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STUDIES ON THE EFFECT OF ZINC APPLICATION ON WHEAT CROP

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ABSTRACT

Two field experiments were carried out at the experimental farm of the Horticulture Research station south El-Tahrir, Menufyia, Governorate, Egypt in 2000/2001 and 2001/2002 growing seasons to study the effect of zinc application at different rates, sources and methods on yield components and some chemical properties of wheat (variety Giza 163). The results could be summarized as follow:

1- All yield and yield components characters were significantly increased by different zinc application treatments compared with control. The promising treatment was applying 0.12% zinc chelate as foliar spray.
2- Nitrogen, phosphorus, Potassium, and Zinc content of grain were increased with applying Zinc compared with control. The highest values were recorded by 0.12% Zinc chelate spraying.

In this investigation, the best treatment was 0.12% Zinc chelate as foliar spray. Compared with other treatments.

Keywords: The effect of Zinc, wheat, application, rates, sources, methods

INTRODUCTION

Zinc deficiency is one of the commonest micronutrient deficiencies and its becoming increasingly significant in crop production. The susceptibility of crop plants to Zn deficiency varies considerably depending on species and even cultivars. Wheat is one of the cereals crops are rather insensitive whereas Zn element plays an important role increasing wheat grain yield. Many workers investigated the effect of micronutrients on wheat. Loadha *et al.*,(1975) concluded that the highest yields of grain and dry matter were given by the application of Cu and Fe +Zn in two split dressing as soil application + Foliar application. Shukla and Prasad (1979) Pointed out that the drilling of 25-50 kg zinc sulphate/ha into the soil before sowing was more effective in increasing grain yields than Zinc sulphate applied broadcast or as a foliar spray or Zinc as Zincated superphosphate applied to the soil. El-Kholdny and Hefni (1985), found a marked increase in the grain and straw yields of wheat due to Zinc chelate application as foliar spray in alkaline soil. Also, they found that zinc application increased grain N, P, and K uptake. Takkar and Bansal (1987) study the effects of rates, methods and source of Zinc fertilizer application on yield, Zn content and its uptake in wheat. They found that zinc application as foliar spray gave the highest grain yield, Zinc content and Zinc content and Zn uptake than broadcast application. Sayed (1978) and Hefni (1980), showed that the application of Zinc as foliar spray increased significantly all yield components characters as well as grain and straw yield. Gab-Alla *et al.*, (1986) pointed out that spraying wheat plants with 0.44% $ZnSO_4.7H_2O$ increased spike length number of spikes/m, spike weight, number of grains/spike, weight of grains/spike, 1000- grain – weight, grain

and straw yields/fed, and Protein percentage in grains. El-Kabbany *et al.*, (1996), found that Zinc application alone as foliar spray increased plant height, grain and straw yields, biological yield, spike length, number of grains/spike, weight of grains/spike, 1000- grain weight and N, P, K and Zn content in grains of wheat.

The aims of this investigation are to study the methods and forms of Zinc application on some characters of plants, yield and its components, as well as, some chemical properties tests of grains wheat (Variety Giza 163).

MATERIALS AND METHODS

To achieve the goal of this study two field experiments were carried out during 2000/2001 and 2001/2002 seasons at the Experimental Farm of the Horticulture Research Station, south El-Tahrir, Menufyia Governorate. A Soil sample was taken before experiments and prepared for the determination of some physical and chemical analysis according to Chapman and Pratt (1961) as shown in Table (1).

Experimental design each experimental included 9 treatments of zinc application, namely, 1) control (without zinc applied), 2) 10 kgs $ZnSO_4$ as soil application, 3) 20 kgs $ZnSO_4$ as soil application, 4) 1 kg Zn chelate as soil application, 5) 2 kg Zn chelate as soil application, 6) 0.6 % $ZnSC_4$ as foliar spray, 7) 1.2 % Zn chelate as foliar spray. 80 0.06% Zn chelate as foliar spray, 9) 0.12% Zn chelate as foliar spray. The treatments of soil application were applied by broadcasting method before planting irrigation. Zinc chelate application as foliar spray was added in form EDTA Na_2Zn. The variety was Giza 163. In both growing seasons a complete Randomized Blocks design with 4 replications was used. The plot area was 10.5 m^2. The grains were planted in rows 20 cm a part. Planting dates were 9/12/2000 and 8/12/2001 in the two growing seasons, respectively. Superphosphate (15.5% P_2O_5) at rate of 15.5 Kg P_2O_5 /feddan and 75 Kgs N as ammonium nitrate 33.5% were applied. All amount of superphosphate was added before planting but the amount of ammonium nitrate was divided into two equal doses to be added before the first irrigation and before the next one.

