Journal Tikrit Univ. For Agri. Sci. Vol. (12) No. (4) ,(2012)
ISSN-1813-1646

RESPONSE OF SOME SUNFLOWER HYBRIDS TO ZINC FOLIAR SPRAYING AND PHOSPHORUS FERTILIZER LEVELS UNDER SANDY SOILS CONDITIONS

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KeyWords:
Sunflower,Zn,Soil

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Received:
2-11-2011
Accepted:
21-2-2012

Abstract

Two field experiment were conducted at AL-Quba district- Mosul city during two successive growing seasons of 2010: spring and autumn in a sandy loam soil to study the effect of zinc foliar application and addition of phosphorus fertilizer to the soil on growth characters, yield components and quality of some sunflower hybrids *(Helianthus annuus L.)*. The experiment carried out according to the factorial experiment in a randomized completely block design, consisting of three concentrations of zinc (0, 4, 8 mg.L^{-1}) and three levels of phosphorus fertilizer (0,100 and 200 kg P.ha^{-1}) added as tricalcium superphosphate (48% P_2O_5) with three sunflower hybrids (Pheobus, Iraqi flower and Euroflor). The results showed that the foliar application of the zinc on plant leaves with concentration 8 mg.L^{-1} lead to a significant increased in plant height, stem diameter, leaf area, head diameter, no. of seeds.$head^{-1}$, 1000 seed weight, seed yield, oil percentage, oil yield, protein percentage and protein yield in spring and autumn seasons. The addition of phosphorus fertilizer to the soil with the level 100 kg.ha^{-1} lead to a significant increase in all parameters in both seasons except stem diameter in autumn season. The Iraqi flower hybrid gave a high values for all studied characters in seasons spring and autumn seasons. The interaction between zinc × phosphorus fertilizer level gave a significant increases on the following characters: leaf area, head diameter, 1000 seed weight, seed yield, oil and protein yield in spring and autumn seasons. The interaction among three factors led to a significant effect on following characters: head diameter, no. of seeds.$head^{-1}$ and seed yield in spring season only..

استجابة بعض هجن زهرة الشمس للرش الورقي بالزنك ولمستويات السماد الفوسفاتي تحت ظروف الترب الرملية

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الاستلام:
2011-11-2
القبول :
2012-2-21

الخلاصة

نفذت تجربتين حقليتين في منطقة القبة شمال غرب مدينة الموصل في محافظة نينوى خلال الموسمين المتعاقبين: ربيعي وخريفي للعام 2010 في تربة مزيجية رملية لدراسة تأثير رش الأوراق بعنصر الزنك وإضافة السماد الفوسفاتي إلى التربة وبمستويات مختلفة في نمو وحاصل ونوعية عدة هجن من زهرة الشمس (*Helianthus annuus L.*). وتضمنت كل تجربة ثلاثة تراكيز من الزنك (0،4 و8 ملغم زنك/لتر) وثلاثة مستويات من السماد الفوسفاتي (0، 100و200 كغم فسفور/هكتار) وثلاثة هجن من زهرة الشمس (فيوبس، زهرة العراق ويورفلور). نفذت التجربتين باستخدام التجارب العاملية وفق تصميم القطاعات العشوائية الكاملة وبثلاثة مكررات. أشارت النتائج إلى أن رش أوراق زهرة الشمس بتركيز 8 ملغم زنك/لتر أدى إلى زيادة معنوية في ارتفاع النبات، قطر الساق، المساحة الورقية، قطر القرص الزهري، عدد البذور/قرص، وزن ألف بذرة، حاصل البذور، نسبة الزيت، حاصل الزيت ونسبة وحاصل البروتين في الموسمين الربيعي والخريفي. أدى إضافة السماد الفوسفاتي إلى التربة على هيئة سوبر فوسفات الكالسيوم الثلاثي (48% P_2O_5) وبمقدار 100 كغم فسفور/هكتار إلى زيادة معنوية في جميع الصفات المدروسة ولكلا الموسمين، باستثناء صفة قطر الساق للموسم الخريفي. كما تشير النتائج إلى إن الهجين زهرة العراق أعطى أعلى قيم للصفات: ارتفاع النبات، قطر الساق، المساحة الورقية، قطر القرص الزهري، عدد البذور/قرص، وزن الألف بذرة، حاصل البذور، نسبة وحاصل الزيت ونسبة وحاصل البروتين في الموسمين الربيعي والخريفي. اظهر التداخل الثنائي (تراكيز الزنك × مستويات السماد الفوسفاتي) زيادة معنوية للصفات: المساحة الورقية، قطر القرص الزهري، وزن ألف بذرة، حاصل البذور وحاصل الزيت والبروتين ولكلا الموسمين. وأشار التداخل الثلاثي (تراكيز الزنك × مستويات السماد الفوسفاتي × هجن زهرة الشمس) إلى تأثير معنوي في الصفات: قطر القرص الزهري، عدد البذور/قرص وحاصل البذور وللموسم الربيعي فقط.

