	**0.50**	**0.56**	**0.53**	**21.65**	**26.32**	**23.99**
Zn	**0.51**	**0.57**	**0.54**	**22.59**	**29.07**	**25.83**
Fe+Mn	**0.53**	**0.59**	**0.65**	**30.21**	**32.21**	**31.21**
Fe+Zn	**0.55**	**0.63**	**0.59**	**23.98**	**34.84**	**29.41**
Zn +Mn	**0.53**	**0.61**	**0.57**	**29.73**	**34.34**	**32.04**
Fe+Mn+Zn	**0.57**	**0.60**	**0.58**	**33.11**	**34.86**	**33.99**
X	**0.51**	**0.58**		**25.07**	**29.97**	

Moreover, Combination between spraying 1% urea and Fe + Mn + Zn gave the highest N-uptake value.

Grain-micronutrient concentrations and uptake

Table (5) shows that spraying plants with 1% urea increased Fe, Zn and Mn concentrations by 3 , 7 and 9% ,respectively. However, spraying with micronutrients showed increases in grain-micronutrients concentrations (Fe, Zn and Mn) as compared with control treatment. The increment of grain-Fe concentration ranged between 8-37% where, the lowest value recorded as a result of spraying the plants with Zn + Mn, while, the highest value recorded when plants was sprayed with Fe. On the other hand, the increment in grain-Zn concentration ranged between 23-50%, by Fe + Mn and Zn foliar spray; respectively. The increment in grain-Mn concentration ranged between 18-43%.

Table 5: Effect of additional nitrogen (NFS) and micronutrients foliar spray (MN) as well as their interaction on wheat grain micronutrients concentration (ppm)

Treatments	Iron (ppm)			Zinc (ppm)			Manganese (ppm)		
	control	N FS	X	control	N FS	X	control	N FS	X
Control	69	77	**73**	21	23	**22**	26	30	**28**
Fe	98	102	**100**	29	32	**31**	36	38	**37**
Mn	83	83	**83**	30	31	**31**	39	41	**40**
Zn	90	94	**92**	33	33	**33**	35	45	**40**
Fe+Mn	91	98	**95**	29	27	**27**	37	38	**38**
Fe+Zn	95	97	**96**	26	28	**29**	30	36	**33**
Mn+Zn	77	80	**79**	25	29	**27**	38	40	**39**
Fe+Mn+Zn	85	78	**82**	24	27	**29**	35	37	**36**
X	**86**	**89**		**27**	**29**		**35**	**38**	

The highest value was obtained as a result of spraying wheat plants with Mn or Zn. The lowest value was due to spraying wheat plants with Fe+ Zn treatment. Data also show that spraying wheat plants with 1% urea in combination with Fe +Mn gave the highest iron concentration.

Concerning the interaction effect, it is quite clear that spraying plants with 1% urea in combination with Fe gave the highest grain-iron concentration. On the other hand, spraying plants with 1% urea in combination with zinc showed the highest grain zinc and manganese concentrations.

Table (6): Effect of additional nitrogen (NFS) and micronutrients foliar spray (MN) as well as their interaction on wheat grain micronutrients uptake (g/fed.)

Treatments	Iron (g/fed.)			Zinc (g/fed.)			Manganese (g/fed.)		
	control	N FS	X	control	N FS	X	control	N FS	X
Control	137	155	**146**	42	46	**44**	51	60	**56**
Fe	226	269	**248**	67	84	**76**	83	100	**92**
Mn	194	247	**221**	70	92	**81**	91	122	**107**
Zn	218	268	**243**	80	94	**87**	85	128	**107**
Fe+Mn	241	271	**258**	77	70	**74**	98	106	**102**
Fe+Zn	220	252	**236**	60	81	**71**	70	94	**82**
Mn+Zn	188	210	**199**	61	73	**67**	93	104	**99**
Fe+Mn+Zn	221	225	**223**	62	95	**79**	91	107	**99**
X	**206**	**237**		**65**	**82**		**83**	**103**	

