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Effect of Foliar Spraying with Zn and Different Levels of Phosphatic Fertilizer on Growth and Yield of Sunflower Plants Grown under Saline Condition

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A POT experiment was carried out during the summer season of 2001 in the green house of National Research Centre, Dokki, Giza Egypt. This work aimed to study the interaction effect of different rates of phosphorus (fetilization (32, 48 and 64 P_2O_5 kg/fad) and foliar spraying with zinc (without spray, spray once after 30 days from sowing and twice after 30 and 45 days from sowing) on growth and yield of sunflower plants grown under salinity conditions. Increasing level of phosphorus fertilization from 32 to 48 or 64 P_2O_5 kg/fad greatly increased various growth parameters (*i.e.*, leaves number, dry weight of leaves, stem and head) as well as yield components (head diameter and weight and seed yield). Moreover, foliar spraying with Zn either once or twice significantly increased most growth and yield parameters. The highest dry matter accumulation in leaves , stem and head and the highest yield and yield components recorded by sunflower plants fertilized with P_2O_5 48 kg/fad and foliar sprayed with zinc after 30 days from sowing .

Keywords: Sunflower, Salinity, Phosphorus fertilizers, Foliar spraying with zinc, Growth yield.

Sunflower (*Helianthus annuus* L.) crop occupied the second place after soybeans as an important source for food oils in the world. The expansion in cultivating sunflower crops is of great necessity for many substantial reasons. Among these oil percentage (40-50%) in seeds that characterized with good properties. Moreover this crops thrives in all soil types and can be grown well in the new reclaimed lands where saline soils are prevalent for the obligation to irrigate with water containing soluble salts.

Plant growth is limited with different environmental conditions. One of these conditions is salt stress. Among various factors contributing to plant growth, nutrient availability plays a vital role .The relatively low availability of most macro and micro - elements in most saline soils affect plant growth to a great extent (Carbonell- Barrachina *et al*., 1998 and Tripathi & Sharma, 1999). In this connection, salinity reduces phosphate uptake and accumulation in crops grown in soil a primarily by reducing phosphate availability (Amer,1999). Zinc uptake was also significantly reduced under salinity treatments (Mohammad *et al* ,2003) .

The antagonistic effect of P on Zn uptake has been reported by many investigators (Gunes *et al.*, 1999 and Singh & Ramakala, 2003). In this respect, Shahrokhnia (1998) reported that accumulation of phosphorus fertilizer in the soil can prevent uptake of micro nutrient especially Zn and Fe. Kadar (2001) also reported that there was evidence of P-Zn antagonism , and such P-Zn antagonism induced latent Zn deficiency.

The concentration of Zn in leaf and stem of sunflower plant greatly affected by stage of growth. In this respect, Sfredo & Sarruge (1990) reported that leaf and stem Zn concentration decreased to minimum values coinciding with the period of maximum DM production and then increased slightly towards maturity. Thus the possibility of supplying Zn as foliar spray at 30 and 45 days from sowing is undoubtedly of great importance.

Therefore, the objective of the present study was to investigate the effect of foliar spraying with Zn applied with different rates of phosphorus and their interaction on growth and yield of sunflower plants grown under saline conditions .

Material and Methods

Pot experiment was conducted in the green house of National Research Centre, Giza Dokki Egypt in the summer season of 2001 to investigate the effect of foliar spraying with Zn and different rates of phosphorus fertilizers and their interaction on growth and yield of sunflower plants grown under saline conditions. The experiment include nine treatments which were the combination of three levels of phosphorus (P_1 =32, P_2= 48 and P_3= 64 P_2O_5 kg/fad.) and three zinc treatments (without zinc spray , spraying once after 30 days from sowing and spraying twice after 30 and 45 days from sowing). The pots were arranged in a completely randomized design.

The seeds of sunflower (*Helianthus annuus*) cv. Eroflower were planted in 18^{th} April (2001) in 72 pots. The plants were grown in pots 30 cm in diameter filled with dried clay loam soil . The physical and chemical properties of the used soil are presented in Table 1 using the standard method described by Klute (1986).The pots were divided to three groups 6,9 and 12 g of calcium super phosphate (15.5% P_2O_5) at a relevant rate of 32, 48 and 64 P_2O_5 kg /fad were added per pot before sowing to the first , second and the third group, respectively. 1.5 g potassium sulphate (48% K_2O) was added per pot at a relevant rate of 24 kg K_2O/fad. Ammonium sulphate (20.6% N) 4.38 g per pot at a rate of 30 kg N/ fad was divided into two equal portions and added after 3 weeks from sowing and two weeks later. Sunflower plants were thinned to one plant per pot after three weeks from sowing. All pots were irrigated regularly with saline solution at the level of 3000 ppm which is prepared by dissolving the salt mixture (NaCl and $CaCl_2$ 1:1/ weight).

