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EFFECT OF MINERAL FERTILIZATION AND FOLIAR FEEDING WITH MICRONUTRIENTS APPLICATION ON GROWTH, YIELD AND ELEMENTAL COMPOSITION OF WHEAT PLANTS IN SANDY SOILS

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ABSTRACT

Two field experiments were conducted at Ismailia Agricultural Experimental Station throughout two seasons of 2001/2002 and 2002/2003 to study the effect of N, P, K fertilization combined with some micronutrients foliar sprayed (Fe, Mn and Zn) on growth, yield and mineral composition of wheat plants in sandy soils under the sprinker irrigation involving 8 treatments in each season. Each treatment was replicated three times.

The obtained results could be summarized as follows:

1- The mineral fertilizer recommended dose (N, P and K) combined with micronutrients foliary feeded (Fe, Mn and Zn) gaven highly significant increase for each of plant height, leaf areas, spike length, weight of 100-grain, grain and straw yields comparisonable with control and also treatment of NPK fertilization recommended. Thus the NPK fertilization recommended combined with micronutrients foliary (Fe, Mn and Zn) was the best treatment for the previous parameters over all the studied treatments.

2- The fertilizer recommended combined with some micronutrients foliar sprayed of Fe, Mn and Zn were gave significantly increases for N, P and K uptake in grain and straw over the control and also over the NPK fertilization dose. However, the superiority was achieved as a result of NPK fertilization recommended combined with micronutrients foliary application of Fe, Mn and Zn treatment as compared to the other treatments.

3- The % total recovery of N, P and K uptake was increased as a result of NPK fertilization recommended combined with foliar sprayed of Fe, Mn and Zn while, the low % total recovery was recorded using NPK fertilization recommended individually.

4- The treatments of N, P and K combined with micronutrients foliar feeded Fe, Mn and Zn gave a significant increase for Fe, Mn and Zn uptake in grain and straw over control and also over the mineral fertilizer treatment individually. The superiority was for NPK fertilization recommended combined with foliar sprayed micronutrients of Fe, Mn and Zn treatment over the other treatments.

5- This study under the experimental conditions suggested that the NPK fertilization recommended combined with micronutrients foliar sprayed of Fe, Mn and Zn treatment for wheat plant be the best for gaining the maximum growth and yield.

INTRODUCTION

Wheat (*Triticum aestivum*, L.) is one of the main cereal crops, all over the world and one of the most important winter crop in Egypt. Wheat yield could be increased under the optimal seeding, NPK fertilizations and using the improved high yield varieties. Many problems can face the production of wheat in newly cultivated sand soil like unfilling spikes, fertility of sandy soil, high loss of elements by leaching and its low field capacity.

Nitrogen, phosphorus and potassium are the major nutrient elements which play an essential role in increasing wheat production (Pradkan *et al.*, 1995). The level of each element differs from one location to another according to the soil fertility (Chougule *et al.*, 1993). The balance between these elements is critical for crop production because every element affects the uptake of others, since Grune (1959) reported that phosphorus absorption is a common consequence of adding nitrogen fertilizer. Also, the balance between these nutrient elements can change the physiology of the plant.

Foliar feeding is a technique as a practical way to supply rapidly micronutrients absorption. Othman (1989) found that foliar applications of micronutrients under NPK levels fertilization, significantly reduced dry matter stems and leaves at flowering stage of broad bean plants. Kamh *et al.* (1996) working on wheat fertilized with N, P, K and different micronutrients reported that, the grain at El-Khataba was highest with N, P and K fertilizers, with no significant difference between the two nitrogen rates. In Sinai, the highest yields were given by 60 kg N fed^{-1} with P, K and Mn applied either by soil or foliar application.

The objective of these research is to study the effect of mineral fertilization and foliar application of some micronutrients on growth, yield and mineral composition of wheat plants in sandy soil under sprinker irrigation system.

MATERIALS AND METHODS

A field experiment was established to fulfill the objectives of the present work as follows:

Location: At Ismailia Agricultural Experimental Station.

Soil: Representative surface soil samples (0:30 cm) were taken before performance of the experiment where some characteristics of the investigated soil samples were determined according to Black (1965) and Page (1982) as indicated in Table 1.