Data presented in table 6 show that spraying plants with 1% urea increased grain-Fe, Zn and Mn uptake by 15%, 26 and 24% over control treatment; respectively. However, spraying plants with micronutrient treatments resulted in great increments in grain- iron, Zn and Mn uptake. The highest increment in the uptake of Fe was obtained as a result of spraying wheat plants with Fe + Mn treatmrnt. On the other hand, spraying plants with Zn treatment showed the highest grain Zn and Mn uptake. Concerning the interaction, it was found that spraying plants with 1% urea in combination with spraying Zn nearly showed the highest grain-Fe, Zn and Mn uptake as compared with the other combinations.

Straw-micronutrient concentrations and uptake

Table 7 shows that spraying plants with 1% urea gave 6, 14 and 5% increase over control treatment for Fe , Zn and Mn ; respectively. However, spraying wheat plants with micronutrients resulted in increasing micronutrient concentrations as compared with control plants. It is also interesting to note that spraying plants with a nutrient usually increase its concentration. Concerning the interaction effect, it is quite clear that spraying 1% urea in combination with Fe , Mn + Zn and Fe + Mn gave the highest Fe , Zn and Mn concentrations; respectively.

Data presented in table 8 reveal that spraying plants with 1% urea gave 13, 20 and 12% increase over control treatment for straw- Fe , Zn and Mn uptake ; respectively.

Table (7): Effect of additional nitrogen (NFS) and micronutrients foliar spray (MN) as well as their interaction on wheat straw micronutrient concentration (ppm)

Treatments	Iron (ppm)			Zinc (ppm)			Manganese (ppm)		
	control	N FS	X	control	N FS	X	control	N FS	X
Control	146	153	**150**	30	33	**32**	40	44	**42**
Fe	241	264	**253**	37	48	**43**	64	68	**66**
Mn	198	210	**204**	46	51	**49**	75	65	**70**
Zn	186	23	**195**	55	62	**59**	45	56	**51**
Fe+Mn	212	210	**211**	45	47	**46**	70	85	**78**
Fe+Zn	206	223	**215**	42	44	**43**	79	52	**66**
Mn+Zn	163	180	**172**	52	65	**59**	67	83	**75**
Fe+Mn+Zn	214	219	**217**	48	50	**49**	56	64	**60**
X	**196**	**208**		**44**	**50**		**62**	**65**	

While, spraying wheat plants with micronutrients resulted in increasing straw- micronutrients uptake as compared with control plants. The highest increment in Fe-uptake was obtained as a result of spraying wheat plants with Fe + Mn + Zn treatment. Whereas,

spraying plants with Mn + Zn treatment gave the highest Zn uptake. Moreover, the highest straw-Mn uptake obtained from spraying plants with Fe + Mn treatment.

Table (8): Effect of additional nitrogen (NFS) and micronutrients foliar spray (MN) as well as their interaction on wheat straw micronutrient uptake (g/fed.)

Treatments	Iron (g/fed.)			Zinc (g/fed.)			Manganese (g/fed.)		
	control	N FS	X	control	N FS	X	control	N FS	X
Control	616	681	**649**	127	147	**137**	169	196	**183**
Fe	1062	1267	**1164**	162	230	**196**	284	326	**305**
Mn	857	987	**922**	199	240	**220**	325	306	**316**
Zn	824	1035	**930**	244	316	**280**	199	287	**243**
Fe+Mn	1208	1147	**1178**	257	257	**257**	399	464	**432**
Fe+Zn	898	1233	**1066**	183	243	**213**	344	288	**316**
Mn+Zn	914	1013	**964**	292	366	**329**	376	467	**422**
Fe+Mn+Zn	1243	1272	**1258**	279	291	**285**	325	372	**349**
X	**953**	**1079**		**218**	**261**		**303**	**338**	

It is also clear from table 8 that spraying plants with 1% urea in combination with Fe + Mn + Zn Gave the highest straw-Fe uptake. However, spraying plants with 1% urea in combination with Mn + Zn Gave the highest straw-Zn and Mn uptake.

