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ORIGINAL ARTICLES

Flax Yield And Quality Traits As Affected By Zinc Foliar Application Under Newly Reclaimed Sandy Soils

[1]O.A. Nofal, [2]M.S. Zedian and [2]B.A. Bakry

[1]Plant Nutrition and [2]Field Crops Departments, National Research Centre, Dokki, Cairo, Egypt.

ABSTRACT

Two field trails on flax (*Linumu sitatissimum* L.) cv. Sakha 2 were conducted during the consecutive seasons of 2009/2010 and 2010/2011 on sandy soil at the Experimental Farm of the National Research Centre, Nubaria District, Behira, Governorate, Egypt. The objective was to study the response of flax plants to foliar application by zinc sulphate (ZnSO4.7H2O) at the rates of 0.0, 0.5, 1.0, 1.5 and 2.0 g/L (200 L/Fed. before flowering stage and after capsules filling). The results could be summarized as follows: Increasing Zn fertilization from 0.5 to 2.0 g/L caused significant increases for growth, fiber yield, seed yield and oil % over the control. In addition, saturated and unsaturated fatty acids% under the study induced a positive effect as compared to the control. Also, similar effects were founds in fiber quality such fiber length and fiber finances.The obtained data showed that the highest results were obtained with the rate of 2 g/L.

Key word: Flax, Zinc foliar spray, fatty acid, seed and fiber yield.

Introduction

Flax(*Linumu sitatissimum*L.) is the most important fiber crops after cotton in Egypt. Flax is rich in oil (41%) , protein (20%), dietary fibre (28%). Also,it has a high percentage of essential fatty acids which is an omega -3 fatty acid and linoleic acid, which is an omega-6 fatty acid (Morris, 2005). In addition, the oil of the plant has a special value for human feeding, fabricating paints and different types of varnishes. The cultivated area of flax is decreasing yearly, due to the great competition of other economic winter crops resulting in a gap between production and consumption . Therefore, it is necessary to increase flax productivity per unit area which could be achived by using high yielding cultivars and improving the fertilization (El-Hariri, 1998; El-Gazzar, 2000; El-Hariri, 2002; El-Gazzar, 2006 and El-Shahawy, 2008).

Nutritional disorders creating deficiency symptoms can be affected by unbalanced fertilizer application (Doering, 1987). On the other hand, (El-Fouly, 1983) and (Amberger, 1991) cleared that the availability of micronutrients such as Fe, Mn, Zn and Cu is much affected by pH, $CaCO_3$ content, organic matter and soil texture.

Marschner, (1986) and Oosterhuis *et al*., (1991) cleared that zinc is an cofactor of over 300 enzymes and component of a number of dehydrogenases,proteinases and peptidases;thuszn influences electron transfer reaction including those of the Krebs Cycle and hance affecting the plants energy production.

Hamissa and Abdel Salam (1999), concluded that the important factor that makes fertilization with micronutrients an important issue is the high level of pH value of most Egyptian soils which hinders the utilization of these elements by the cotton plant.Foliar application of nutrients to the plants has been successfully used in correction of nutrient deficiency especially micronutrients (Hsu and Ashmead, 1984), and quickly counter a mineral unbalance that would inhibit plant metabolism.

Eid *et al.*, (1997) reported that Fe, Mn and Zn are important for the metabolic processes of cotton plant leading to both better production and high quality.

Moawad, (2001); Mostafa and El-Deeb, (2003) studied the effect of micronutrients on flax yield and quality.

The aim of the present study was to investigate the effect of foliar application with Zn on flax yield and quality.

Materials and Methods

Two field trails on flax cv. Sakha 2 (local double purpose) were performed duringthe two winter seasons of 2009/2010 and2010/2011. In both seasons, the work was conducted on sandy soil under sprinkler irrigation system at the Experimental Farm of the National Research Centre, Nubaria sector, BehiraGovernorate,

Corresponding Author: O.A. Nofal, Plant Nutrition and 2Field Crops Departments, National Research Centre, Dokki, Cairo, Egypt.

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 2mm sieve and analyzed according to Chapman and Pratt(1978).Physical and chemical analysis for soil of the experimental sites are presented in (Table 1).

