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Comparing the agronomic reaction of nut and oil sunflowers in different phosphorus and zinc fertilizer condition

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Abstract

The act in response of oil and nut sunflowers type (*Helianthus annus* L. cv. Zaria oily and Ghalami nut type) to different basis and level of phosphorus and zinc fertilizer under field situation this trial was conduct at Agricultural Research Centre, Islamic Azad University Arak, Iran during 2011.Phosphorus levels were 350, 175, 175 kg/ha triple super phosphate plus 100g/ha phosphorus solubilising bacteria and pure PSB, Zinc levels were 0, 25 kg/ha soil application from zinc sulphate, 25 kg/ha in form of soil use zinc sulphate in addition soluble zinc 10% and soluble zinc 10% as solo foliar application. Result explains in oil type sunflower the peak grain yield was 2.52 t/ha by 100 g/ha phosphorus solubilising bacteria. It was for nut sunflower type 3.68 t/ha by support with 175 kg/ha superphosphate fertilizer plus 25 kg/ha zinc sulphate. Utilization of 175kg/ha superphosphate compound without zinc compound and also 350 kg/ha triple super phosphate plus 25kg/ha zinc sulphate were the same effects on head width of oil sunflower heads by 15.3 to 15.4 cm as greatest diameter of heads in oil sunflower kind. The least head size in oil sunflower type was 10.33 cm by use of 350 kg/ha triple super phosphate fertilizer in addition foliar application of soluble zinc 10% significantly. Stem thickness measurements affected by our treatments in both sunflower types and Means comparisons for LAI show that in oil sunflower type the highest LAI was obtain by pure PSB in non zinc application condition(4.09). In nut sunflower type also, the maximum LAI was estimated in 350 kg/ha triple super phosphate utilize plus foliar application of soluble zinc 10% plots (6.09).

Keywords: sunflower, zinc, phosphorus, nut seed, oil seed, yield.

Introduction

Sunflower is one of the major crops species for the production of suitable for eating oil and nuts in many countries of the world, including Iran. It is a summer crop in Iran where about 60,000 ha are grown from this amount about 15,000 ha is nut type annually. Numerous researchers (Suzer and Atakiss, 1993; Petakov, 1994; Punia and Gill, 1994) have found significant positive correlations between morphological characteristics such as head diameter and seed yield. A yield component that directly changes hybrid model is head size which is expressed as head diameter in cm. Head size should be intermediate, with a diameter of 20-25 cm (Ekin, 2010). Increase in head size above the optimum value results in reduced kernel yield (g/head), increased husk percentage, increased number of empty seeds and reduced oil content in seed (Škorić, 1989).

Phosphorus is a critical nutrient for growth and sustainable production of oil and grains in sunflowers, which affects grain yield, oil content and quality, and under conditions of deficiency, leaf area and photosynthesis is reduced (Rodriguez, 1998). Application phosphate solublizing microorganisms (PSM) increase efficiency and

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solubility of insoluble phosphate. Plant growth promoting bacteria (PGPR) are a group of free living microorganisms that use different methods to increase plant growth (Glick, 1997). Some of these bacteria increase P uptake by the plant go to the group of phosphate solublizing bacteria and as biological fertilizers is used to increase plant growth and yield (Chen *et al.*, 2006). Bahl, *et al.* (1997) found that there are a significant yield response up to 60 kg N/ha and 30 kg/ha P2O5, in the absence of P, decreased oil percentage in sunflower seeds, P application low than 30 kg/ha P2O5 significantly increased oil content. Padmavathi and Prayaga (2003) indicated that sunflower fertilized with 50 and 75 kg/ha P2O5 recorded significantly higher seed yield about 1593 and 1688 kg/ha respectively over 25kg/ha P2O5 (1324 kg/ha). Jahangirn (2006) found that maximum no. of seeds. Head and seed yield were produced by the application of 75kg/ha P2O5.