4. Discussion

In both seasons, the data in table 1 show that the soil experimental clay soil was of high pH, medium $CaCO_3$ and organic matter, and very low E.C., reflecting no salinity problems. Available nutrient contents were high for Ca and Cu; medium for P, K, Mg and low in Fe, Zn and Mn (Ankerman and Large, 1974). Low available Fe, Zn and Mn might be due to the high soil pH (Amberger, 1991). Zinc is increasingly the most commonly micronutrient in many regions (IFDC, 1996). Generally, similar soil characteristics were found to be prevailing in wheat and maize fields of the Nile-Valley and Delta (Sillanpää. 1982).

Results of this experiments revealed that spraying wheat plants with 1% urea increased grain and straw yields; grain-weight; biological yield; grain micronutrients concentration and uptake as well as grain-protein yield. This is may be due to the stimulating effect of urea through improving the physiological performance of plants and multiple advantage of foliar application method such rapid and efficient response to plant needs, less product needed and independence of soil conditions (Yildirim *et al*., 2007). Similar results were observed by Mailto *et al.*, (2006) who reported that wheat grain and straw yields were significantly increased by the integral application of urea through broadcasting and foliar spray over soil application alone. It is also recognized that supplementary foliar fertilization during crop growth improves the mineral status of plants and increase the crop yield (Mosluh *et al*., 1978, and Kolota and Osinska, 2006).

Concerning the effect of micronutrients foliar spray on the aforementioned parameters studied in this experiments, the positive marked increases could be due to maintain balanced plant physiology as mentioned in several research studies on their reaction and disturbances caused by their deficiency (Malakouti, 2008). In line of these results Römheld and El-Fouly (1999) also reported that the efficiency of foliar feeding is higher than of soil fertilization, one reason is because of the supply of the required nutrient goes directly to the location of the high demand in the leaves and its relatively quick absorption. They stated that the time of 50% absorption of nitrogen as urea is 1/2 -2 hours and 1-2 days for both Zn and Mn. It is well known that micronutrients are essential elements for life, even though they are present in small amount in plant. They activate some 100 enzymes in various plants (Mingle, 1974).For example, the relationship between the presence of enough zinc and the production of carbonic anhydrase enzyme (Abou El-Nour, 2002). Carbonic anhydrsae have an important role in photosynthesis. In line of this fact, Mengle, 1974 mentioned that the compound being accepted by ribulose-diphosphate is bicarbonate and not CO_2, and it is presumed that green plant cells are able to convert CO_2 very quickly into HCO_3 and vice versa by means of carbonic anhydrase. The positive marked effect of spraying micronutrient on the studied parameters may also be due to the stimulating effect of these nutrients on root growth and nutrient uptake by root as reported by Abdalla and Mobarak, 1992. It is also noticed that Foliar feeding of nutrient may

actually promote root absorption of the same nutrient, similar results were obtained by Oosterhuis, 1998.

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5. References:

1. Abou El-Nour E.A.A. (2002) Can supplemented potassium foliar feeding reduce the recommended soil potassium?. Pakistan Journal of Biological Science, 5 (3):259-262
2. Abdalla F.E. and Moubarak Z.M. (1992) Shoot intake of nutrients from micronutrient fertilizers formulation in faba bean. Afric. J. Agric. Sci. 19: 147-160.
3. Amberger A (1991) Importance of micronutrients for crop production under semi-arid conditions of Northern Africa and Middle East. Proc 4th Micronutrients Workshop, 18-22 Feb. 1989, Amman- Jordan, M.M. El-Fouly and A.F.A. Fawzi (eds.), NRC, Cairo: 5-30
4. Ankerman D. and Large R. (1974) Soil and Plant Analysis. A & L Agricultural Laborratories, Inc. USA:42-44
5. Chapman HD, Pratt PF. (1961) Methods of Analysis for Soils, Plant and Waters. Univ. of California, Dept of Agric. Sci., USA: 5-6 and 56-58
6. Cottenie A.M., Verloo L., Kiekens G.V. and Camerlynck R. (1982) Chemical Analysis of Plant and Soil. PP. 100 – 129. Laboratory of Analytical and Agrochemistry, State Univ. Ghent. Belgium.
7. El-Fouly M.M. (1983) Micronutrients in arid and semi arid areas: Level in soils and plants and the need for fertilizers with reference to Egypt. Proc. 17th colloquium of the International Potash Institute (IPI), Bern, Switzerland: 163-173
8. El-Fouly M.M. and El-Sayed A.A. (1997) Foliar fertilization: An environmentally friendly application of fertilizers. Dahlia Greidinger International Symposium on "Fertilization and Environment" 24-27 March, Haifa, Israel, John, I. (ed.):346-357
9. IFDC (1996) The bases of zinc in crop production. Technical Bulletin T-43, International Fertilizer Development Centre (IFDC), Muscle Shoals, Alabama, USA
10. Kolota E. and Osinska M. (2001) Efficiency of foliar nutrition of field vegetables grown at different nitrogen rates. In: Proc. IC Environ. Probl. N-Fert. Acta Hort.,563: 87-91
11. Malakouti M.J. (2008) The Effect of micronutrients in ensuring efficient use of macronutrients. Turk. J. For., 32: 215-220
12. Matilo A., Hassan Z.U., Shah A.N. and Khan H. (2006) Growth, yield and nutrient uptake of wheat (*Triticum eastivum* L.) in relation to foliar and soil application of urea. Int. J. Agri. Biol., 8 (4):477-481
13. Mengel K. (1974) Plant ionic status. The Plant Root and Its Environment, Ed. Carson, E.W. ,Univ. Press of Virginia Charlottesville: 63-81
14. MoA (1998) Wheat cultivation in the old lands (Valley soils). Technical pamphlet no. 417/1998, Central Administration for Agricultural Extension, Agricultural Research Center, Ministry of Agriculture (MoA)-Egypt. P. 28 (in Arabic)
15. Mosluh K.I. , Jagdish S. and Rashid A.K. (1978) Efficiency of urea spray for wheat crop under irrigated conditions in Iraq. Plant and Soil, 49: 175-178
16. Oosterhuis D.M. (1998) Foliar fertilization of cotton with potassium in the USA. Proc. Symp. "Foliar Fertilization: A Technique to Improve Production and Decrease Pollution" 10-14 Dec. 1995, Cairo, Eds. El-Fouly et al.: 49-64
17. Röemheld V. and El-Fouly M.M. (1999) Foliar nutrient application: Challenge and limits in crop production. Proc. 2nd International Workshop on " Foliar Fertilization" April 4-10 Bangkok, Thailand: 1-32
18. Sajid A., Khan A.R. , Mairaj G. , Fida M. and Bibi S. (2008) Assessment of different crop nutrient management practices for yield improvement. Australian J. of Crop Sciense, 2 (3): 150-157
19. Sillanpää M. (1982) Micronutrients and the nutrient status of soils: A Globle Study. FAO Soil Bulletin 48, Food and Agriculture Organization (FAO), Rome. The Near East, Egypt: 289-298
20. Soepardi G. (1998) Fosfo N: high concentrated N and P foliar fertilizer. Proc. Symp. " Foliar Fertilization: A Technique to Improve Production and Decrease Pollution" 10-14 Dec. 1995, Cairo, Eds. El-Fouly *et al*.: 41-48
21. Yildirim E., Guvenc M., Turan M. and Karatas A. (2007) Effect of foliar urea application on quality, growth, mineral uptake and yield of broccoli (*Brassica oleracea* L. var. italica). Plant Soil Environ, 53 (3): 120-128

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