Introduction

Sunflower (*Helianthus annuus L.*) is considered the main source of edible oil next soybean. Crop require a sufficient, but not excessive supply of essential mineral elements for optimal productivity. An insufficient supply of macro and micro elements. Phosphorus is most important nutrient limiting sunflower productivity (Blamey and Chapman, 1981), share in some metabolism process such as formation RNA and DNA, energy compounds ADP and ATP, enzymes catalyst NAD-NADP and phospholipids construction, affected on plant growth, as well as root, inflorescence, grain formation and ripening. Regarding to its effect on sunflower, Balwinder and Bishnoi, (1994) reported that sunflower cv. HBSF8 were grown in apot experiment, dry matter, yield and phosphorus uptake increased significantly with up to 80 mg $P_2O_5.kg^{-1}$ in low P soils, and with up to 60 mg in medium and high P soils. Bahl, *et al*. (1997) found that there are a significant yield response up to 60 kg $N.ha^{-1}$ and 30 kg $P_2O_5.ha^{-1}$, in the absence of P, decreased oil percentage in sunflower seeds, P application<30 kg $P_2O_5.kg^{-1}$significantly increased oil content. Padmavathi and Prayaga (2003) indicated that sunflower fertilized with 50 and 75 kg P_2O_5 $.ha^{-1}$ recorded significantly higher seed yield (1593 and 1688 $kg.ha^{-1}$) respectively over 25kg P_2O_5. ha^{-1}(1324 $kg.ha^{-1}$). Jahangirn (2006) found that maximum no.of seeds. $head^{-1}$ and seed yield were produced by the application of 75kg $P_2O_5.ha^{-1}$.

Zinc had effect in protein synthesis, gene regulation, DNA transcription, protection cells from oxidative damage. Zinc deficiency reduces net photosynthesis, internodal 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 $kg.ha^{-1}$), oil percentage (36%), oil yield (616 $kg.ha^{-1}$), protein percentage (16.6%) and protein yield (284.8$kg.ha^{-1}$) obtained by spraying sunflower leaves with zinc concentration of 0.5 ppm. Praksh and Halaswamy (2004), found that spraying plant leaves with 0.3 $ZnSo_4$ gave a high values of head diameter (20 cm), no. of $seeds.head^{-1}$, 1000 seed weight (62.2gm) and seed yield (1600 $kg.ha^{-1}$). Gitte *et al*, 2005 indicated that adding 5.25 kg $Zn.ha^{-1}$ to the soil, produce maximum values of 1000 seed weight (65 gm), seed yield (3400 $kg.ha^{-1}$) and oil percentage (41%). Marschner, (1995) reported that critical concentration of zinc in plant leaves ranged 15-20 $mg.kg^{-1}$ dry weight. The aim of the research was to determine the effect of zinc and phosphorus fertilizer on yield and its components of sunflower hybrids under the environmental conditions of AL-Quba district-Mosul.