Among the micronutrients, zinc deficiency is most widespread on a wide range of soils (Grewal *et al.*, 1997 and Marie and Howarth. 2009).Zinc had effect in protein synthesis, gene regulation, DNA transcription, protection cells from oxidative damage. Zinc deficiency reduces net photosynthesis, intermodal length of stem, increasing chlorosis and necrotic spots in the leaves and severely reduce seed yield (Alloway, 2008). Sankaran, *et al.* 2001 concluded that the highest seed yield (1716 kg/ha), oil percentage (36%), oil yield (616 kg.ha-1), protein percentage (16.6%) and protein yield (284.8kg.ha-1) obtained by spraying sunflower leaves with zinc concentration of 0.5 ppm. Praksh and Halaswamy (2004), found that spraying plant leaves with 0.3 ZnSo4 gave a high values of head diameter (20 cm), no. of seeds/head, 1000 seed weight (62.2gm) and seed yield (1600 kg/ha). Gitte *et al*, 2005 indicated that adding 5.25 kg Zn/ha to the soil, produce maximum values of 1000 seed weight (65 gm), seed yield (3400 kg/ha) and oil percentage (41%). Marschner, (1995) reported that critical concentration of zinc in plant leaves ranged 15-20 mg/kg dry weight. The objectives of this investigation were to assess the Comparing the agronomic reaction of nut and oil sunflowers in different phosphorus and zinc fertilizer condition.

Materials and methods

Two separated field experiments were conducted during growing season of 2010 at Arak, Iran (34°03'08" N, 49°48'26" W; 1711 m above sea level) on a sandy loam soil having 0.08, 4.1, 166 and 0.63 ppm available N, P, K and Zn respectively, (Table 1). Both experiments were laid out according to the split plot experiment biased on Randomized Completely Block Design with three replications. Treatments in the main plots were four levels of phosphorus application (350 kg/ha, 175kg/ha, 175 kg/hatriple super phosphate (TSP) plus phosphorus solubilizing bacteria (PSB) and PSB net. Phosphorus fertilizers were applied to the soil in form of triple super phosphate with 48%P_2O_5 and Phosphor solubilising bacteria a combination *Pantoea agglomerans* strains P5 and *Pseudomonas putida strain* P13 and sub plots were arranged for zinc treatments in four levels too, (0, 25kg/ha zinc sulphate (ZS) in form of soil application, 25kg/ha soil application from zinc sulphate plus soluble zinc 10% (SZ) as foliar application and net soluble zinc 10% as foliar application on the leaves in same dose during sunflower budding stage. Zinc sulphate ($ZnSO_4.7H_2O$10%) application was in soil and water soluble zinc in foliar application type. Two hybrids seeds of sunflowers (Zaria oily and Ghalami nut type) sown in separated field experiments at 7th June, but harvested at 20th October for oil type and 25th October for nut type respectively. In both field trials the distances between hills were 20 cm with 50 cm distant ridges to to give a plant population of 75000 plants per hectare.

Table 1. The physical and chemical characters of soil before planting (0 to 30 cm depth)

Soil. Physico-Chemical properties			
pH (Sat. paste)	7.80	Zn (mg kg-1)	0.63
EC (dS m-1)	2.70	Fe (mg kg-1)	2.90
Organic matter (%)	0.75	Mn (mg kg-1)	3.30
P (mg kg-1)	4.10	Cu (mg kg-1)	0.12
K (mg kg-1)	166	Texture	Sandy Clay loam

Before planting the soil samples were collected from 0-30cm depth and analysed for physico-chemical characteristics (Table 1) according to the methods described by Ryan *et al.* (2001). Thus, common agronomical needs same as nitrogen fertilizer was applied in the form of urea (46%N) by adding 150 kg/ha in three time by equal doses, 50 kg/ha in sowing and the remaining 50kg/ha 30 days after sowing and last part of urea before flowering stage. Potassium fertilizer also, was applied by adding to the soil for 150 kg/ha potassium sulphates (48%K_2O) as basic

Table 2. Analysis of variance for grain yield and yield components of oil and nut sunflower

