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Effect of Zero Tilled Dibbled and Phosphorus Fertilizer on Growth and Yield of Sunflower (*Helianthus annuus* L.)

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Abstract: A field trial was carried out to investigate the effect of cultivation method (no tillage versus conventional ploughing) and phosphorus fertilization (100, 200 and 300 kg ha^{-1}) on some growth characters of sunflower field variety Aqmar. The results showed that there were not significant differences between the two methods of cultivation on seed yield and plant height. However, ploughing method was superior in the rest of the parameters. Levels of phosphorus fertilizer had significant effect on all the characters with the exception of number of days from sowing to the 50% flowering where 200 and 300 kg ha^{-1} were superior over 100 kg ha^{-1} in all characters. The use of 200 kg ha^{-1} in improving growth characters and increased seed yield is appropriate. The interaction of ploughing and 300 kg ha^{-1} phosphor fertilizer gave the best values.

Keywords: Conservative cultivation, Industrial crops, Nutritive element, Ploughing

Sunflower (*Helianthus annuus* L.) is considered one of the major crops in the Iraq due to its various uses among them oil from oily cultivars and feeds for animals (Cheyed 2014). It is the best fourth oily crop in the world (Nisar 2011). This crop is characterized by its high capability of adaption in a wide range of environmental conditions; therefore it is grown widely around the world (Agele 2007). Iraqi environment is suitable to produce sunflower, yet its productivity still low due to the bad application of husbandry practices and not using modern agricultural systems, which conserve the soil texture and improve the plant growth in the field, in turn increases the seed yield of unit area. Zero (no) tillage method improve the physical chemical and biological characteristic of soil, which has led to more stability of productivity (Alrijbo and Hussan 2011, Chauhan et al 2015), besides it is economical method reduces the costs of production (Piggin et al 2002) via lessening of energy waste manpower and reduces the required time for seed bed preparation. Also, it increases the rain water harvesting in the dry and semi dry regions compared with the conventional method of cultivation (Anaerson et al 2000), especially in the region of very low water table(Humphreys et al 2004). Nutritional element in seed play a key role in agricultural production, as Iraqi sails contain high levels of calcium carbonates which makes the pH soil close to the alkalinity, there for, soils suffer from the reduction of essential aliments availability for plant growth among them phosphorus (Zeboon 2006). The phosphorus is the second important element after nitrogen, which affects all growth stage of sunflower, seed yield and quality (Salih 2013), there for, this study was conducted to investigate the response of oily sunflower (Aqmar oily cultivar) to the zero-tillage and phosphorus levels.

MATERIAL AND METHODS

A field trial was conducted at the alternate site (site of college of agriculture- university of Baghdad) Abu-Ghraib during the spring and fall seasons of 2015. The objective was to investigate the effect of zero-tillage compared with the conventional method and phosphorus levels (100, 200, and 300) kg P_2O_5 ha^{-1} which triple super phosphate was the main source of phosphorus on some growth characters and seed yield of Aqmar oily cultivar. A piece of land previously grown with sunflower in the spring season was used to be the same for cultivation in the fall season. This land was divided to six stripes, three of the were ploughed after the removal of plant residues random and the rest of land left without ploughing with the plant residual been left, each stripe was divided to experimental units 3 × 4 m as the same dimension of unploughed plots to assure the homogenous experimental units. Sowing was performed on rows 75 cm between them and 25 cm between plants in rows to achieve plant population density 53000. A distance of 75 cm between experimental units was left. Three-five seeds were placed in each hill, then a thinning was done after the completion of full field emergence and the formation of first pair of true leaves. The design was split-block design where the main factor was no-tillage and conventional ploughing and the sub plots for phosphorus fertilizer with three replication. All phosphorus fertilizer was applied at cultivation with the cultivation rows.

Nitrogen fertilizer (urea 40% N) with the rate 280 Kg ha^{-1} was applied twice the first after field emergence and the second one at the beginning of floral bud formation.