Sowing date took place on mid November in both seasons. The trails were arranged in a randomized complete blocks design with four replicates. The plot area was 10.5 m^2 (3m x 3.5m) Each mineral fertilizer of NPK were added at the rates of 100%from that recommended by the Egyptian Ministry of Agriculture .For phosphorus fertilizer was added by 150 Kg P_2O_5/fed. as calcium superphosphate (15.5% P_2O_5)whereas for nitrogen fertilizer was 200Kg N/fed. as ammonium nitrate (33.5% N) split into five equal doses before irrigation and after two weeks from that and 50 Kg K_2O/fed. as potassium sulphate (48% K_2O) in one dose during land preparation. Zn foliar treatments were applied as zinc sulphate (35%zn) at the stage of beginning of flowering and during capsules filling respectively. These treatments were:

1. Control (untreated, spraying with tap water).
2. 0.5 g/L (200 L/fed.
3. 1.0 g/L
4. 1.5 g/L
5. 2.0 g/L

Table 1: Soil physio-chemical characters.

Sand %	88
Silt %	4
Clay %	8.0
Texture	Sandy
pH (1: 2.5 water)	8.83
E.C(mmhos/cm)(1:2.5)	0.12
$CaCO_3$ %	4.8
O.M %	0.24
P (mg/100g)	0.22
K (mg/100g)	10.18
Ca (mg/100g)	92.0
Mg (mg/100g)	18.4
Na (mg/100g)	12.36
Fe (mg/kg)	8.92
Mn (mg/kg)	8.34
Zn (mg/kg)	0.13
Cu (mg/kg)	0.10

At full maturity stage in the end of April and appearance of harvesting symptoms. Flax plants of /m^2 were pulled and then left on ground for air – dryed .Capsules were removed carefully , and then retting was carried out at Tanta flax and Oil Company using warm water retting system under controlled condition (30-35^oC). Also,random representative samples of ten plants were taken from every experimental until to estimate the following characters :

1. Morphological characters of flax plant are presented in (Table 2):
a. Total plant height (cm).
b. Technical stem length (cm)=total plant height (cm)-fruiting zone length (cm).
c. Stem diameter (mm).
d. Fruiting zone length (cm).

2. Seed and Straw Yields and Its Related Characters Are Presented In (Table 3):

a. No.of fruiting branches /plant.
b. No.of capsules / plant.
c. No. of seeds / capsule.
d. Seed yield /plant (g).
e. 1000-seed weight (seed index) (g).
f. Seed yield(kg/fed.).
g. Harvest index (%).
h. Straw yield /plant (g).
i. Straw yield (Ton/fed.).
j. Seed Oil(%): crude oil in the seed was determined according to A.O.A.C., (1980). Using Soxhelt apparatus and petroleum Eather (40-60^oC).
k. Biological yield (kg/fed.).

3. Seed Quality (Figs 1,2):

Fatty acids profile: fatty acids were determined according to methods described by Stahl (1967). The amount of each individual fatty acid in the oil under investigation was determined according to Nelson *et al.,* (1970).

4. Fiber Yield And Its Technological Characters (Fig.3):

a. Fiber yield (kg/fed.)=straw yield (kg/fed.)after retting multiplied by fiber %
b. Fiber (%)
c. Fiber length :Fiber length in (cm) was measured according to the standard of the A.S.T.M.Designation B.S.3697(1974)
d. Fiber fineness according to A.S.T.M.Designation D-1577(2006).

5. Statistical Analysis:

The analysis of variance procedure of completely randomized block design according to Snedecor and Cochran (1990)was used.

The combined analysis was conducted for the data of the two seasons aftertested the variances homogeneity of both seasons according to Gomez and Gomez(1984).The least significant difference (LSD)was used to Compared between different means. Obtained data were statistically Analyzed using MSTAT computer program. (MSTATC,1988).

Results and Discussion

Experimental Soil Characteristics:

Physical and chemical properties of the experimental soil are reported in (Table 1). These results reveal that the soil contain lower or deficient status of all nutrients for sandy texture and the high pH value with low organic matter content (Ankerman and Large, 1974). In this connection, several authors found that micronutrients deficiency may occur under such soil conditions (Sillanpaa, 1982 and Amberger, 1991). Foliar application of micronutrients was found to be more successful for correction of their deficit in crops (Alexander, 1986).

