J. Agric. Sci. Mansoura Univ., 34 (4): 4113 - 4120, 2009

IMPACT OF ZINC FOLIAR APPLICATION ON LENTIL PLANT (*Lens culimaries*, Medic) GROWN ON SANDY SOIL

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ABSTRACT

Two field experiments were carried out at El-Ismailia Agricultural Research Station, El-Ismailia Governorate during the two winter growing seasons, 2005/2006 and 2006/2007 to study the effect of sprayed zinc as chelate form at rates of control, 0.5, 1.0, 2.0 and 3.0 g/Liter on yield components, yield and chemical composition of lentil plant (*Lens culinaris*, Medic.) grown on sandy soil.

Results can be summarized as follows:

Generally, foliar application of zinc achieved significant increases of lentil yield and its components, as compared with control treatment received no zinc in both growing seasons.

Spraying zinc at rates of 1.0 & 2.0 g/liter led to significant increases in most parameters of yield and its components, compared to the other treatments in both seasons. Meanwhile, zinc at the rate of 3.0 g/liter gave significant decreases in the most parameters.

In first season, in most cases, zinc foliar application at the rates of 1.0 and 2.0 g/liter increased significantly macro and micro nutrient contents in seed lentil plants, compared to the other treatments. Meanwhile, the control treatment and zinc application at the rate of rate of 3.0 g/liter decreased significantly such nutrients. On the other hand, foliar application at the rates of 1.0 and 2.0 g/liter increased significantly N & protein percentages. While, zinc addition did not significantly affect P& K percentages, as well as Fe, Zn and Mn concentrations in the second season.

Keywords: Lentil plants (*Lens culimaries*, Medic), Zink fertilizer, foliar application, zinc rates

INTRODUCTION

In Egypt, lentil (*Lens culinaris*, Medic.) is one of the most important leguminous crops. The area cultivated with lentil has been increasing in the Nile Delta and the newly reclaimed soils. Since the reclaimed sandy soils are considered a valuable for future expansion, attention should be drawn with respect to the nutritional status of these soils. It is important to increase the total production through good agronomic management. Proper supply of nutrients plays a major role in the increase lentil yield. Several researchers have reported the increase yield of lentil as a result of macro–and micronutrients application. Fawzi et al. (1983) showed that intensive use of nitrogen and phosphorus fertilization and micronutrients for high yielding varieties of faba beans resulted in nutrient imbalance shown by wide–spread micronutrients deficiency symptoms particularly Zn, Mn and Fe.

The use of micronutrients as fertilizers has been recently increasing. Element such as zinc is fully as important as the primary nutrients, nitrogen, phosphorus, and potassium, although the former is used in much smaller quantities. Plants become more sensitive to zinc deficiency especially in soils having high pH. Accordingly, zinc fertilization can increase crop yield. Balanced crop nutrition supplying all essential nutrients, including zinc, is a cost effective management strategy. Zinc fertilizers are needed when the available zinc in the top soil becomes depleted. Zinc plays an important role as a metal component of enzymes, as a functional, structural or regulatory co-factor for a large number of enzymes, in carbohydrate metabolism, protein synthesis and particularly the build up of the amino acid tryptophan, as well as a precursor for the synthesis of IAA (Marschner, 1986). Low zinc concentration induces accumulation of amino acids and reducing sugars in plant tissue (Marschner, 1995).

Zeidan et al. (2006) concluded that the increase in the studied characters of lentil plants due to micronutrients might be attributed to their influences on enhancing the photosynthesis process and translocation of photosynthetic products to seeds, as a result of increased enzymatic activity and other biological activities. Therefore, it is very important to add micronutrients such as Fe, Zn and Mn in order to avoid their deficiency during the growth of lentil plants in sandy soils in particular.

The aim of this work is to determine yield components, yield quantity and chemical composition of lentil plants in response to zinc fertilizer in sandy soil.

MATERIALS AND METHODS

The present investigation was carried out at El-Ismailia Agricultural Research Station. (ARC) during the two winter growth seasons of 2005/2006 and 2006/2007 to study the effect of zinc fertilizer on lentil yield components and yield quantity, chemical composition of lentil (*Lens culinaris*, Medic) plants cultivated in sandy soil.