Material and Methods

The experiment was conducted during spring and autumn growing season of 2010 at AL-Quba in the west north region of Mosul city at Nineveh province, on a sandy loam soil having 27.4, 9.4, 152.0 and 0.38 ppm available N,P,K and Zn for spring season, 30.0,8.62,156.0 and 0.32 ppm for autumn season respectively, (table 1). The experiment was laid out according to the factorial experiment in a Randomized Completely Block Design with three replications having a net plot area of 18 m^2 (4.5m x 4.0m). Three levels of foliar application (0, 4 and 8 $mg.Zn.L^{-1}$ dist. water used as zinc sulphate ($ZnSo_4.7H_2o$ 35% Zn) sprayed on the leaves in one dose during budding stage, phosphorus fertilizers was applied to the soil in the form of tricalcium superphosphate (48%P_2O_5) in one dose with the levels (0,100 and 200 kg $P.ha^{-1}$) pre soil preparation. Three hybrids of sunflower (Pheobus, Iraqi flower and Eroflor) were sown at7th April and 3rd July, harvested at 10th August and 28th October for spring and autumn growing seasons, respectively. The distance between hills was 30 cm with 75 cm apart ridges to attain a plant density of 44444 $plants.ha^{-1}$. The plant were thinned to one plant per hill 30 days after sowing. Nitrogen fertilizer was applied in the form of urea (46%N) by adding 80 kg $N.ha^{-1}$ in two equal doses, half with sowing and the remaining half after thinning. Potassium was applied by adding to the soil 40 kg K. ha^{-1} as potassium sulphate (48%K_2O) at the seeds sowing. The first irrigation was applied immediately after sowing and after wards irrigation was scheduled at about three day's intervals.

Table (1) : The physical and chemical characters of soil filed experiments before planting (0 to 30 cm depth) in both seasons.

Seasons	spring	autumn
	physical characters	
Sand (%)	59.00	58.00
Silt (%)	24.00	32.00
Clay (%)	17.00	10.00
Texture	sandy loom	sandy loom
	chemical characters	
Organic matter (%)	0.76	0.88
Available N (ppm)	27.40	30.00
Available P (ppm)	9.40	8.62
Available K (ppm)	152.00	156.00
Available Zn (ppm)	0.38	0.32
Total $CaCo_3$ (%)	26.8	24.4
pH	7.4	6.8
E.C. ($ds.cm^{-1}$)	0.98	1.80

All other agronomic practices were kept normal and uniform for all the treatments. Ten plants from each plot were selected at random to record plant height (cm), stem diameter (cm), leaf area ($cm^2.plant^{-1}$) $=0.65\sum li^2$, while $\sum li^2$= summation of leaves length square. $plant^{-1}$ (El-Sahookie and El-Dabas,1982), head diameter (cm). no. of $seeds.ha^{-1}$ and weight of 1000 seed (g.). At harvest, all the plants were taken from the two inner ridges of each experimental plot to measure seed yield, oil yield ($ton.ha^{-1}$)= seed oil% × seed yield ($ton.ha^{-1}$), and protein yield ($ton.ha^{-1}$). Oil seed content was determined by using soxholet apparatus (A.O.A.C., 1980), Nitrogen estimated by using microkieldahl apparatus extracted with 2M KCl (Agrawal *et al*, 1980), (while protein%= N% × 6.25). Phosphorus in soil was determined with spectrophotometer at 882 nm wave length using 0.5 sodium carbonate (Olsen, *et al*. 1954). Potassium was estimated with flamephotometer, using 1M ammonium acetate. Zinc extracted with 0.005 M DTPA method (Page *et al.*, 1982) measured by atomic absorption apparatus. Data were analyzed by factorial experiment in a Randomized Completely Block Design with three factors and three replications (Snedecor and Cochran,1982). Then Duncan's multiple range test (Duncan,1955) at 0.05 % and 0.01 % level of significance were used to compare treatment means.