The solutions of spraying were added twice, after 30 days from sowing and at the beginning of heading (75 days after sowing). At maturity wheat plants harvested and the following characters were measured and recorded, plant height, spike length, number of spikelet/spike, grains weight/spike, 1000-grain weight as well as grain and straw yields. Samples of grains were taken in each treatment from three replicates and dried electric oven at 70 C° then ground to powder for chemical analysis. Nitrogen was determined according to improve macrokjeldahe/ method (A.O.A.C 1975). Phosphorus was calculated colorimetrically using spectrophotometer, K was determined using flame photometer according to Chapman and Pratt (1961). Zn was determined using atomic absorption spectrophotometer, SP 90.

The data were statistically analyzed and Duncan's multiple range rest at the 5% level (Gmez and Gomez 1984) was done for comparisons, among

treatments. The follcwing symbols were used 12 treatments to indicate significance between the means:

a) Capital letters for Zinc applied treatments (A, B, C, ...)
b) Small letters with dash for years (a', b',..)
c) Small letters for the interaction between years and zinc applied treatments (a, b, c ...)
d) Means having the same symbols were not significant

Table (1): Chemical and physical analysis of the experimental soil, for the upper layer (0-40 cm).

Chemical analysis	2000/ 2001	2001/ 2002	Mechaical analysis	2000/ 2001	2001/ 2002
pH (in the soil paste)	7.90	7.60	Sand (%)	52.07	58.09
EC (mmhos/cm)	3.30	4.60	Silt (%)	22.10	24.00
O.M (%)	0.80	0.86	Clay (%)	25.91	17.82
Soluble ions (me/L):			Texture	S.C.L	S.C
HCO_3^-	2.60	2.90			
$SO_4^=$	3.30	14.10			
CL^-	28.10	35.0			
Ca^{++}	12.40	21.90			
Mg^{++}	3.70	10.80			
Na^+	17.20	18.60			
K^+	0.55	1.00			
SP (%)	60.00	55.00			
AV. Zn (ppm)	1.30	1.10			

RESULTS AND DISCUSSIONS

1-Growth Parameters:

Plant height:

The obtained data showed that plant height was significantly affected by the growing seasons as well as different fertilization treatments. These results may be due to the variation between weather conditions Prevailed through the two seasons. Averages of plant height as affected by different rates, methods and forms of Zinc application are given in Table (2). It was evident that plant height significantly increased with Zinc applied compared to control. This increase may be due to the fact that Zinc participates in the production of IAA, which is essential for the elongation of plants (Katyal and Randhaw 1983)

The highest treatments was obtained by 0.12% Zn chelate as foliar spray in the first and second seasons, respectively. The plants sprayed with Zn were much sperior in height if compared with the other treatments than soil broadcast application method to the soil. This result is in agreement with Takkar and Bansal (1987) and El-Kabbany *et al.*, (1996)

Zn chelate 0.12% as foliar spray appeared the highest effect on enhancing the plant heights in this investigation.

These results are similar to those obtained by Boehle and Lindsay (1969) who recommended ¼ to 1% Zn in a foliar spray for emergency applications.

Spike Length:

Data in Table (2) revealed that spike length was not significantly affected by the two growing seabut it was significantly affected by Zn applied treatments in two growing seasons. Data presented in Table (2) pointed out that Zn fertilizer rates, method and forms increased spike length compared to control. The tallest spikes were obtained from plots fertilizer with 0.12% Zn chelate as foliar spray while the shortest one were obtained from the unfertilized plots. The best methods off application were foliar spray method. With this respect El-Kabbany *et al.*, (1996) in Egypt found that length increased by spraying wheat plants with Zn alone.

Number of spikelets/spike: Table (2) showed that the averages of number of spikelets/spike as affected by Zn fertilizer. It was evident that Zn applied as foliar spray with 0.12% Zn chelate gave number of spikelets/spike significantly higher than other treatments and Control.