Soil of the experimental field was sampled to carry out mechanical and chemical analyses before sowing according to the standard methods of Ryan et al. (1996). Results of those analyses are presented in Table (1)

Table (1): some physical and chemical properties of the studied soils

Mechanical analysis		**Season**	
		2005/2006	**2006/2007**
Coarse sand (%)		65.17	62.16
Fine sand (%)		32.40	33.10
Silt (%)		1.39	1.45
Clay (%)		1.04	1.00
Soil texture		Sandy	Sandy
pH (1: 2.5)		7.90	8.10
EC (dS/m)		0.14	0.13
$CaCO_3$ (%)		1.35	1.40
OM(%)		0.15	0.13
Chemical analysis			
N	Available (ppm)	12.0	12.0
P		5.7	4.8
K		65.0	55
Zn		0.4	0.6

Seeds of lentil variety Giza 9 were sown at the rate of 50 kg /fed. in November 25th and 29th in the first and second seasons, respectively. The plot area was 10.5m^2 (1/400 fed.), this contained 15 rows (20 cm. apart and 3.5m. long).Nitrogen fertilizer was added 15 days after sowing to all experimental plots at the rate of 15 kg N /fed. as ammonium sulphate (20.6 % N) .Seeds of lentil were inoculated prior to sowing with a pure culture of the specific rhizobia strain .The preceding crop was peanut in the first season and maize in the second. Phosphate fertilizer, as superphosphate (15.5% P_2O_5) and potassium as potassium sulphate (48% K_2O), were applied at the rate of 30 and 24 kg/fed., respectively, before sowing to all experimental plots. This experiment included 5 treatments (control, 0.5, 1.0, 2.0 and 3.0 g Zn /liter), which were sprayed by zinc chelate. A randomized complete block design with six replicates was used. At harvest (140 days from sowing), ten plants were randomly taken from each plot to study the following characters: - Plant height (cm), No. of branches/plant, No. of pods/plant, Weight of pods/plant, 1000- seeds Weight (g), seeds weight/plant (g) and straw weight /plant (g). Plants of each plot were harvested, air-dried and weighed to determine seed and straw yields /fed.

Plant samples were digested according to the procedure of Ryan et al. (1996), then the digested plant solutions were analysed for N, P and K contents. Nitrogen was determined using micro Kjeldahl ,while phosphorous was determined colorimetrically using ammonium molybdate and ammonium metavanadate according to the procedure outlined by Ryan et al. (1996). Potassium was determined using the flame spectrophotometry method (Black, 1982).

All obtained results were statistically analyzed using Mstat computer package to calculate F ratio according to Snedecor and Cochran (1980). Least significant differences method (L.S.D.) was used to differentiate means at the 0.05 level (Waller and Duncan, 1969).

RESULTS AND DISCUSSION

1-Effect of zinc foliar application on lentil yield and its components in the season of 2005/2006

Data in Table (2) showed that lentil yield and its components were significantly increased by the foliar application of zinc as compared with the control treatment.

It could be noticed that the highest significant mean values of plant height, weight of pods, 1000- seeds weight (g) and seeds weight/plant (g) were gained, significantly when zinc was applied at 2.0g/liter, as compared with the other tested treatments.

Regarding the effect of foliar application of zinc on No. of pods /plant, data showed that zinc at rate of 1.0 g/liter, the highest mean value was obtained compared to the other treatments. On the other hand, the lowest mean values were recorded at higher rate at (3.0 g/liter) and the control treatment, but with no significant difference between them.