Results and Discussion

Data to a soil analysis (table1), it was found there was a deficiency in the available of zinc for both seasons (Zn>0.5 ppm) according to Lindsay, *et al*. (1978). I was also concluded that soil availability of zinc decreased when soil content of $CaCO_3$ and pH increased, as well as zinc increased with increasing clay and organic matter (Rammadan, *et al*. 1995). Results of statistical analysis showed that foliar application of zinc levels significantly affected all studied characters (table 4). Regarding to zinc fertilizer, data in tables 2 and 3 revealed that a significant high values of plant height, stem diameter, leaf area, head diameter, no. of $seeds.head^{-1}$, 1000 seed weight, seed yield, seed oil percentage, oil yield, seed protein percentage and protein yield were obtained with zinc level 8 $mg.L^{-1}$ for both seasons. The increase in growth and yield components may be due to the effect of zinc in metabolism process i.e. chloroplast structure and photosynthesis (Alloway, 2008). The seed yield of sunflower is exceeded when concentration of zinc at foliar application increased from 0 to 8 $mg.L^{-1}$, in which was observed that average seed yield increased from 1.61 to 2.67 $ton.ha^{-1}$ in spring season, and from 2.26 to 3.22 $ton.ha^{-1}$ in autumn season, respectively. The superiority in seed yield may be attributed to the increase in head diameter, no. of $seeds.head^{-1}$, 1000 seed weight. Furthermore, seed oil percentage increased from 40.15 to 43.54% in spring season, and from 42.39% to 45.99% in autumn season, respectively. The significant positive relations between seed oil content and high zinc application were also reported by Sankaran *et al*.,(2001) and Gitte *et al*.,(2005). The total protein yield significantly increased from 0.23 to 0.45 $ton.ha^{-1}$ in spring season, and from 0.34 to 0.57 $ton.ha^{-1}$ in autumn season as zinc foliar application increased from 0 to 8 $mg.L^{-1}$., respectively. The increase in protein yield may be attributed to the increase in seed yield and protein percentage. Similar results were reported by Gitte *et al*.,(2005).

The analysis of soil (table1) showed that there was a lack of available phosphorus in the sandy soil for both seasons. The critical limit of available phosphorus for sunflower were established as 14.7 and 16.2 $kg.ha^{-1}$ by Olsen and Modified Olsen test, respectively (Singh and Singh, 1997). The data presented in tables 2 and 3 showed that increased the phosphorus fertilizer from 0 to 100 $kg.ha^{-1}$led to a significant increase in the following parameters: plant height (12.3% and 3.8%), leaf area (7.4 and 6.6%), head diameter (7.9 and 4.0%), seed yield (15.6 and 8.8%), oil yield (17.35% and 11.31%) and protein yield (21.57% and 15.49%) in spring and autumn seasons respectively. These results are in agreement with those reported by Bahi, *et al* (1997); Geleta, *et al*. (1997); Jahangir (2006); Osman and Awed, (2010). The results obtained from tables 2 and 3 revealed very clearly that there was positive response for sunflower crop to phosphorus fertilizer and that this response is more better in autumn season compared to that achieved in spring season. This allow the suggestion that the reason for this difference may be attributed to the fact that there was more absorption for phosphorus element by sunflower plant when pH of the soil equal 6.8 (table1), and this reflected to improve the growth characters of the plant in which led to increase yield and its components.

The results in tables 2 and 3 indicate that Iraqi flower hybrids exceeded Euroflor and Pheobus hybrid in plant height, stem diameter, leaf area, head diameter, no. of seeds. head^{-1}, 1000 seed weight, seed yield, seed oil percentage, oil yield, seed protein percentage and protein yield for both seasons. Iraqi flower hybrid also exceeded Euroflor by 22.63% and 12.69% , Pheobus hybrid by 21.98 % and 18.14% in seed yield in spring and autumn seasons respectively. The differences between sunflower hybrids in seed yield may be attributed to their differences in growth traits such as leaf area, head diameter that reflected differences in yield components such as number and weight of seeds head^{-1} as well as 1000 seed weight, increased seed yield per plant as well as per unit area. The increases of Iraqi flower hybrid in oil yield compared with Euroflor and Pheobus hybrids may be attributed to the genetically variation among the tested hybrids in yield components and consequently seed yield as well as oil percentage.