Generally, Zn applied to wheat plants increased the number of spikelets/spike compared to control. The similar results were obtained by El-Kabbany *et al* (1996)

Table (2): The effect of Zinc application in the two growing seasons on plant height (cm), spike length (cm), and the number of spikelets/spike.

Treat.	Plant height (cm)			Spike length (cm)			Number of spikelets/spike		
	2000/ 2001	2001/ 2002	AV.	2000/ 2001	2001/ 2002	AV.	2000/ 2001	2001/ 2002	AV.
1	113.8	102.9	108.3	9.3	10.3	9.8	19.6	21.6	20.6
	De	H	E	c	bc	C	f	bcd	F
2	116.4	110.0	113.2	10.4	10.7	10.5	20.6	22.2	21.4
	Cd	g	CD	bc	abc	BC	ef	abc	DE
3	117.0	110.1	113.6	10.5	10.8	10.7	21.3	22.3	21.8
	bc	G	BCD	bc	ab	ABC	cde	ab	CD
4	115.1	109.3	112.2	10.0	10.5	10.2	20.2	22.2	21.2
	cde	G	D	bc	be	C	f	abc	CDE
5	116.7	109.5	113.1	10.2	10.7	10.4	21.2	22.2	21.7
	bcd	g	CD	bc	ab	BC	de	abc	EF
6	118.1	110.5	114.3	10.5	10.8	10.6	21.5	22.2	21.8
	bc	Fg	BC	bc	ab	ABC	bcde	abc	CD
7	119.4	111.5	115.4	10.7	10.9	10.8	22.1	22.4	22.2
	b	Fg	B	ab	ab	AB	abcd	a	BC
8	121.5	112.3	116.9	11.2	10.9	11.1	22.7	22.4	22.2
	a	Efg	A	ab	ab	AB	a	a	AB
9	123.3	113.6	118.5	11.7	11.2	110.4	22.8	22.7	22.8
	a	Def	A	a	ab	A	a	a	A
	117.3	110.0		10.5	10.7		21.3	22.2	
	a	B		a	a		b	a	

2- Yield and Yield components:

Weight of grains/spike: Data presented in Table (3) indicated that spraying wheat plants with Zn have a significant increase in weight of grains/spike compared with control. The highest weight was given from the treatment of 0-12% Zn chelate as foliar spray.

It was evident from Table (3) that Zn application as foliar spray was more effective than soil broadcasting method. These results were in was more effective than soil broadcasting method. These results were in agreement with those obtained by Takkar and Bansal (1987), Mohammed *et al.*, (1990) in Egypt and El-Kabbany *et al.*, (1996).

1000-grains-weight: The combined analysis of variance showed that 1000-grains-weight was significantly affected by the two growing seasons. This could be attributed to different climatic factors and or to soil fertility. Data in Table (3) showed that the average of 1000-grains-weight was increased with Zn applied compared to control. The best treatment was 0.12% Zn chelate as foliar spray on wheat plants. Table (3) also, illustrated that foliar spray method was more effective than soil broadcasting method. These results are in a good line with those obtained by El-Kabbany *et al.*, (1996).

Grain yield:

Data in Table (3) indicated that grain yield was not significant among the two growing seasons. It was evident that the foliar spraying of Zn applied gave the highest grain yield than soil broadcasting method. The highest grain yield was obtained from 0.12% Zn chelate applied as foliar spraying method in both the two growing seasons. This increase in grain yield may be due to the fact that Zn^{2+} play an important role in some enzymatic systems. Which lead to increased grain yield and yield components. These results were agreement with those obtained by Shukla and Prasad (1979), El-Kholdny and Hefni (1985), Takkar and Bansal (1987), Mohammed *et al.*, (1990) and El-Kabbany *et al.*,(1996).

Straw yield:

The combined analysis of variance revealed that this trait was not significant affected by the growing seasons. Concerning the significant treatments in Table (3), the highest straw yield was obtained with the treatment of applying 0-12% Zn chelate as foliar spray while the lowest one was obtained by the untreated one. Application of Zn as foliar spray was more effective than soil broadcasting application. This increase in straw yield of wheat plants may be due to that applying micronutrients delayed the senescence of wheat plants through an increase in the level of IAA, chlorophyll content and NAR in leaves consequently increased the total dry matter accumulation and yield components (Hemantranjan and Garg 1984), and Garg (1987). These results were in agreement with those obtained by Loadha *et al.*, (1975) and El-Kabbany *et al.*, (1996).