Table (2): Effect of zinc foliar application on lentil yield and its components in the season of 2005/2006

Treatment (Zinc rates g/l)	Plant height (cm)	No. of branches/ Plant	No. of pods/ plant	Weight of pods / plant (g)	1000 - seeds Weight (g)	Seed weight /plant (g)	Straw weight /plant (g)	Seed yield (kg/fed^{-1})	Straw yield (kg/fed^{-1})
Control	32.25	2.70	10.40	0.434	22.40	0.322	0.628	257.6	1.80
0.5	34.43	3.40	16.95	0.469	22.41	0.433	0.681	371.2	1.30
1	35.90	5.20	23.40	0.645	26.52	0.500	0.890	480.	2.42
2	38.78	4.50	17.08	0.839	27.79	0.767	0.986	497.6	2.78
3	35.73	3.30	10.68	0.590	23.50	0.420	0.638	321.6	1.19
LSD at 0.05	3.34	1.10	03.73	0.013	04.39	0.124	0.700	128	0.61

With respect to No. of branches/plant, seeds and straw yield/fed., data clearly showed that both zinc rates of 1.0&2.0 g/liter gave the highest mean values, compared to the other treatments, with no significant differences between them. Meanwhile, the lowest mean values of No. of branches/plant and seed yield were obtained with no addition of zinc (control treatment). While, the foliar application of zinc at both rates of 0.5 & 3.0g /liter, as well as the control treatment gave the lowest mean values for straw weight /plant and total straw yield in the first season. These results are in agreement with those obtained by Okaz et al. (1994) and Zeidan et al. (2006) who reported that increases in the studied characters of lentil plants due to micronutrients might be attributed to their influences on enhancing the photosynthesis process and translocation of photosynthetic products to the seeds as a result of enhanced enzymatic activity and other biological activities. Therefore, it is very important to add micronutrients such as Fe, Zn and Mn in order to avoid the deficiency of such elements during the growth of lentil plant in sandy soils.

2-Effect of zinc foliar application on lentil yield and its components in the season of 2006/2007

In most cases, results in the second season had the same trend of those of the first one. Data presented in Table (3) revealed that the foliar application of zinc at 1.0 and/or 2.0 g/liter significantly gave the highest values for the entire lentil tested parameters in that season (2006/2007).

On the other hand, the lowest mean values were recorded when no addition of zinc (control treatment) was practiced. It could be observed that the highest mean values of plant height were obtained whit the foliar application of zinc at 2.0 and 0.5 g/liter. Meanwhile, the lowest mean values for plant height were recorded when 1.0 gm/liter and control treatment were practiced but with no significant differences between them.

The foliar application of zinc at both rates of 1.0 & 2.0 g/liter gave the highest mean values of No. of branches and No. of pods. On the other respect, Zn spray on lintel plants with 0.5 g/liter and control treatment (no zinc addition) gave the lowest values.

The foliar application of zinc at 2.0 g/liter gave the highest value of pods/ plant weight, compared to the other treatments, while the lowest one was obtained for the control treatment (no zinc addition).

Table (3): Effect of zinc foliar application on lentil yield and its components in the season of 2006/2007

Treatment (Zinc rates g/l)	Plant height (cm)	No. of branches/ Plant	No. of pods/ plant	Weight of pods / plant (g)	1000 - seeds Weight (g)	Seed weight /plant (g)	Straw weight /plant (g)	Seed yield (kg/fed^{-1})	Straw yield (kg/fed^{-1})
Control	27.85	2.7	13.03	0.444	21.96	0.406	0.611	220.8	0.90
0.5	34.83	2.8	14.23	0.498	22.47	0.511	0.691	302.4	1.52
1	28.63	4.6	18.75	0.660	27.64	0.543	0.754	440	1.65
2	37.23	4.0	23.33	0.943	24.90	0.770	0.939	481.6	1.81
3	32.20	3.2	13.80	0.475	22.63	0.450	0.675	291.2	1.53
LSD at 0.05	3.76	0.94	6.35	0.022	1.73	0.145	0.200	99.2	0.25

Regarding the effect of foliar application of zinc on 1000 - seeds weight (g) of lentil, data showed that spraying zinc at 1.0 g /liter gave the highest significant mean value, as compared with the other tested treatments. Meanwhile, control treatment, 0.5 and 3.0 g/liter gave the lowest mean values (21.96, 22.47 and 22.63), respectively, with no significance differences among them.