Table (2): Mean values of plant height, stem diameter, leaf area, head diameter, number of seeds/head and 1000 seed weight as affected by Zinc and phosphorus fertilizer levels for the sunflower hybrids in spring and autumn season.

Main effect and interaction	plant height (cm)		stem diameter (cm)		leaf area ($cm^2.plant^{-1}$)		head diameter (cm)		no. of seeds.head^{-1}		1000 seed weight (gm)	
	Spring season	Autumn season	Spring season	Autumn season	Spring season	Autumn season	Spring season	Autumn season	Spring season	Autumn season	Spring season	Autumn season
Zinc level (Zn):												
Zn_1:o mg.L^{-1}	145.4b	142.0c	2.1b	2.5b	2977.2c	3058.3b	19.4c	20.4b	820.8c	901.7c	54.5c	56.4c
Zn_2:4 mg.L^{-1}	154.3a	147.9b	2.5a	2.8a	3066.3b	3265.9a	19.8b	21.7b	848.7b	926.3b	57.2b	60.1b
Zn_3:8 mg.L^{-1}	157.1a	155.8a	2.8a	2.6a	3304.4a	3305.9a	20.7a	21.5a	916.6a	966.5a	62.2a	64.0a
Phosphorus level (P):												
P_1:0 kg.ha^{-1}	147.7c	147.8b	2.3c	2.6	3024.2c	3134.6b	19.3c	21.1b	808.5c	891.4b	55.6c	58.8c
P_2:100 kg.ha^{-1}	156.9a	153.4a	2.5a	2.8	3248.5a	3341.1a	20.8a	22.0a	911.2a	996.2a	60.4a	61.8a
P_3:200 kg.ha^{-1}	152.2b	144.4b	2.4b	2.7	3075.1b	3154.3b	19.8b	20.6c	866.3b	906.9b	57.8b	59.9b
Hybrids (C)												
Pheobus	127.7c	132.9c	1.5c	2.1c	2845.2c	2941.9c	19.4b	20.7b	809.4c	882.8c	55.0c	58.1c
Iraqi flower	167.5a	159.4a	2.9a	3.1a	3433.4a	3464.5a	21.4a	22.4a	944.0a	1008.6a	60.8a	62.9a
Euroflor	161.6b	153.3b	2.8b	2.9b	3069.2b	3223.6b	19.1c	20.5b	832.7b	903.2b	58.1b	59.4b
Interactions:												
Zn × P	N.S.	N.S.	N.S.	N.S.	**	**	**	**	**	N.S.	**	**
Zn × C	N.S.	N.S.	**	**	**	*	**	N.S.	**	**	**	**
P × C	N.S.	N.S.	N.S.	N.S.	**	N.S.	**	N.S.	**	N.S.	N.S.	N.S.
Zn × P × C	N.S.	N.S.	N.S.	N.S.	**	N.S.	**	N.S.	**	N.S.	N.S.	N.S.

* , ** significant at the 0.05 and 0.01 probability level, respectively.
N.S. not significant.
The mean values with in column followed by different letters are significantly at 0.05 and 0.01 level.

Table (3): Mean values of seed yield, seed oil percentage, oil yield, seed protein percentage and protein yield as affected by zinc and phosphorus fertilizer levels for the sunflower hybrids in spring and autumn season.