Table (3): The effect of zinc application (rates methods and forms) on yield and yield components of wheat (Giza 163) in the two growing seasons 2000/2001 and 2001/2002.

Treat.	Weight of grains/spike (g)			1000-grains-weight (g)			Grains yield (ardab/fed.)			Straw yield (ton/fed)			Biological yield (ton/fed)		
	2000/2001	2001/2002	Average	2000/2001	2001/2002	Average	2000/2001	2001/2002	Average	2000/2001	2001/2002	Average	2000/2001	2001/2002	Average
1	1.7	1.8	1.8	45.3	36.7	40.5	12.52	10.89	11.70	2.17	2.19	2.18	4.05	3.82	3.94
	d	d	D	b	d	C	F	G	D	h	h	E	f	f	E
2	2.1	2.2	2.1	46.2	39.4	42.8	13.80	13.16	13.48	3.15	3.11	3.13	5.22	5.08	5.15
	cd	cd	CD	ab	cd	BC	Cdef	Ef	C	fg	fg	D	de	e	CD
3	2.3	2.2	2.2	47.5	40.1	43.8	14.88	13.33	14.10	3.96	3.45	3.71	6.19	5.45	5.82
	cd	cd	BC	ab	c	B	Bcd	Ef	BC	ac	defg	BC	b	cde	B
4	2.1	2.0	2.0	46.4	39.0	42.7	13.68	13.09	13.38	3.03	3.10	3.06	5.08	5.06	5.07
	cd	cd	CD	ab	cd	BC	Def	Ef	C	g	fg	D	e	bc	D
5	2.3	2.1	2.2	47.1	39.7	43.4	14.43	13.23	13.83	3.81	3.28	3.45	5.77	5.27	5.52
	cd	cd	BC	ab	cd	B	Cde	Ef	BC	bcdef	efg	BCD	bcd	dc	BCD
6	2.4	2.2	2.3	46.4	39.8	43.1	14.17	13.15	13.66	3.85	3.37	3.61	5.98	5.34	5.66
	bcd	cd	BC	ab	cd	BC	Cde	Ef	BC	bcd	defg	BC	bc	cde	B
7	2.6	2.4	2.5	47.9	40.5	44.2	14.10	13.16	14.30	4.00	3.61	3.81	6.12	5.58	5.85
	bc	bcd	AB	ab	c	B	Cde	ef	BC	b	bcdef	B	b	bcd	B
8	2.9	2.4	2.6	47.8	40.5	44.2	15.10	13.95	14.52	3.50	3.35	3.43	5.77	5.44	5.61
	ab	bcd	AB	ab	c	B	Bc	cde	B	cdefg	defg	CD	bcd	cde	BC
9	3.2	2.5	2.9	48.9	45.6	47.3	16.57	16.15	16.36	4.84	3.80	4.31	7.33	6.22	6.78
	a	bc	A	a	ab	A	A	ab	A	a	bcde	A	a	b	A
	2.39	2.19		47.05	40.03		14.46	13.39		3.55	3.25		5.72	5.25	
	a	a		a	b		a	a		a	a		a	a	

Ardab = 150 kg Feddan = 4200m2 Ton= 100 kg.

Biological yield:

Data presented in Table (3) pointed out that this trait was affected by the growing seasons and fertilizer with Zn applied. It was evident that Zn application increased biological yield. The highest value 6.78 ton/fed. was obtained as result of 0.12% Zn chelate as foliar spray where as the lowest one was 3.94 ton/fed. was obtained by untreated one.

Also, data showed that foliar spray method was affective than soil broadcasting method in all treatments. The results are in a harmony with those obtained by El-Kabbany *et al.*, (1996).

3- N, P, K and Zn content:

The combined analysis of variance in Table (4) painted out that nitrogen and potassium contents were significantly affected by the growing seasons while phosphorus content was not significantly affected by the same factor. It is clear from such data that all applied treatments increased N, P and K content compared to control. From the present data, it could be noticed that the highest values were occurred as a result of 0.12% Zn chelate application as foliar spray than other treatments. The highest values were 2.22%, 0.57% and 0.60% as an average of the two growing seasons for N, P and K content, respectively.