TABLE 1. Mechanical and chemical analysis of the soil .

Mechanical and chemical analysis	
Sand%	22.48
Silt %	30.97
Clay %	46.55
Texture	clay
Organic matter	2.10
ph	6.49
Ec (millimose/cm)	0.62
$CaCO_3$ %	1.84
Macro elements:	
Soluble N mg/100 g soil	21.00
P (p.p.m.)	19.20
K (mg/ 100 g soil)	24.37
Mg (mg/ 100 g soil)	189.00
Micro elements:	
Fe (ppm)	2.01
Zn (ppm)	12.67
Mn (ppm)	14.21
Cu (ppm)	1.39

After 30 days from sowing , each group is divided to three subgroup. The first one unsprayed with Zn solution and the second sprayed with 0.5 g/litre chelated zinc (12 %) in the form of EDTA and containing organic and amino acids. The third one is sprayed with the chelated zinc after 30 and 45 days from sowing.

Representative plant samples from four replicates were taken after 60 days from sowing and their growth criteria were recorded, *i.e*, plant height , number of leaves, head diameter and dry weight of leaves stem as well as head per plant. The photosynthetic pigments, *i.e.*, chlorophyll a, chlorophyll b and carotenoids were extracted by aceton 85 % and calculated using Von Wettstine formula (1975) as mg / dc^2. The concentration of total soluble solids (T.S.S.) in the cell sap was recorded using refractometer and the corresponding values of osmotic potential (Atm.) were then obtained from tables given by Gusev (1960). Proline acid content was determined according to the method described by Bates & Tear (1973).

At harvest time the following data were recorded from four replicates : plant height (cm), head diameter (cm) , head weight (g/ plant) , seed weight (gm/plant) and weight of 100 seeds (seed index). Seed oil content (%) was estimated on dry weight basis according to the method described by A.O.A.C. (1975) using Soxhlet apparatus and petroleum ether as a solvent.

The obtained results were subjected to statistical analysis of variance of factorial experiment in completely randomized design according to Snedcor & Cochran (1980).

Results and Discussion

Effect on vegetative growth

Regarding the effect of P fertilization on the growth of sunflower grown under saline condition, data in Table 2 indicate that regardless of zinc treatment , increasing the level of P application from 32 kg P_2O_5 /fad to 48 or 64 resulted in a corresponding increase in various growth parameters, *i.e.*, plant height, leaves number as well as the dry weight of leaves, stem and head. These findings were in agreement with the results obtained by Aulakh *et al.* (1980) who recorded that application of P increased dry weight and height of plants grown under saline conditions. In addition, Malik *et al.* (1999b) added that increasing P rate increased growth at all salinity levels.

As for the effect of foliar spraying of Zn on growth parameters of sunflower plant grown under saline condition, the same table revealed that in general, foliar spraying with zinc either once or twice significantly increased most growth parameter as plant height , leaves number as well as stem and head dry weight as compared with unsprayed plants. These findings coincide with those obtained by Thalooth & Kabesh (1988) on soybean and Trehan & Sharma (2000) on sunflower who reported that relative shoot dry matter-yield without zinc expressed as percentage of yield with adequate zinc was 64, 57 % and 130 % for potato, maize and sunflower , respectively, indicating that sunflower was most zinc efficient plant . Such simulative effect of Zn on growth parameters under saline condition may be attributed to the effect of Zn on producing growth substances, *i.e.*, auxin , which in turn encourage the meristematic activity of the plants which resulted in more cell divisions and enlargement (Devlin & Withan, 1983). The simulative effect of Zn on growth may also be attributed to the effect of Zn on protein synthesis. In this concern, Obata & Umebayashi (1988) reported that Zn deficiency depressed the ribosomal content followed by reduction in protein synthesis.