S.O.V.	D.F	Mean Squares									
		Grain yield		Head diameter		Stem thickness		Plant high		Leaf area index	
		oil	nut	oil	nut	oil	nut	oil	nut	oil	nut
Replication (R)	2	0.0001n.s	0.099n.s	1.003ns	3.690ns	19.27ns	27.650ns	1032.330ns	1071.440	0.070n.s	0.209n.s
Phosphorus (P)	3	0.001*	1.57n.s	6.310ns	3.920ns	15.58ns	21.550ns	941.240ns	945.910ns	1.320n.s	3.830*
Error	6	0.0002	0.72	4.900	1.630	13.99	7.950	727.560	847.990	0.330	0.640
Zinc (Z)	3	0.001n.s	0.74n.s	3.930ns	0.660ns	7.79ns	15.940ns	885.240ns	680.910ns	0.700*	1.097**
P.Z Int.	9	0.0008n.s	0.87 *	5.550*	1.330ns	19.27ns	27.650ns	559.220ns	507.480ns	1.940**	3.240**
Error	24	0.0005	0.34	2.520	2.320	15.58	21.550	510.080	560.460	0.200	0.227
CV (%)		13.60	22.59	12.000	9.950	22.870	13.270	17.360	14.210	13.23	9.54

*,** show significant differences at 0.05 and 0.01 probability level respectively.

fertilizer. The first surface irrigation was applied immediately after sowing and after wards irrigation was scheduled at about 5 to 7 day's intervals. Plant samples were taken from middle of plots for measuring data. Plant height was measured using a meter rule from ground level to the terminal apex; stem thickness was taken using coils from the point above ground level, leaf area was calculated using Karanja (1990) model, as the average of all plants from the central rows of each plot at the stage of physiological maturity.

Analyses of the data were performed using SAS 9.1 software package. Treatment means were compared using Duncan's multiple range tests at 5% probability level (Steel and Torrie, 1980).

Results and Discussion

Grain yield

The analysis of variance on studied traits demonstrated that in sunflowers types via oil and nut type sunflowers the highest significant grain yield ($P \leq 0.05$) in oil type was 2.52 t/ha which obtained by soil application of 100 g/ha phosphorus solubilising bacteria. It was 3.68 t/ha in P2Z2 or application of 175 kg/ha superphosphate with 25 kg/ha zinc sulphate for nut type (Table 2). Confirming the results was by Rashid *et al.* (1997) and El-Fouly *et al.* (2001).

Tables 2 showed the interaction effects of phosphorus and zinc analysis of variance results. Data regarding the effect of treatment interactions displayed that the observed interaction difference for grain yields was non-significant in treatments for oil type sunflower. According to the grain yield means were compared by Duncan's multiple range tests at 5% probability level the lowest grain yield in oil type sunflower was 1.28 and 1.29 t/ha by P3Z2 and P4Z1 respectively. Therefore, same record for nut type sunflower was 1.66 t/ha by P4Z1 (Fig. 1).

Object current reports will be show in both sunflower types the zinc application either in soil or foliar application could not increase grain yield without enough available phosphorus nutrition levels. The stimulatory effect of zinc in sunflower plant may be due to its role in enhancing metabolic process. These results are in harmony with those obtained by Chhotu *et al.*, 2008; Marie and Howarth, 2009.

In other hand, soil application among of 0 to 25 kg/ha zinc sulphate alone or with phosphorus solubilising bacteria bio fertilizer plus 175kg/ha superphosphate (P3) and phosphorus solubilising bacteria alone (P4) application had no significant difference in grain yield. Mirzapour and Khoshgoftar (2006) found increase in seed yield of oily sunflower with 10 and 20 kg/ha zinc. This adequate amount of zinc and iron indicates the necessity of zinc and iron application to plants (Marschner, 1995).

Head size

Results of analysis of variance showed the simple and interaction effects of phosphorus and zinc treatments had not significant difference in range of $P<0.01$ for both sunflowers head diameter size except in oil type sunflower treatment interactions (Table 2). Utilization of 175kg/ha superphosphate compound (P3) without zinc compound (Z1) and also 350 kg/ha triple super phosphate plus 25kg/ha zinc sulphate (P1Z2) were the same effects on head width of oil sunflower heads by 15.3 to 15.4 cm as greatest diameter of heads in oil sunflower kind. The least head size in oil sunflower type was 10.33 cm by use of 350 kg/ha triple super phosphate fertilizer