Effect Of Zn Foliar Application On Morphological Characters:

The results given in (Table 2) indicate clearly that morphological characters of flax at harvest was significantly affected by different Zn foliar treatments in both seasons.

The same Table shows that the mean values of studied characters of plants tend to increase with increasing Zn levelfrom (0.0-to 2.0g/L). The highest values of total plant height,and technical stem length ,stem diameter and fruiting zone length were obtained with Zn at the rate of 2 g/L may be referred to its role in biosynthesis of the natural axine, indole acetic acid (Mengel and Kirkby, 1987) and account promotion of stem elongation. (El-Shahawy *et al.,* 2008) indicated the positive effect of micronutrients on the growth of flax plants.

Table 2: Effect of different levels of zinc foliar application on morphological characters of flax plant (combined of two seasons).

Treatments	Total plant height(cm)	Technical stem length (cm)	Stem diameter (mm)	Length of fruiting zone (cm)
Control	60.22	51.44	1.76	8.78
0.5 g/L	63.76	54.85	1.79	8.91
1.0 g/L	66.76	55.83	1.83	10.93
1.5 g/L	70.43	58.69	1.95	11.74
2.0 g/L	72.17	59.33	2.02	12.79
L.S.D. 5%	3.34	0.70	0.04	1.05

Effect Of Zn Foliar Application On Yield And Its Components:

Data in (Table 3) show that the number of fruiting branches /plant ,number of capsules /plant ,number of seeds /capsule, seed yield /plant, 1000-seeds weight, seed yield /fed., harvest index, straw yield /plant,straw yield(ton/fed.)and seed oil percentage of flax plant were significantly increased by Zn foliar application as compared with the control.

The number of fruiting branches/plant was reached the highest increase due to foliar sprayings with the high level of Zn element (2.0g/L). In this connection, it is worthy to note that trace elements were reported to control the hormonal balanced of the plant (Coke and Whittington, 1968).

For seed index, the results indicated that seed index was significantly affected by Zn foliar application. This results may be due to that Zn element have important functions in plant metabolism especially in chlorophyll synthesis, photosynthesis, nitrate reduction, amino acid and protein synthesis, In this respect. (Tailakov, 1976) cleared that spraying cotton plants with trace elements were reported to increase the uptake of other nutritive elements which must be reflect on the final yield.

Table (3) illustrate that the increase on seed flax yield/plant and/fed. Were significantly and this result may be due to the two foliar applications with Zn at the high level in both seasons which (Sillanpaa, 1982) reported that the plants can't take up their micronutrients requirements under undesirable soil conditions, such as high pH, low organic matter content. These increase of flax yield/plant and/fed. may be attributed to the effect of micronutrients on dry matter yield or due to the great efficiency of enzyme activities which affected plant pigments and at the rate of photosynthesis. (Amberger, 1974; Hegab, *et al.*, 1987 and Eid *et al.*, 1997), reported with cotton plants.Sawan *et al*.,(2001)presented that application of zinc increased seed yield, and oil yield as well as total unsaturated fatty acids (oleic and linoleic) content in cotton.

Data presented in (Table 3) exhibit that seed Oil% was significantly increased by spraying flax plants with Zn elements, El-Halawani, 1979; El-Kashlan*et al.,* 1995; Abd El-Shafy, 1998; Wassel *et al.,* 2000 and Abdel Shafy *et al.,* 2001), found the same results with cotton plants.

The high level (2.0g/L) of Zn treatment significantly increased seed yield/fed.of flax by 19.66%, straw yield/fed. by 14.57% and oil% by 4.7% over the control. In this connection, Mohsen *et al*., (2009) suggest that foliar Zn and Mn application can improve the seed yield of safflower.

Table 3: Effect of different levels of zinc foliar application on yield and its components of flax plant (combined of two seasons).