The interaction effect of level of phosphorus and foliar spraying of Zn show a positive effect on all growth parameters, *i.e.*, plant height, leaves number and the dry weight of leaves, stem and head. The highest dry mater accumulation in leaves, stem and head was obtained by sunflower plants fertilized by the moderate level of phosphate fertilizer (48 kg P_2O_5/fad) and foliar sprayed with Zn after 30 days then followed by plants sprayed twice after 30 and 45 days from sowing except dry weight of head . These results added more support to those obtained by Trehan & Sharma (2000) who reported that application of Zn in combination of phosphorus significantly increased the growth of plants. These results may be attributed to the effect of Zn in increasing the uptake of the three major nutrients (NPK) (Latha *et al.*, 2002). These results may be attributed also to the indirect contact of the foliar sprays to the higher parts of the plant. In this connection (Zhang *et al.*,1991) reported that, it is well known that the mobilizing forces seem to be strongest in the higher parts of the plant than in root. These results proved the fact that the success of foliar mode of application is governed by the availability of nutrients in soil where nutrient absorption is restricted.

Effect on photosynthetic pigment contents

Data presented in Table 2 indicate that increasing rate of phosphorus fertilization from 32kg P_2O_5 /fad. to 48kg P_2O_5/fad significantly increased either chlorophyll "a" or chlorophyll "b". Phosphorus fertilization with 48 kg P_2O_5 /fad slightly increased these pigments. Carotenoids content followed the same trend. The positive effect of increasing P-levels on chlorophyll content in the leaves was reported by Ibrahim *et al.* (1983).

Data presented in the same table also show that foliar spraying with Zn significantly increased photosynthetic pigments, *i.e.*, chlorophyll "a", chlorophyll "b" and carotenoids. Similar results obtained by Khurana & Chatterjee (2001) who reported that concentration of chlorophyll a and b, and soluble proteins were maximum at .065 mg Zn l^{-1} (adequate) and were lowered significantly in both deficiency and excess of Zn. (Losanka *et al.*, 2002). Also reported that Zn deficiency caused a strong reduction in chlorophyll content in maize plants.

Regarding the interaction effect of phosphorus and zinc on photosynthetic pigments content the same table shows that the highest chlorophyll a and b contents was obtained by sunflower plants fertilized by 48 kg P_2O_5/fad and foliar sprayed with Zn once after 30 days from sowing.

Effect on cell sap concentration, osmotic pressure and proline content

Data presented in Table 2 show that cell sap concentration as well as osmotic pressure increased by either increasing the level of phosphorus fertilizer from 32 kg P_2O_5/fad to 48 or 64 or by foliar application of Zn. Such effect may be attributed to the effect of phosphorus in increasing cation exchange capacity of roots (Tripathi & Gehlot, 1999) and to the promoting effect of phosphorus in increasing transportation of K+ in the plant (Deng *et al.*, 2002), in turn increasing cell sap concentration and the osmotic pressure. The highest cell sap concentration and consequently osmotic pressure was obtained by sunflower plants fertilized with the high level of phosphorus fertilizer (64 kg P_2O_5/ fad) and foliar sprayed once with Zn.

As for proline acid content the same table indicate that, in general, increasing the level of phosphorus fertilization slightly increased the proline acid content. Foliar application of Zn also increased this criterion and the highest proline acid content was recorded by the leaves of sunflower plants fertilized with 64 kg P_2O_5/fad and foliar sprayed twice with Zn.

TABLE 2. Effect of foliar spraying with Zn and different levels of phoshorus fertillzer on the growth of sunflower plants grown under salinity conditions.