With respect to seeds weight/plant (g), data revealed that zinc at the rate of 2.0 g/liter increased significantly this parameter, as compared to the other treatments. On the other hand, control treatments, 0.5, 1.0 and 3.0 g /liter gave the lowest mean values (0.406, 0.511, 0.543 and 0.450), respectively, with no significant differences among them. Also, data revealed that Zn at 1.0 and 2.0 g /liter increased significantly the straw weight /plant (g), seed and straw yields. While, the lowest mean values were recorded when control treatment and 0.5 g Zn/liter were applied. These results ascertained those aforementioned regarding most of the studied growth attributes as well as seed and straw yield. Also, such results support the importance of foliar application of zinc to lentil plants. Plants become more sensitive to zinc deficiency in soils having high pH value (see Table 1) thus zinc uptake decreases. Where zinc deficiency is a limiting factor, zinc fertilization can increase crop yields. Balanced crop nutrition supplying all essential nutrients, including zinc, is a cost effective management strategy. Even with zinc-efficient varieties, zinc fertilizers are needed when the available zinc in the top-soil becomes depleted. The same trend was found by Khalil and Khlifa (1991), and Srivastava et al.(1999) and Singh (2001) who concluded that there was a positive grain yield response to the application of 2.0 kg Zn/ha, but a negative response occurred from 2.0 to 4.0 kg Zn/ha.

3-Effect of zinc foliar application on Lentil plants macro and micronutrients contents in the season of 2005/2006

Results in Table (4) indicated that zinc foliar application at the rate of 2.0 g/liter increased significantly N % and Mn ppm in lentil plant seeds compared to the other treatments with no significant differences among 0.5, 1.0 and 2.0 g Zn/liter. Meanwhile, the control treatment and zinc at the rate of 3.0 g/liter decreased significantly the same nutrients.

As for the effect of zinc foliar application on P % on lentil plant seeds, the highest mean value was recorded when lentil plants were sprayed with

1.0 g Zn/liter followed by 0.5 g Zn /liter. The control treatment, zinc at the rates of 2.0 and 3.0 g /liter gave the lowest mean percentages of P (0.285, 0.303 and 0.294, respectively).

Zinc foliar application to lentil plants at the rates of 0.5, 1.0 and 2.0 g/liter gave the highest mean percentages of K (0.65, 0.66 and 0.65%), respectively. While the control treatment and zinc at the rate of 3.0 g /liter gave the lowest mean percentages of K (0.54 and 0.54, respectively).

Table (4) Effect of zinc as a foliar application on lentil seed macro and micronutrients contents in the season of 2005/2006

Treatment (Zinc rates g/l)	N	P	K	Protein	Fe	Zn	Mn
	%				ppm		
Control	4.112	0.285	0.54	25.7	297.38	69.6	19.4
0.5	4.416	0.365	0.65	27.6	420.63	78.0	22.7
1	4.704	0.415	0.66	29.4	386.13	79.3	23.8
2	4.784	0.303	0.65	29.9	420.63	83.2	26.1
3	4.272	0.294	0.54	26.7	401.88	89.03	20.0
LSD at 0.05	0.432	0.088	0.08	2.7	NS	4.6	4.7

With regard to protein percentage, data revealed that, foliar application of zinc at the rates of 1.0 and 2.0 g / liter increased significantly the protein %. On the other hand, the control treatment (without addition zinc) decreased significantly the protein % in lentil plant seeds. Moreover, Fe and Zn ppm had not influenced by zinc foliar application. Similar results were obtained by Marschner (1986) who concluded that zinc plays an important role as a metal component for a large number of enzymes, as a functional, structural or regulatory co-factor in carbohydrate metabolism, protein and amino acids synthesis and as a precursor for the synthesis of IAA.

4-Effect of zinc foliar application on macro and micronutrients contents of lentil plants grown in the season of 2006/2007

Statistical analysis shown in Table (5) noted that zinc foliar application at the rates of 1.0 and 2.0 g / liter increased significantly N and protein percentages, compared to the other treatments. Meanwhile, data showed that the lowest mean values of N and protein contents were obtained when control treatment and the highest zinc rate were applied.