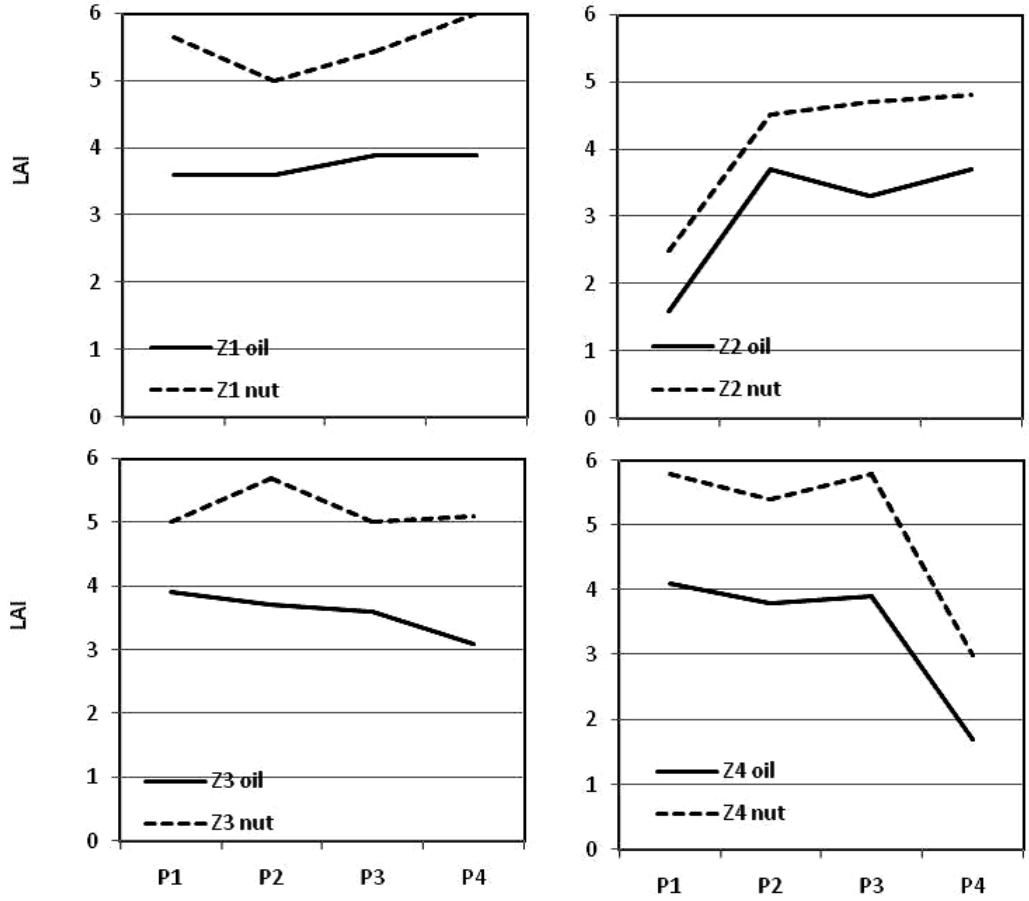

Fig. 1. Effect of phosphorus and zinc treatments on LAI (left) and seed yield (right) in oil (—) and nut (----) sunflowers. P1=350 kg/ha, P2=175kg/ha, P3=175 kg/ha triple super phosphate (TSP) plus phosphorus solubilising bacteria and P4=PSB net. Z1=0, Z2=25kg/ha zinc sulphate (ZS) in form of soil application, Z3=25kg/ha soil application from zinc sulphate plus soluble zinc 10% (SZ) as foliar application and Z4= net soluble zinc 10% (SZ) as foliar application on the leaves in same dose during sunflower budding stage.

in addition foliar application of soluble zinc 10% (P3Z4) significantly. The numbers of leaves per plant, leaf area index were increased significantly with the addition of zinc foliar application up to 5 mg/L compared to the check and the high level of zinc in the both locations. Other results were obtained by Chhotu *et al.*, (2008) who found that head size were increased with increasing zinc application from 0 to 20 mg/L.

Stem thickness

Stem thickness measurements grades and its statistical analysis of related dates specify that our current treatments did not put significant difference on stem thickness changes in both sunflower types (Table 2). Other researches results demonstrated that for stem diameter while they appear to be little response to 10 mg/L for current traits. On the other hand, some sunflower genotypes might be better reflected the greatest response to zinc foliar application, Auld (2001); Sharma (2006); Mirzapour and Khoshgoftar (2006); Martin *et al.*, (2007); Chhotu *et al.*, (2008); Marie and Howarth (2009) and Al-Doori and Al-Dulaimy (2012), found that zinc fertilization produced maximum stem diameter.