Table 1: Particle size distribution (%) and chemical properties of the soil in the experimental site.

pH[1]	E.C[2] ($dS.m^{-1}$)	Cations mel^{-1}				Anions mel^{-1}			
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	Cl^{-}	SO_4^{--}
7.8	1.62	4.56	2.60	3.07	0.36	-	6.6	12.83	1.16

Av. N[3] (ppm)	Av. P[4] (ppm)	Av. K[5] (ppm	Av. Zn[6] (ppm)	Av. Mn (ppm)	Av. Fe (ppm)	Av. Cu (ppm)
12.0	4.0	34.0	0.63	1.60	4.00	0.26

Coarse sand %	Fine sand %	Silt %	Clay %	O : M %	$CaCO_3$ %	Soil texture
80	16	2	2	0.23	1.50	Sandy soil

1- 1:25 suspension **2- 1: 5 Extract**
3- extracted by 1 % K_2SO_4 **4- extracted by 1M sodium bicarbonate.**
5- extracted by 1M ammonium acetate. **6- extracted by DTPA.**

Studied crop: Wheat (*Triticum aestivum*, L.) "Sakha 69" was obtained from Agric. Res. Center. The planting date was 20th and 25th of November in the two seasons 2001/2002 and 2002/2003, respectively.

Experimental plot: 3 x 4 m

Experimental treatments: The experiment was carried out in a randomized complete block design involving 8 treatments. Each treatment was replicated three times. The detailed experimental treatments were as follows:

1- Control treatment without any additions.
2- Recommended dose of nitrogen only.
3- Recommended dose of nitrogen and phosphorus.
4- Recommended dose of N, P and K.
5- Recommended dose of N, P, K and Zn foliary.
6- Recommended dose of N, P, K and Mn foliary.
7- Recommended dose of N, P, K and Fe foliary.
8- Recommended dose of N, P, K with Zn, Mn and Fe foliary.

The nitrogen was added with 120 kg N fed^{-1} on five doses as ammonium sulfate (20.6 % N), the phosphorus with 30 kg P_2O_5 fed^{-1} as one dose in the form of calcium superphosphate (15 % P_2O_5) and 50 kg K_2O fed^{-1} in one dose as potassium sulphate (48 % K_2O), while, foliar feeding with the micronutrients was performed after 30 and 60 days from planting as Mn and zinc sulphate, whereas Fe as chelated (Fe EDTA) with 0.5 g/litre. Foliar application were done after 45 days from sowing, the foliary replicated 4 times with intervals 15 days.

At harvest was estimated the following characters:

1- Plant height (cm).
2- Leaf area (cm^2).
3- Spike length (cm).
4- Weight of 1000-grain (g).
5- Weight of grains (kg fed^{-1}).
6- Weight of straw (kg fed^{-1}).
7- N, P and K uptake (kg fed^{-1}).
8- Zn, Mn and Fe uptake (g fed^{-1}).
9- Total recovery percentage for elements was calculated according to Mikkelson (1987) in grain and straw

$$= \frac{\text{element uptake (fertilizer plant)} - \text{element uptake (control)}}{\text{applied element - rate}} \times 100$$

Samples of grain and straw were oven dried, weighed and ground. N, P, K, Zn, Mn and Fe contents in plant materials were determined according to the methods mentioned by Jackson (1973).

Statistical analysis: the randomized complete block design was adopted and analyzed according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Growth and yield components:

The data in Table 2 show significant differences among the studied parameters (plant height, leaf area, spike length, weight of 1000-grain, grain and straw yields). The results revealed that, the superiority was for (NPK Recom. + Fe, Zn and Mn) treatment over the other treatments and gave the greater percentages over the control by (23.95, 58.64, 43.35, 64.01,162.61 and 90.44) respectively for the previous parameters, calculated as an average in both seasons. Meanwhile, this treatment shows percent increasing over

(NPK Rec.) treatment, by 14.24, 30.57, 16.24, 46.18, 96.36 and 43.06 %) respectively for the studied parameters, calculated as an average in both seasons. The NPK Rec. treatment showing increases percentage over the control for the previous studied parameters were 8.53, 21.50, 23.33, 12.27, 33.75 and 33.07%. These results reveal that, fertilization with (NPK Rec. combined with foliar spray with Fe, Zn Mn) treatment helps the plants to develop, giving more growth and more yield and was encourage micronutrient uptaking directly through foliages due to difficulties of uptaking from soil. This finding is consistent with Arafa and Abdel-Nour (1986) and also Sharshar *et al.* (2000).