Five plants were randomly chosen from the middle rows to record the period from sowing to the 50% flowering, plant height (cm), leaf area (cm^2), chlorophyll content of leaves, Phosphorus ratio of leaves and seed yield $plant^{-1}$.

Data were analyzed according to the used design average using LSD at 0.05 for comparison.

RESULTS AND DISCUSSION

Number of days from sowing to the 50% flowering: Table 1 show the significant effect of phosphorus fertilizer only in the spring season with no significant effect of cultivation method and interaction in both seasons. Increased phosphorus fertilizer from 100 to 300 kg ha^{-1} increased the number of days from sowing to the 50% flowering by 1.5 day in spring season.

Plant height (cm): Table 2 indicates that there was significant effect of both study factors and their interaction except the effect of cultivation method with no significant differences between them. Plants of conventional method where superior in the plant height 178.03 cm compared with 170.80 cm for no-tillage method in the fall season. This may be that ploughing helps in the increase of root system via breaking down sub-down layers of soil. The increase of phosphorus fertilizer from 100 to 300 kg ha^{-1} increased plant height from 161 and 106 cm and 174.83 and 119.25 cm, respectively with no significant difference with 200 kg ha^{-1} in the increasing root system and plant growth which, in turn, increases plant height. This result confirms the findings of Zeboon (2006).

Concerning interaction, plants of cultivated area and fertilized with 300 kg ha^{-1} gave the highest value in both seasons (189.41 and 127.66 cm) compared with 158.29 and 106.1 cm during both seasons for no tillage × 100 kg ha^{-1} of phosphorus.

Leaf area (m^2 $plant^{-1}$): It is clear from Table 3 that both study factors and their interactions had significant effect on leaf area. Plants of tilled cultivation gave the highest average

Table 1. Effect of zero tilled dibbled and phosphorus fertilizer on number of days from sowing to the 50% flowering in spring and full season

Phosphorus fertilizer (kg h^{-1}) (P)	Spring season			Fall season		
	Cultivation system (C)		Mean (P)	Cultivation system		Mean (P)
	Zero- tillage	Ploughed		Zero- tillage	Ploughed	
100	73.33	72.67	73	54.93	55.44	55.18
200	73.67	73.33	73.5	55.78	54.93	55.35
300	75	74.5	74.5	55.44	56.59	56.02
Mean (C)	74	73.33		55.38	55.65	
LSD 0.05 (P)		1.3			N.S	
LSD 0.05 (C)		N.S*			N.S	
LSD 0.05 (P×C)		N.S			N.S	

NS: Non significant

Table 2. Effect of zero tilled dibbled and phosphorus fertilizer on plant height (cm)in spring and full season

Phosphorus fertilizer (kg h^{-1}) (P)	Spring season			Fall season		
	Cultivation system (C)		Mean (P)	Cultivation system		Mean (P)
	Zero- tillage	Ploughed		Zero- tillage	Ploughed	
100	158.29	164.63	161.46	106.01	106.62	106.31
200	179.27	180.07	179.67	116.29	120.01	118.15
300	174.83	189.41	178.83	110.85	127.66	119.25
Mean (C)	170.80	178.03		111.05	118.09	
LSD 0.05 (P)		2.9			5.17	
LSD 0.05 (C)		4.01			N.S*	
LSD 0.05 (P×C)		3.57			6.96	

NS: Non significant

0.777 and 0.366 m^2 $plant^{-1}$ in both seasons compared with 0.690 and 0.333 m^2 $plant^{-1}$ for no-tilled cultivation, respectively. This may be due that ploughing (tilling) increases root system of plants as a result of breaking down sub-surface layers of soil, which ultimately improve the vegetative growth characters of plants among them increased plant height (Table 2).

It is also clear from Table 3 that phosphorus fertilizer had significant effect on this character. The highest level 200 and 300 kg ha^{-1} recorded the highest average 0.707 and 0.775 m^2 and 0.383 and 0.388 m^{-2} in both spring and fall seasons, respectively with no significant differences between them.