Plant height

Data of plant height indicate that we did not see significant difference between highest and lowest plant height in both sunflower types (Table 2). Increase in shoot length was recorded in bread and durum wheat (Cakmak*et al.* 1997), safflower and sunflower (Ismail and Azooz, 2005) with zinc application. Our consequences show that in all probability the defined levels of P and Zn nutrition in present scientific report were not restrictive factor for significant changes in sunflowers plant high. Plant height also, had a little response to zinc foliar application (Auld,

Table 3. Effect of phosphorus and zinc treatments on grain yield and yield components of oil and nut sunflower

Treatments	Means									
	Grain yield kg/ha		Head diameter cm		Stem thickness mm		Plant high cm		Leaf area index	
	oil	nut	oil	nut	oil	nut	oil	nut	oil	nut
P1:350kh/ha TSP	2.43a	2.99a	14.07a	16.00a	15.67a	24.00a	134.58a	178.25a	3.73a	5.56a
P2:175kg/ha TSP	2.07ab	2.83a	12.33a	15.46a	16.50a	23.83a	137.42a	168.42a	3.94a	5.16a
P3:175kg/ha TSP+PSB 100g/ha	1.89b	2.39a	13.44a	15.15a	15.67a	22.33a	117.42a	161.33a	3.50a	4.98ab
P4: PSB 100 g/ha	2.46a	2.22a	13.11a	14.64a	18.08a	21.17a	131.00a	158.25a	3.38a	4.22b
Z1:0 kg/haControl	2.52a	2.93a	13.20a	15.60a	17.00a	24.42a	137.08a	174.75a	3.27ab	5.25a
Z2:25kg/ha ZS soil appl.	1.78a	2.61ab	13.38a	15.39a	16.50a	22.75a	130.42a	170.83a	3.57a	5.24a
Z3:$ZnSO_4.7H_2O$10% foliar appl.	2.29a	2.58ab	13.88a	15.19a	17.08a	22.50a	135.00a	162.25a	3.61a	4.73a
Z4: Dual soil and foliar appl.	2.26a	2.32b	12.49a	15.07a	15.33a	21.67a	117.92a	158.42a	3.11b	4.72a

Mean with similar letters are not significantly difference at the 0.05 probability level according to Duncan's multiple test. P1=350 kg/ha, P2=175kg/ha, P3=175 kg/ha triple super phosphate (TSP) plus phosphorus solubilising bacteria (PSB) and P4=PSB net. Z1=0, Z2=25kg/ha zinc sulphate (ZS) in form of soil application, Z3=25kg/ha soil application from zinc sulphate plus soluble zinc 10% (SZ) as foliar application and Z4= net soluble zinc 10% (SZ) as foliar application on the leaves in same dose during sunflower budding stage.

2001); Chhotu *et al*., (2008) and Al-Doori and Al-Dulaimy (2012).

Leaf area index

Table 2 showed that the P treatment had significantly effects on leaf area index (LAI) in nut sunflower type (P≤0.05). Therefore, Zinc treatment and phosphorus and zinc interaction treatments were significant (P≤0.05) effects on LAI of both sunflower types leaf sources (Fig 1). Means comparisons tables for leaf area index that made by Duncan multiple test, clearly demonstrate that in oil sunflower type the uppermost of LAI was obtain in use of pure PSB in non zinc application plots (P4Z1) by 4.09 and the least LAI were measured in case of use pure PSB biofertilizer plus net soluble zinc 10% as foliar application on sunflower leaves during budding stage (P4Z4) and make use of 175kg/ha triple super phosphate in non zinc application plots (P2Z1) by 2.76 and 2.58 as plant leaf area index respectively. In nut sunflower type also, the highest LAI was estimated in 350 kg/ha triple super

Table 4. Interaction effect of phosphorus and zinc treatments on grain yield and yield components of oil and nut sunflower