Macronutrients uptake & % of total recovery:

Data in Table 3 show significant increases among studied parameters (N, K, P uptake and % of total recovery).

It is clear that, the (NPK Rec. combined with Fe, Zn and Mn) treatment show the superiority over the other treatments and the percent increases over control were (236.49, 574.17, 441.98, 535.95, 161.77 and 433.58 %) for N, P and K uptake in straw and grain respectively, calculated as an average in both seasons. While this (N, P, K Recom.+ Zn, Mn,Fe) treatment shows higher percentage over (NPK Rec.) treatment by (89.91, 319.17, 327.60, 282.57, 61.62 and 180.45 %) for the previous parameters in straw and grain, respectively calculated as an average in the two seasons.

The NPK Rec. treatment showing increases percentage over the control for the previous studied parameters were (77.27, 60.84, 26.77, 66.27, 67.04 and 90.25 %) respectively in straw and grain, calculated as an average in both seasons.

The results in the same table show that the highest percentage of N, P and K uptake recovery was obtained with NPK Rec + Fe, Zn and Mn treatment and calculated as 30.26, 48.23, 76.33 %, respectively for N, P and K uptake recovery as a mean in both seasons. While the low efficiency of N, P and K uptake recovery was obtained with NP Rec. alone treatment. These results are in harmony with those obtained by Badawi *et al.* (1990) and also El-Mancy *et al.* (1997).

These results may confirm that due to the balance between these elements is critical for crop production because each element affects the uptake of others and also, can change the physiology of the plant nutrients uptake. The result is similar to that obtained by Harmati, 1991 and Chougule *et al.*, 1993).

Micronutrients uptake:

The data in Table 4 indicated that, Zn, Mn and Fe uptake by wheat plants was significantly increased as affected with treatment application. It is obvious that the (NPK Rec. combined with Fe, Mn and Zn) treatment gave the highest percentage over control by 182.04, 782.81, 816.08, 406.93, 94.10 and 194.06%, respectively in straw and grain for the previous parameters, calculated as an average in both seasons. The same treatment gave the highest percentage over NPK Rec. treatment by (166.48, 137.81, 372.57, 262.90, 81.13 and 116.16 %) for the pervious parameters in straw and grain, respectively, calculated as an average in both seasons.

Table 2: Effect of mineral NPK fertilization and micronutrients foliar feeded on growth and yield components of wheat plants.

Treatments	Plant height (cm)		Leaf area (cm^2)		Spike length (cm)		Weight of 100-grain (g)		Grain yield (kg fed^{-1})		Straw yield (kg fed^{-1})	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control	49.90	49.80	15.40	15.30	9.01	9.12	30.00	31.60	557.30	556.00	634.00	632.80
N Rec.*	53.10	53.00	18.40	18.15	10.03	10.08	32.70	32.30	666.00	463.70	791.30	799.70
NP Rec.	54.10	54.10	18.70	18.60	11.10	11.26	44.80	34.30	750.30	738.70	839.00	847.30
NPK Rec.	55.30	55.330	19.80	19.90	11.80	12.23	46.70	36.30	841.30	829.00	932.70	921.00
NPK Rec. + Zn	58.40	58.60	23.30	23.00	12.03	12.16	45.40	46.00	1338.3	1347.3	1179.7	1181.6
NPK Rec. + Mn	57.30	57.20	22.00	22.40	12.40	12.81	41.20	40.30	1157.0	1164.0	1150.3	1139.7
NPK Rec. + Fe	56.50	56.70	20.90	21.00	12.00	12.30	38.30	39.00	1070.0	1058.3	1166.7	1170.7
NPK Rec. + Zn, Mn, Fe	61.70	61.90	24.30	24.40	12.88	13.11	50.30	50.70	1468.3	1455.3	1200.3	1212.1
LSD at 5%	**1.28**	**1.23**	**0.63**	**0.61**	**1.00**	**1.01**	**2.79**	**3.44**	**32.18**	**31.13**	**35.51**	**36.40**

Table 3: Effect of mineral NPK fertilization and micronutrients foliar sprayed on N, P and K contents of wheat plants.