Main effect and interaction	seed yield (ton.ha^{-1})		seed oil (%)		oil yield (ton.ha^{-1})		seed protein (%)		protein yield (ton.ha^{-1})	
	Spring season	Autumn season	Spring season	Autumn season	Spring season	Autumn season	Spring season	Autumn season	Spring season	Autumn season
Zinc level (Zn):										
Zn_1:o mg.L^{-1}	1.61c	2.26c	40.15c	42.39c	0.65c	0.97c	14.67c	15.12c	0.24c	0.34c
Zn_2:4 mg.L^{-1}	1.87b	2.54b	41.76b	44.87b	0.78b	1.15b	15.29b	16.07b	0.29b	0.41b
Zn_3:8 mg.L^{-1}	2.67a	3.22a	43.54a	45.99a	1.17a	1.49a	16.52a	17.42a	0.45a	0.57a
Phosphorus level (P):										
P_1:0 kg.ha^{-1}	1.90c	2.59b	41.43b	44.09b	0.80c	1.16b	14.91b	15.62b	0.29c	0.41c
P_2:100 kg.ha^{-1}	2.20a	2.82a	41.91a	45.05a	0.93a	1.29a	15.70a	16.59a	0.35a	0.48a
P_3:200 kg.ha^{-1}	2.05b	2.60b	42.10a	44.11b	0.87b	1.16b	15.87a	16.40a	0.33b	0.43b
Hybrids (C):										
Pheobus	1.91b	2.48c	40.56c	43.42c	0.78b	1.09c	14.87c	15.37c	0.29b	0.39c
Iraqi flower	2.33a	2.93a	43.96a	45.90a	1.03a	1.36a	16.43a	17.54a	0.39a	0.52a
Euroflor	1.91b	2.60b	40.92b	43.92b	0.78b	1.16b	15.18b	15.69b	0.29b	0.41b
Interactions:										
Zn × P	**	**	**	N.S.	**	**	N.S.	N.S.	**	**
Zn × C	**	**	**	N.S.	**	**	**	**	**	**
P × C	*	**	N.S.	N.S.	N.S.	*	*	**	N.S.	**
Zn × P × C	**	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

* , ** significant at the 0.05 and 0.01 probability level, respectively.
N.S. not significant.
The mean values with in column followed by different letters are significantly at 0.05 and 0.01 level.

Table (4): Analysis of variance F values for some growth characters, yield and yield components and quality in spring and autumn seasons.