P Treatments	Zn Treatments	Growth parameters: Plant height (cm.)	Leaves. No (No./ plant)	Dry weight g/plant: Leaves	Stem	Head	Photosynthetic Pigments mg/dc: Chl.a	Chl.b	Cart.	Proline acid (mg/ g fresh wt)	Cell sap conc. (%)	Osmotic Pressure (atm.)
P1	Zn0	66.00	16.75	3.48	3.53	2.28	1.59	0.63	4.09	2.74	7.33	5.84
	Zn1	90.75	19.75	4.75	4.99	3.67	2.29	0.85	5.24	2.08	7.67	6.13
	Zn2	82.00	17.50	4.01	4.38	3.63	1.83	0.70	4.50	2.64	7.67	6.02
P2	Zn0	82.25	19.25	4.40	4.60	2.81	1.76	0.71	4.44	2.88	8.33	6.71
	Zn1	96.25	21.75	6.10	5.37	4.45	2.47	0.94	4.71	2.79	9.17	7.48
	Zn2	89.75	21.00	5.66	5.35	3.70	2.4	0.91	5.68	2.38	9.00	7.32
P3	Zn0	84.25	19.00	4.26	4.33	2.88	1.61	0.58	4.59	2.69	8.50	6.87
	Zn1	95.00	19.75	4.78	5.28	4.21	2.28	0.87	5.17	2.94	9.67	7.94
	Zn2	86.50	20.00	4.78	5.27	3.91	1.98	0.71	3.90	3.01	9.50	7.79
Means of P	P1	79.58	18.00	4.08	4.30	3.19	1.90	0.73	4.61	2.49	7.56	6.00
	P2	89.42	20.67	5.39	5.11	3.65	2.21	0.85	4.94	2.68	8.83	7.17
	P3	88.58	19.58	4.61	4.96	3.67	1.96	0.72	4.55	2.88	9.22	7.53
Means of Zn	Zn 0	77.50	18.33	4.05	4.15	2.66	1.65	0.64	4.37	2.77	8.05	6.47
	Zn1	94.00	20.42	5.21	5.21	4.11	2.35	0.89	5.04	2.60	8.84	7.18
	Zn2	86.08	19.50	4.82	5.00	3.75	2.07	0.74	4.70	2.68	8.72	7.04
LSD (P= 0.05)	LSD P	4.78	1.09	0.52	0.70	N.S	0.23	0.08	0.37	0.33	0.53	0.64
	LSD Zn	4.78	1.09	0.52	0.70	0.57	0.23	0.08	0.37	0.33	0.53	0.64
	LSD P&Zn	8.28	1.88	0.9	1.21	0.98	0.40	0.15	0.64	0.58	0.92	0.80

Effect on Yield

It is obviously indicated from Table 3 that plant height significantly increased by increasing level of phosphorus . Similar results were obtained by Aulakh *et al.* (1980). As for the effect of Zn, it was found that plant height significantly increased with foliar application of Zn .

It was also observed from the same table (Table 3) that head diameter, head weight, seed yield as well as seed index increased by increasing level of phosphorus fertilizer from 32 to 48 or 64 kg P_2O_5/ fad. These results were supported with the findings obtained Ujjinaiah, *et al.*, (1989) who reported that increasing P rate increased the 1000 seed wt. of the resulting seeds. Naphade & Naphade (1991) and Malik *et al.* (1999a) also added that increasing P rate generally increased yield components and seed yield at all salinity levels. Such promoting effect of phosphorus on seed yield of sunflower plants under saline condition may be attributed to the suggestion that phosphorus has a role in increasing water use efficiency and withstanding problems of water stress and salinity in crops, it is suggested that P fertilizer placement may help to maximize water use efficiency (Tripathi & Gehlot,1999).

It is worthy to note also that there is not significant difference between the high two levels of phosphorus 48 to 64 kg P_2O_5/ fad. on seed yield and most yield parameters (Table 3). These results coincide with those obtained by Chaniara *et al.*, (1989) who reported that yields were similar with 40, 60 and 80 kg P_2O_5/ ha . The same table also shows that significant increment in most yield parameters, *i.e.*, head diameter, head weight, seed yield and seed index were found due to foliar spray with Zn either once or twice . The data also shows that there is no significant effect on head diameter, head weight and seed index between plants foliar sprayed with zinc one time (after 30 days from sowing) or two times (after 30 and 45 days from sowing). The superiority of Zn in increasing sunflower yield may be attributed to the important role of Zn element in the biochemical function in plants, since zinc deficiency depressed the ribosomal content followed by reduction in protein synthesis (Obata & Umebayashi, 1988) . The superiority of Zn may be also attributed to the effect of zinc in increasing the uptake of all the major nutrients (NPK) (Latha *et al.*, 2002).

As for the effect of P on oil percentage the data in Table 3 indicate that increasing the level of phosphorus fertilizer from 32 to 48 or 64 significantly increased oil percentage . The same table also shows that foliar spraying with Zn once or twice has positive effect on increasing oil content. Similar results obtained by Khurana & Chatterjee (2001) who reported that oil content was highest (23.4%) at .065 mg Zn l^{-1} .

TABLE 3. Effect of foliar spraying with Zn and different levels of phosphorus fertilizer on the yield of sunflower plants grown under salinity conditions.