The increase in nitrogen content may be due to that Zn is very closely involved in the N metabolism of plant wherever in Zn deficient conditions, plants protein synthesis plants protein levels are markedly reduced and amino acids and amids are accumulated (Mengel and Kirkby, 1987). In addition, Dhillon *et al.*, (1987) reported that either Zn or Cu increased N uptake and substantially increased the translocation of absorbed nitrogen into protein. Also, Table (4) revealed that Zn content in wheat grains was significantly increased by $ZnSO_4$ or Zn chelate application compared to control in the two growing seasons. The highest value (35.5ppm) was obtained by 0.12% Zn chelate applied as foliar spray while the lowest value (22.5ppm) induced with control. This result is in agreement with Takkar and Bansal (1987) and El-Kabbany *et al.*, (1996).

Table (4): The effect of zinc application on N, P, K and Zn content of wheat (Giza 163) in the two growing seasons 2000/2001 and 2001/2002.

Treat.	N (%)			P (%)			K (%)			Zn (%)		
	2000/ 2001	2001/ 2002	Average	2000/ 2001	2001/ 2002	Average	2000/ 2001	2001/ 2002	Average	2000/ 2001	2001/ 2002	Average
1	1.70	1.63	1.69	0.47	0.47	0.47	0.46	0.56	0.51	23.0	22.0	22.5
	m	m	H	b	c	C	i	defgh	D	cd	a	D
2	1.84	1.84	1.64	0.51	0.51	0.52	0.50	0.59	0.55	28.0	27.0	27.5
	k	k	FG	a	b	B	hi	cdefg	CD	abcd	bad	C
3	1.89	1.93	1.91	0.54	0.55	0.54	0.52	0.59	0.56	29.0	28.0	28.5
	h	g	D	a	a	B	hi	abcdef	BC	abcd	abcd	BC
4	1.84	1.79	1.82	0.55	0.54	0.55	0.53	0.60	0.56	32.5	27.0	29.8
	k	l	G	a	a	B	gi	abcd	ABC	abc	bcd	BC
5	1.87	1.88	1.87	0.56	0.55	0.56	0.55	0.61	0.58	33.0	29.0	31.0
	ij	hi	EF	a	a	AB	efgh	abcd	ABC	ab	abcd	B
6	1.94	1.86	1.90	0.55	0.55	0.55	0.52	0.59	0.55	28.0	27.2	27.6
	fg	l	DE	a	a	AB	hi	abcdef	BC	abcd	bcd	C
7	1.96	1.95	1.96	0.55	0.54	0.55	0.52	0.63	0.58	29.0	27.5	28.3
	b	ef	C	a	a	AB	fgh	abc	ABC	abcd	abcd	BC
8	2.08	2.01	2.05	0.55	0.56	0.55	0.54	0.64	0.59	33.0	29.0	31.0
	c	a	B	a	a	AB	fgh	ab	AB	ab	abcd	B
9	2.26	2.27	2.22	0.57	0.57	0.57	0.55	0.65	0.60	35.0	36.0	35.5
	a	b	A	a	a	A	efgh	a	A	ab	a	A
	1.94	1.89		0.54	0.54		0.61	0.61		30.1	28.1	
	a	b		a	a		a	a		a	b	

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دراسة تأثير إضافة الزنك على محصول القمح

فايزة سلامة على سلامة – إبراهيم محمد سالم – نجيب رشدى طلبة

معهد بحوث الأراضى والمياه والبيئة – مركز البحوث الزراعية – الجيزة – مصر

أقيمت تجربتان بمحطة البساتين بالقطاع الغربى لمديرية التحرير – محافظة الدقهلية لدراسة تأثير اضافة عنصر الزنك (طرق – صور – معدلات) فى موسمى ٢٠٠١/٢٠٠٠ ، ٢٠٠٢/٢٠٠١ على النمو والمحصول ومكوناته والتركيب الكيماوى وتتلخص النتائج فى الآتى:-

- إزداد طول النبات وطول السنبلة وعدد السنبلات باضافة عنصر الزنك.
- إزداد محصول القش والحب ووزن حبوب السنبلة ووزن الـ ١٠٠٠ حبة وكذا حبوب المحصول الحيوى لنباتات القمح باضافة الزنك.
- إزداد تركيز كل من النتروجين – الفوسفور – البوتاسيوم – الزنك فى حبوب القمح باضافة الزنك.
- تفوقت الإضافة بالرش على طريقة الإضافة الأرضية وكان أفضل معدل هو ٠,١٢% زنك على صورة زنك مخلبى فى هذا البحث