Treatments	Means									
	Grain yield kg/ha		Head diameter cm		Stem thickness mm		Plant high cm		Leaf area index	
	oil	nut	oil	nut	oil	nut	oil	nut	oil	nut
P1Z1	2.56a	3.06ab	13.00a-c	16.16a	15.67a	27.00a	133.33ab	175.67ab	3.62ab	5.65a-c
P1Z2	2.32a	3.43ab	15.40a	15.33a	16.00a	16.00ab	142.67a	184.33ab	3.56ab	5.04b-e
P1Z3	2.67a	2.66a-e	14.17ab	16.33a	15.33a	23.00ab	133.33ab	139.00b	3.87ab	5.44a-e
P1Z4	2.18a	2.15cde	13.70ab	16.16a	15.67a	23.00ab	129.00ab	174.67ab	3.87ab	6.09a
P2Z1	1.88a	2.59a-e	12.03bc	14.25a	19.67a	25.33ab	136.00ab	151.00ab	2.58c	2.45f
P2Z2	2.24a	3.68a	12.17bc	14.04a	14.33a	23.00ab	135.33ab	158.33ab	3.17b	4.46c-e
P2Z3	2.13a	2.28a-d	13.00a-c	15.16a	16.67a	19.33b	150.00a	161.67ab	3.33ab	4.71e
P2Z4	2.04a	3.40ab	12.10bc	15.08a	15.33a	21.66ab	128.33ab	174.33ab	3.68ab	4.84de
P3Z1	2.47a	3.00a-d	15.33a	15.83a	14.67a	23.66ab	130.67ab	165.67ab	3.78ab	4.97b-e
P3Z2	1.28a	2.16cde	13.10a-c	15.00a	15.67a	24.00ab	97.33b	183.00ab	3.76ab	5.67a-d
P3Z3	1.70a	1.87de	15.00ab	15.66a	17.33a	24.00ab	136.33ab	178.00ab	3.36ab	5.04b-e
P3Z4	2.10a	2.53b-e	10.33c	15.33a	15.00a	24.33ab	105.33ab	186.33ab	3.12b	5.06b-e
P4Z1	3.18a	1.66e	12.43a-c	14.50a	18.00a	21.66ab	148.33a	141.33ab	4.09a	5.79a-c
P4Z2	1.29a	2.42b-e	12.83a-c	15.90a	20.00a	21.00ab	146.33a	157.67ab	3.81ab	5.40a-e
P4Z3	2.66a	2.45b-e	13.33a-c	14.37a	19.00a	20.33ab	120.33ab	120.33ab	3.86ab	5.80ab
P4Z4	2.72a	2.34b-e	13.83ab	15.83a	15.33a	21.66ab	109.00ab	163.67ab	2.76c	2.92f

Mean with similar letters are not significantly difference at the 0.05 probability level according to Duncan's multiple test. P1=350 kg/ha, P2=175kg/ha, P3=175 kg/ha triple super phosphate (TSP) plus phosphorus solubilising bacteria (PSB) and P4=PSB net. Z1=0, Z2=25kg/ha zinc sulphate (ZS) in form of soil application, Z3=25kg/ha soil application from zinc sulphate plus soluble zinc 10% (SZ) as foliar application and Z4= net soluble zinc 10% (SZ) as foliar application on the leaves in same dose during sunflower budding stage.

phosphate utilize plus foliar application of soluble zinc 10% during budding stage (P1Z4) by 6.09. The least LAI were calculated in P4Z4 and P2Z1 by 2.92 and 2.45 respectively, parallel to oil sunflower type. Moreover, the differences in leaf area index may be attributed to the differences in leaf area per plant. In this concern, (Salama, 1996) showed that taller genotypes had more leaves and leaf primordial that the others sunflower cultivars.These findings confirmed those obtained by Auld (2001); El-fouly *et al.*, (2001); Sharma (2006); Mirzapour and Khoshgoftar (2006); Chhotu *et al.*, (2008) who found that the application of 15 mg Zn/L increased sunflower leaf area plant and number of leaves per plant.

Conclusions

Soil and foliar application of P and Z affected on grain yields in nut type sunflower and head size in oil type and on leaf area index in oil and nut type of sunflower significantly. The stem thickness and plant high had not significant changes by P and Z interaction in this soil condition levels. So, these characters are not suitable for determine the interaction effects of P and Zinc fertilizers in a sandy loam soil with about 0.08, 4.1, 166 and 0.63 ppm available N, P, K and Zn respectively for oil and nut types sunflowers. Thus, the consequences of this study propose that soil application of zinc sulphate may increase grain yield and LAI in sunflower grain under Arak soil conditions for both sunflower types.

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