P Treatments	Zn Treatments	Yield parameters					
		Plant height (cm.)	Head diameter cm.	Head weight g/plant	Seed yield g/plant	Seed index	Oil content (%)
P1	Zn0	69.88	6.45	8.3	4.95	1.70	31.27
	Zn1	89.38	7.78	11.09	7.45	1.92	32.37
	Zn2	86.13	7.20	11.4	7.37	1.83	32.20
P2	Zn0	71.75	7.10	11.53	7.08	1.73	32.2
	Zn1	90.00	8.30	14.53	10.33	1.84	35.90
	Zn2	86.63	8.08	14.07	9.89	1.97	33.97
P3	Zn0	74.88	7.45	10.36	6.67	1.79	30.13
	Zn1	89.88	8.25	14.84	9.89	2.08	35.53
	Zn2	94.13	7.60	14.7	9.38	2.02	32.87
Means of P	P1	81.80	7.14	10.26	6.59	1.82	31.95
	P2	82.79	7.83	13.38	9.10	1.85	34.02
	P3	86.30	7.77	13.30	8.65	1.96	32.84
Means of Zn	Zn 0	72.17	7.00	10.06	6.23	1.74	31.20
	Zn1	89.75	8.11	13.49	9.22	1.95	34.60
	Zn2	88.96	7.63	13.39	8.88	1.94	33.01
LSD (P=0.05)	LSD P	3.96	0.35	1.75	1.22	N.S.	0.72
	LSD Zn	3.96	0.35	1.75	1.22	0.15	0.72
	LSD P&Zn		0.60	3.03	2.11	0.26	1.24

There is a positive interaction effect between different levels of phosphorus fertilizer and foliar spray of zinc on most yield parameters. The highest seed yield and the most promising interaction was obtained by sunflower plants fertilized with 48 kg P_2O_5/fad and foliar sprayed with zinc once at 30 days after sowing followed by plants sprayed twice at the same level of phosphorus fertilizer. These results were supported by the findings of Germa & Minhas (1987) and Glushcenko *et al.* (1991) who reported that in the presence of P, application of Zn results in significant increasing in yield.

From the above mentioned results, it can be concluded that increasing the level of phosphorus fertilization to 48 kg P_2O_5/fad and foliar spraying with Zn had a favorable effect on enhancing growth and yield of sunflower plants grown under salinity condition . Such promoting effect of phosphorus may be attributed to the effect of phosphorus in increasing cation exchange capacity (CEC) of roots under saline- sodic condition (Tripathi & Gehlot,1999), and to the effect of superphosphate in increasing the selective transportation of K^+ in the plant and significantly enhancing SR_{KNa} (selective ratio) ,thus alleviating salt injury (Deng *et al.*,2002). The simulative effect of Zn on growth and yield of sunflower plants may be also attributed to the effect of Zn in increasing protein synthesis (Obata & Umebayashi ,1988) and the uptake of all the major nutrients (NPK) (Latha *et al.*, 2002). From these results , it can be concluded that foliar nutrition of sunflower plants with Zn may increase the efficiency of phosphorus utilization in enhancing the vegetative growth and the yield under saline condition.

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تأثير الرش بالزنك والتسميد بمعدلات مختلفة من التسميد الفوسفاتى على نمو ومحصول نبات عباد الشمس النامى تحت ظروف ملحية

اليس توفيق ثالوث ، نادية محرم بدر* و ماجدة حسنين محمد
قسم المحاصيل و *قسم العلاقات المائية والرى الحقلى المركز القومى للبحوث-القاهرة - مصر٠

أجرى هذا البحث فى الصوبة الزراعية للمركز القومى للبحوث خلال الموسم الصيفى ٢٠٠١ وذلك بهدف دراسة تأثير الرش بالزنك والتسميد بمعدلات مختلفة من التسميد الفوسفاتى على نمو ومحصول نبات عباد الشمس النامى تحت ظروف ملحية ٠ وقد وجد ان زيادة معدلات التسميد الفوسفاتى الى ٤٨ و ٦٤ كجم فو$_{٢}$ أ$_{٥}$ أدى الى زيادة طول النبات وعدد الأوراق والوزن الجاف للساق والأوراق ومكونات المحصول المختلفة من زيادة قطر ووزن القرص والحبوب بالمقارنة بالتسميد بمعدل ٣٢ كجم فو$_{٢}$ أ$_{٥}$ كما وجد ان الرش بالزنك لمرة واحدة بعد ٣٠ يوم من الزراعة أدى الى زيادة فى معظم صفات النمو والمحصول بالمقارنة بالنباتات الغير مرشوشة والمرشوشة مرتين بعد ٣٠ و ٤٥ يوم من الزراعة٠ وأعلى محصول تم الحصول عليه بواسطة نباتات عباد الشمس التى تم تسميدها بواسطة ٤٨ كجم فو$_{٢}$ أ$_{٥}$ ورشها بواسطة الزنك المخلبى بعد ٣٠ يوم من الزراعة٠