Treatments	N-uptake (kg fed^{-1})				% total recovery	P-uptake (kg fed^{-1})				% total recovery	K-uptake (kg fed^{-1})				% total recovery
	Straw		Grain			Straw		Grain			Straw		Grain		
	1st season	2nd season	1st season	2nd season		1st season	2nd season	1st season	2nd season		1st season	2nd season	1st season	2nd season	
Control	7.15	7.78	3.22	3.24	--	1.78	1.77	1.16	1.12	--	6.95	6.91	1.65	1.63	--
N Rec.*	14.90	14 85	7.15	7.02	9.42	2.98	2.97	2.14	2.11	10.26	11.96	11.85	3.43	3.37	28.08
NP Rec.	13.31	13.10	5.25	5.14	6.44	2.23	2.27	1.90	1.89	7.19	11.30	11.15	3.12	3.12	24.08
NPK Rec.	18.80	18.54	8.66	8.54	13.87	3.85	3.78	2.29	2.86	14.42	17.19	17.00	5.25	5.27	57.46
NPK Rec. + Zn	20.23	20.12	16.14	16.23	21.48	8.09	7.94	6.16	6.20	39.61	19.38	19.40	7.19	7.76	76.25
NPK Rec. + Mn	19.69	19.52	13.06	12.94	18.34	6.05	5.91	5.40	5.30	30.35	18.35	18.34	6.04	5.98	65.79
NPK Rec. + Fe	18.49	18 33	9.77	9.51	14.52	4.21	4.21	3.67	3.60	19.13	14.34	14.36	4.25	4.17	41.63
NPK Rec. + Zn, Mn, Fe	25.06	25.09	21.94	21.61	30 26	9.63	9.61	7.39	7.11	48.23	18.10	18.18	8.70	8.80	76.33
LSD at 5%	0.93	0.94	0.92	0 91	--	0.90	0.84	0.29	0.27	--	0.86	0.89	0.42	0.40	--

* Rec. = Recommended dose

Table 4: Effect of mineral NPK fertilization and micronutrients foliar sprayed on Fe, Mn and Zn contents of wheat plants.

Treatments	Fe-uptake (mg fed^{-1})				Mn-uptake (mg fed^{-1})				Zn-uptake (mg fed^{-1})			
	Straw		Grain		Straw		Grain		Straw		Grain	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control	1.59	1.68	7.82	7.97	2.16	2.20	7.57	7.05	27.65	27.78	17.90	17.95
N Rec.*	1.56	1.64	20.16	20.13	7.73	7.71	11.65	11.75	40.39	40.63	25.44	5.60
NP Rec.	1.73	1.73	29.32	29.29	4.35	4.11	10.28	10.12	29.67	29.73	24.31	24.46
NPK Rec.	2.76	2.73	30.56	30.53	7.72	7.79	15.04	14.87	46.43	46.48	40.60	40.76
NPK Rec. + Zn	3.57	3.46	60.61	60.40	22.96	23.04	44.93	44.78	92.34	90.68	70.81	68.82
NPK Rec. + Mn	2.35	2.36	30.84	30.65	19.14	20.03	29.85	29.87	57.37	56.23	67.49	70.94
NPK Rec. + Fe	2.98	3.25	33.87	34.35	8.30	8.13	16.45	16.45	54.29	54.35	38.93	39.47
NPK Rec. + Zn, Mn, Fe	4.53	4.69	69.82	69.56	19.85	20.09	37.18	36.85	53.67	53.92	52.64	52.78
LSD at 5%	**0.62**	**0.33**	4.77	**4.76**	**2.67**	**2.39**	**4.73**	**4.72**	**4.89**	**5.04**	**9.57**	**9.91**

* Rec. = Recommended dose

Meanwhile, the NPK Rec. treatment shows the highest percentage over control by 5.91, 271.22, 94.11, 39.368, 7.17 and 36.04%) in straw and grain respectively for the studied parameters calculated as an average in both seasons.