This may be due to the role of phosphorus in formation cell membranes and transportation of sugar (saccharides) from their sites of formation in leaves to the other parts of plants of increase of photosynthesis which increases plant activities among them leaf area. This result was in agreement with the findings of AL-Tammimi (2010) and Alias et al (2003).

Concerning interaction, plants of tilled land and fertilized with the 300 kg ha^{-1} of phosphorus gave the highest value in both seasons (0.836 and 0.423 m^2 $plant^{-1}$), respectively compared with the lowest value (0.606 and 0.262 m^2 $plant^{-1}$) for plants resulted from un-tilled land and fertilized with 100 kg ha^{-1} in both seasons. The increase of leaf area with the increases of phosphorus level in the tilled area may be attributed to the fact that excited soil because of tilling allow easy movement and distribution of phosphorus around the root system which increase its absorption by plants and then increases plant growth characters among them plant height (Table 2) and leaf area (Table 3).

Plant dry weight (gm): A significant effect of both factors and most their interaction was obtained on plant dry weight (Table 4). Plants of tilled method gave the highest value of dry weight 138.9 gm $plant^{-1}$ compared with 130.4 gm of un-tilled land in the season. This may be due to the high plant height (Table 2) and leaf area (Table 3) which in turn, increased plant dry weight. It is also clear from Table 4. That high level of phosphorus 300 and 200 kg ha^{-1} recorded the highest averages (277.7, 272.5, 147.3 and 148.1 gm $plant^{-1}$) with no significant differences between these two levels in both season, respectively, compared with 207.1 and 108.4 gm $plant^{-1}$ for 100 kg ha^{-1} level in both season, respectively. This was due to the increase of both plant height and leaf area. This result confirmed the finding, of Salih (2013) who

Table 3. Effect of zero tilled dibbled and phosphorus fertilizer on leaf area (m^2 $plant^{-1}$) in spring and full season

Phosphorus fertilizer (kg h^{-1}) (P)	Spring season			Fall season		
	Cultivation system (C)		Mean (P)	Cultivation system		Mean (P)
	Zero- tillage	Ploughed		Zero- tillage	Ploughed	
100	0.606	0.71	0.658	0.262	0.296	0.279
200	0.765	0.785	0.775	0.384	0.381	0.383
300	0.699	0.836	0.767	0.352	0.423	0.388
Mean (C)	0.69	0.777		0.333	0.366	
LSD 0.05 (P)		0.036			0.012	
LSD 0.05 (C)		0.035			0.032	
LSD 0.05 (P×C)		0.038			0.026	

Table 4. Effect of zero tilled dibbled and phosphorus fertilizer on plant dry weight (gm) in spring and full season

Phosphorus fertilizer (kg h^{-1}) (P)	Spring season			Fall season		
	Cultivation system (C)		Mean (P)	Cultivation system		Mean (P)
	Zero- tillage	Ploughed		Zero- tillage	Ploughed	
100	198.2	216	207.1	106.5	110.4	108.4
200	274.4	270.6	272.5	146.3	150.0	148.1
300	265.1	290.3	277.7	138.3	156.2	147.3
Mean (C)	245.9	259		130.4	138.9	
LSD 0.05 (P)		5.5			7.9	
LSD 0.05 (C)		NS*			2.8	
LSD 0.05 (P×C)		10.2			7.7	

NS: Non significant

reported that phosphorus increases growth characters at all plant growth stages.

Concerning interactions, highest level of phosphorus 300 kg ha^{-1} and tilled treatment gave the highest value (290.3 and 156.2 gm $plant^{-1}$) in both seasons with no significant differences with the 200 kg ha^{-1}× tilled treatment in the fall seasons compared with 100 kg ha^{-1} × un-tilled treatment which gave the lowest values 198.2 and 106.5 gm $plant^{-1}$ respectively in both season with no significant differences with the same level × tilled treatment in the fall season.