S.O.V	D.f	M.S. for spring season										
		Plant height (cm)	stem diameter (cm)	leaf area (cm^2\plant)	head diameter (cm)	no. of seeds/head	1000 seeds weight(g.)	yield (ton.ha^{-1})	Oil (%)	oil yield (ton.ha^{-1})	protein (%)	protein yield (ton.ha^{-1})
Replications	2	343.04938	0.37210000	22834.568	0.5377777	258.4198	3.958364	0.07788	5.64925	0.02994	3.55864	0.00805818
A	2	1000.947**	1.546211**	772744.1**	11.3945**	65558.22**	410.28**	8.257**	77.56**	1.980**	23.81**	0.319301**
B	2	567.5780**	0.4612148**	373275.44**	16.29447**	71561.02**	156.54**	0.5896**	3.2693**	0.1287**	7.0877**	0.027413**
C	2	12445.10**	15.73273**	2379379.4**	44.5772**	139737.1**	231.51**	1.5947**	94.081**	0.563**	18.421**	0.089933**
A × B	4	37.976 n.s.	0.010298 n.s.	73420.90**	1.838707**	5978.89**	9.2485**	0.2642**	1.7497**	0.0620**	0.228 n.s.	0.006884**
A × C	4	42.406 n.s.	0.223792**	24143.10**	2.64903**	25513.18**	10.5846**	0.1121**	1.9190**	0.0419**	2.1297**	0.010659**
B × C	4	27.853 n.s.	0.014240 n.s.	25255.13**	1.61352**	900.43**	2.4199 n.s.	0.0157*	0.338 n.s.	0.002 n.s.	0.5987*	0.00004 n.s.
A×B × C	8	18.996 n.s.	0.010426 n.s.	19570.32**	1.64160**	916.41**	2.212 n.s.	0.0194**	0.672 n.s.	0.002 n.s.	0.284 n.s.	0.0003 n.s.
Error	52	28.01092	0.02964872	2849.953	0.0488034	37.7787	2.315351	0.00628	0.41592	0.00164	0.22351	0.00046013
Total	80											
S.O.V	D.f	M.S. for autumn season										
Replications	2	913.38272	1.17601975	128449.383	28.581604	101320.938	136.8900	8.16354	136.861	2.37251	9.73592	0.28920879
A	2	1285.347**	1.352075**	477039.7**	13.5386**	28944.93**	387.87**	6.649**	91.76**	1.932**	36.025**	0.352535**
B	2	554.5432**	0.113971 n.s.	350550.5**	13.1409**	86391.00**	62.403**	0.448**	8.054**	0.1496**	7.1071**	0.029160**
C	2	5197.529**	7.845608**	1847383.9**	30.6827**	123032.9**	162.14**	1.4648**	46.359**	0.533**	37.138**	0.142274**
A × B	4	159.441 n.s.	0.150817 n.s.	25381.52**	4.78284**	72.489 n.s.	18.003**	0.2004**	1.422 n.s.	0.0494**	0.127 n.s.	0.008246**
A × C	4	12.697 n.s.	0.218854**	39628.05*	0.83188 n.s.	7386.917**	10.3822**	0.0553**	0.953 n.s.	0.0250**	2.8812**	0.007592**
B × C	4	22.0525 n.s.	0.031223 n.s.	23211.49 n.s.	0.74426 n.s.	966.263 n.s.	0.9819 n.s.	0.0424**	0.953 n.s.	0.0096*	1.1698**	0.002680**
A×B × C	8	13.5330 n.s.	0.068378 n.s.	13677.64 n.s.	0.63793 n.s.	1538.53 n.s.	1.9120 n.s.	0.020 n.s.	0.486 n.s.	0.004 n.s.	0.326 n.s.	0.00051 n.s.
Error	52	75.07502	0.06237873	12898.101	0.6851947	1306.8870	1.995641	0.01269	0.62211	0.00371	0.29566	0.00075752
Total	80											

*,** Significant at the 0.05 and 0.01 probability levels, respectively. and n.s. not significant.

Tables 2 and 3 showed that the interaction between zinc and phosphorus application had a significant effect on leaf area, head diameter, 1000 seed weight, seed yield, oil, protein yield for both seasons. Similar conclusions were obtained by Osman and Awed, (2010). These results may be explained that phosphorus fertilizer improves the root growth of plant and encourages zinc element to be absorbed which reflected on enhancing the growth characters and increase the total yield of the crop. The interaction between zinc and sunflower hybrids had a significant effect on stem diameter, leaf area, no. of seeds $head^{-1}$, 1000 seed weight, seed yield, oil yield, seed protein percentage and protein yield for both seasons. These results are in agreement with those obtained by Khurana and Chatterjee, (2001); Praksh and Halaswamy, (2004). The interaction between phosphorus fertilizer and sunflower hybrids showed significant effects on leaf area, head diameter and no. of seeds $head^{-1}$ in spring season, as well as oil and protein yield in autumn season, while seed yield and seed protein percentage significantly increased in both seasons as illustrated in tables 2 and 3. Similar results were found by Blamey and Chapman, 1982, Osman and Awed, (2010). The insignificant effect between hybrids and phosphorus fertilizer on other characteristic showed that each of these two factors acted independently on these traits. The interaction effect among the three studying factors showed significant effects on leaf area, head diameter, no. of seeds $head^{-1}$, and seed yield in spring season only.

It could be concluded that maximizing seed yield per unit area could be achieved by sowing sunflower Iraqi flower hybrid, spraying the leaves with 8 mg $Zn.L^{-1}$ and adding to the soil 100 kg $P.ha^{-1}$ under the environmental conditions of the west north region of Mosul city at Nineveh Governorate. Furthermore, this hybrid can be planted successfully in spring and autumn seasons.

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