These results indicating that, the use of micronutrients by means of foliar application was preferred to avoid not only nutrients fixation in the soil, but also their leaching by irrigation water and accordingly can encourage the uptake of mineral composition of wheat plant. The similar results were confirmed by Anton *et al.* (2001), Balland *et al.* (2000) and also Abd El-Hameed *et al.* (2003). It was concluded that the use of NPK Rec combined with Fe, Mn and Zn foliar applied on wheat plants was recommended as necessary for reaching the highest possible yields.

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تأثير التسميد المعدني والتغذية الورقية (نتروجين، فوسفور، بوتاسيوم) والعناصر الصغرى على النمو والإنتاجية والمحتوى العنصرى لنباتات القمح النامية فى الأراضى الرملية

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أجريت تجربتان حقليتان بمحطة التجارب الزراعية بالإسماعيلية خلال موسمى (٢٠٠١/٢٠٠٢ و ٢٠٠٢/٢٠٠٣) وذلك بهدف دراسة تأثير التسميد المعدنى (العناصر النيتروجين ، فوسفور ، بوتاسيوم) مع العناصر الصغرى رشا على الأوراق (حديد ، منجنيز ، زنك) على النمو والإنتاجية والتركيب العنصرى لنباتات القمح فى أرض رملية تحت نظام الرى المحورى. صممت التجربة فى قطاعات كاملة عشوائية وشملت ٨ معاملات وكررت كل معاملة ٣ مرات.

وقد أوضحت النتائج المتحصل عليها كالتالى:

١ــ أن التسميد المعدنى الموصى به (نيتروجين ، فوسفور ، بوتاسيوم) مع الرش ببعض العناصر الصغرى (الحديد ، المنجنيز ، الزنك) قد أدى إلى زيادة معنوية فى أطوال النبات ، مساحة الأوراق ، طول السنابل، وزن ١٠٠٠ حبة ، محصول الحبوب والقش بالمقارنة بالكنترول ومن ذلك يتضح أن أفضل المعاملات تأثيرا على القياسات النباتية تحت الدراسة قد حققت نتيجة لإضافة النتروجين، الفوسفور، البوتاسيوم الموصى به + الرش بالعناصر الصغرى (الحديد ، المنجنيز ، الزنك) كانت هى الأفضل للصفات السابقة عن باقى المعاملات.

٢ــ أن التسميد المعدنى الموصى به من النيتروجين ، الفوسفور ، البوتاسيوم مع الرش بالعناصر الصغرى (الحديد ، المنجنيز ، الزنك) أدى إلى زيادة معنوية فى النيتروجين ، الفوسفور ، البوتاسيوم الممتص لكل من الحبوب والقش عن الكنترول.

٣ــ أدى التسميد المعدنى الموصى به من النيتروجين ، الفوسفور ، البوتاسيوم مع الرش بالعناصر الصغرى (الحديد ، المنجنيز ، الزنك) إلى زيادة نسبة الاستفادة الكلية من النتروجين والبوتاسيوم الممتص بينما نسبة الإستفادة الكلية كانت أقل مع المعاملة التسميد المعدنى الموصى به (نيتروجين ، فوسفور ، بوتاسيوم) منفردا.

٤ــ أدى التسميد المعدنى الموصى به من النيتروجين ، الفوسفور ، البوتاسيوم مع الرش بالعناصر الصغرى (الحديد ، المنجنيز ، الزنك) إلى زيادة معنوية مع الحديد ، المنجنيز والزنك الممتص لكل من الحبوب والقش عن الكنترول ومعاملات الرش بالعناصر الصغرى منفردا.

٥ــ لذا توصى الدراسة إلى إجراء التسميد المعدنى الموصى به من (النيتروجين ، الفوسفور ، البوتاسيوم) مع الرش بالعناصر الصغرى (الحديد ، المنجنيز ، الزنك) لنباتات القمح للحصول على أقصى نمو والإنتاجية لمثل هذه الأراضى.