Table (5): Effect of zinc foliar application on macro and micronutrients contents of lentil seed yield in the season of 2006/2007

Treatment (Zinc rates g/l)	N	P	K	Protein	Fe	Zn	Mn
	%				ppm		
Control	4.096	0.275	0.50	25.6	349.90	69.4	23.1
0.5	4.464	0.353	0.60	27.9	438.10	77.5	25.0
1	4.72	0.384	0.65	29.5	394.90	77.5	25.0
2	4.704	0.297	0.65	29.4	387.50	84.5	26.3
3	4.24	0.286	0.57	26.5	364.30	85.5	23.6
LSD at 0.05	0.368	NS	NS	2.3	NS	NS	NS

Results of Table (5) showed that P and K contents as well as Fe, Mn and Zn ppm were not affected by zinc foliar application. In this respect, Marschner (1995) concluded that zinc plays an important role in protein and starch synthesis, and therefore a low zinc concentration induces accumulation of amino acids. These results are in agreement with those obtained by Okaz et al. (1994) who found that P, k, Fe, Mn, Zn and protein contents in lentil seeds were significantly increased by most micronutrient treatments. Abdel–Salam (1998) reported that foliar application of Zn significantly increased Zn content in grains of faba bean. Ziaeian and Malakouti (2001) indicated that Fe, Mn and Zn fertilization caused significant increases in concentration and total uptake in wheat shoots. Aysen Akay(2006) reported that Zn and protein contents of chickpea seeds were significantly increased by Zn foliar application. Mohammed (2006) found that Zn foliar application increased Zn and Fe concentration in wheat grains. Sheriff and Said (1998) found that foliar application with micronutrients either separately or in a mixture to lentil significantly increased number of branches and pods/plant, 1000–seed weight and seed yield/fed. The response of lentil plants, in the present study, to Fe, Mn and Zn app may be due to the low contents of these elements in the experimental soil.

From the aforementioned results, it could be concluded that the importance of zinc foliar application to lentil plants is due to its influences on enhancing the photosynthesis process and translocation of photosynthetic products to the seeds as a result of increasing enzymatic activity and other biological activities. Therefore, it is recommended to add Zn to avoid the deficiency of this element during the growth of lentil plants in sandy soils.

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أثر اضافة الزنك رشا على نبات العدس النامى فى ارض رملية

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اقيمت تجربتين حقليتين بمحطة البحوث الزراعية بالاسماعيلية خلال الموسمين الشتويين ٢٠٠٥/٢٠٠٦ و ٢٠٠٦/٢٠٠٧ لدراسة تأثير الرش بتركيزات من الزنك (بدون اضافة ، ٠,٥ و ١,٠ و ٢,٠ و ٣,٠ جم/لتر فى صورة زنك مخلبى) على المحصول ومكوناته وكذلك المحتوى الكيميائى لنبات العدس النامى فى ارض رملية.

وكانت أهم النتائج ما يلى:

عموما أدت اضافة الزنك لنبات العدس الى زيادة معنوية فى المحصول ومكوناته فى كلا الموسمين مقارنة بالكنترول.

ادى الرش بالزنك بمعدل ١,٠ و ٢,٠ جم /لتر الى تفوق معنوى ملحوظ فى معظم صفات المحصول ومكوناته وذلك فى كلا الموسمين. بينما ادى الرش بمعدل ٣,٠ جم /لتر الى نقص معنوى ملحوظ فى معظم صفات المحصول ومكوناته وذلك فى كلا الموسمين متساويا مع معاملتى بدون اضافة ، ٠,٥ جم/لتر .

بالنسبة للمحتوى الغذائى فى الموسم الاول ، اعطى الرش بالزنك بمعدل ١,٠ و ٢,٠ جم /لتر الى تفوق معنوى ملحوظ مقارنة بباقى المعاملات(بدون اضافة ، ٠,٥ و ٣,٠ جم/لتر). فى حين انه فى الموسم الثانى اعطى الرش بالزنك بمعدل ١,٠ و ٢,٠ جم /لتر الى تفوق معنوى ملحوظ فى محتوى النيتروجين والبروتين (كنسبة مئوية) مقارنة بباقى المعاملات(بدون اضافة ، ٠,٥ و ٣,٠ جم/لتر). بينما لم يتأثر الفوسفور والبوتاسيوم (كنسبة مئوية) وكذلك الحديد والزنك والمنجنيز (كجزء فى المليون) باضافة الزنك بصفة عامة.