Treatments	No. of fruiting branches/ plant	No. of capsules/ plant	No. of seeds / capsules	Seed yield/ plant (g)	1000-seeds weight (g)	Seed yield/fed (Kg/fed)	Harvest index (%)	Straw yield/ plant (g)	Straw yield (Ton/fed)	Seed Oil (%)
Control	3.48	5.56	6.20	0.32	5.14	438.65	14.39	0.79	2.609	37.10
0.5 g/L	3.53	6.46	7.40	0.34	5.96	495.55	15.74	0.99	2.653	37.98
1.0 g/L	3.64	6.96	7.80	0.35	6.57	523.05	15.99	1.00	2.748	38.62
1.5 g/L	3.70	6.88	8.30	0.36	8.02	539.72	15.49	1.00	2.944	38.73
2.0 g/L	3.87	7.10	8.90	0.37	8.17	545.98	15.17	1.20	3.054	38.93
L.S.D. 5%	0.18	0.44	0.59	0.03	0.17	32.82	1.38	0.08	0.13	0.66

Effect of Zn foliar application on fatty acids % :

Data presented in Figs (1,2) pointed out that all treatments of Zn element especially high dose gave a positive effect on saturated fatty acids, i.e. Myristic and Palmatic and unsaturated fatty acids, i.e. Stearic; Olic; Linolic and Linolenic fatty acids. It seems that Zn has a beneficial effect on the formation fatty acids.

The improved of physiological performance in tested plants due to more nutrients uptake by treated flax plants from soil. Such results are in harmony with those obtained by (Fawzi, 1991 and El-Shahawy*et al.,* 2008).In this respect, Mohsen *et al.,* (2009) indicated that Zn and Mn application can improve the seed quality of safflower.

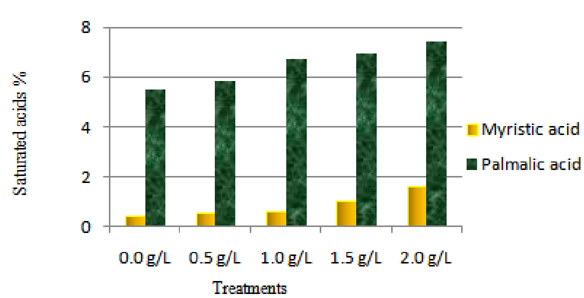

Fig. 1: Comparison between the effect of different levels of zinc foliar application on saturated fatty acids % of flax seeds. (combined of two seasons).

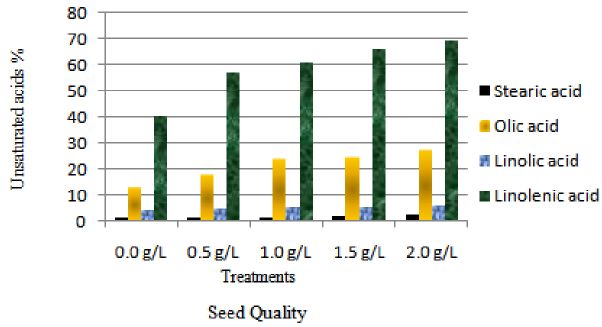

Fig. 2 : Comparison between the effect of different levels of zinc foliar application on unsaturated fatty acids % of flax seeds (combined of two seasons).

Effect Of Zn Foliar Application On Fiber Yield:

Results in Fig. (3) clear that fiber yield and fiber % were significantly affected by spraying Zn element for two times in both seasons.

The same Fig. shows that the increase in fiber length and fiber fineness by increasing Zn rates over the control, may be due to the role of this element on fundamental metabolic reaction and acceleration protein synthesis which affects fiber properties (Abdel Shafy*et al.*, 2001).

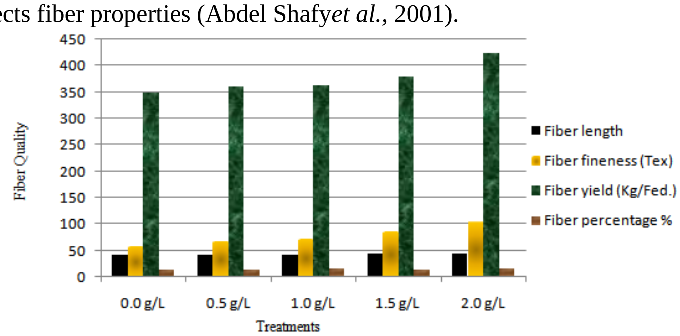

Fig. 3 : Effect of different levels of zinc foliar application on fiber yield and its technological characters of flax plants (combined of two seasons).

Conclusion:

It be concluded that Zn foliar feeding is important to correct the nutrient balance in flax plant (Sahka 2) under undesirable soil conditions. The high level of Zn (2 g/L) with two times of application could be recommended for giving best growth which reflect on high seed flax yield and fiber quality.

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