Dry weight of root system (gm): Table 5 illustrates the significant effect of both factors and their interaction except the effect of tilled treatment in the spring season. Plants of tilled area gave the highest value 15.28 gm compared with 13.15 gm for plants growth in the no-tilled area. This may be due to the high plant height (Table 2) and leaf area (Table 3), hence, increased dry weight of plant including root dry weight. Table 5 also shows that high level of phosphorus 300 * 200 kg ha^{-1} gave the highest averages 28.07 and 27.38 gm with no significant differences between for spring season and 16.00 and 15.96 gm for fall season compared with 22.50 and 11.22 for the 100 kg ha^{-1} in both season, respectively. This may be attributed to the role of phosphorus in enhancement of many vital biochemical reaction in the plants especially improvement of root system (Griffith 2010).

Concerning interactions, the highest level of phosphorus 300 kg ha^{-1} in the tilled area gave the highest value in both season. Respectively 30.23 and 17.61 gm with no significant differences with the 200 kg ha^{-1} in the tilled area in fall season compared with 19.82 and 10.65 gm for 100 kg ha^{-1} in tilled areas in both seasons, respectively.

Chlorophyll content of leaves (mg gm^{-1} fresh weight): Table 6 shows significant effect of both study factors and their interaction in both seasons. Plants of tilled areas recorded the highest average of chlorophyll content 38.67 and 43.79 mg gm^{-1} fresh weight in both seasons compared with 36.43 and 40.92 mg gm^{-1} fresh weight for plants resulted from un tilled areas. Tis may be due the effect of tilling on root dry weight (Table 5) which in turn improving vegetative growth (Table 2 and 3), hence improving photosynthesis efficiency and plant chlorophyll contest. Also, phosphorus fertilizer level significantly increased this character where 200 and 300 kg

Table 5. Effect of zero tilled dibbled and phosphorus fertilizer on dry weight of root system (gm) in spring and full season

Phosphorus fertilizer (kg h^{-1}) (P)	Spring season			Fall season		
	Cultivation system (C)		Mean (P)	Cultivation system		Mean (P)
	Zero- tillage	Ploughed		Zero- tillage	Ploughed	
100	21.02	23.77	22.5	10.27	12.17	11.22
200	27.90	26.86	27.38	15.86	16.06	15.96
300	25.92	30.23	28.07	14.40	17.61	16.00
Mean (C)	25.02	26.95		13.51	15.28	
LSD 0.05 (P)		1.85			1.52	
LSD 0.05 (C)		NS*			1.56	
LSD 0.05 (P×C)		2.05			1.61	

NS: Non significant

Table 6. Effect of zero tilled dibbled and phosphorusus fertilizer on chlorophyll content of leaves (mg gm^{-1} fresh weight)in spring and full season

Phosphorus fertilizer (kg h^{-1}) (P)	Spring season			Fall season		
	Cultivation system (C)		Mean (P)	Cultivation system		Mean (P)
	Zero- tillage	Ploughed		Zero- tillage	Ploughed	
100	32.63	34.02	33.33	38.83	39.89	38.86
200	40.08	39.37	39.73	43.64	44.12	43.88
300	36.58	42.61	39.59	41.29	47.37	44.33
Mean (C)	36.43	38.67		40.92	43.79	
LSD 0.05 (P)		1.12			1.43	
LSD 0.05 (C)		2.13			1.43	
LSD 0.05 (P×C)		1.79			1.52	

Table 7. Effect of zero tilled dibbled and phosphorus fertilizer on phosphorus ratio of leaves (%) in spring and full season

Phosphorus fertilizer (kg h^{-1}) (P)	Spring season			Fall season		
	Cultivation system (C)		Mean (P)	Cultivation system		Mean (P)
	Zero- tillage	Ploughed		Zero- tillage	Ploughed	
100	0.417	0.446	0.432	0.274	0.295	0.284
200	0.61	0.63	0.62	0.413	0.428	0.42
300	0.526	0.65	0.588	0.376	0.454	0.415
Mean (C)	0.518	0.576		0.354	0.392	
LSD 0.05 (P)		0.029			0.015	
LSD 0.05 (C)		0.055			0.015	
LSD 0.05 (P×C)		NS*			0.016	

NS: Non significant

Table 8. Effect of zero tilled dibbled and phosphorus fertilizer on plant seed yield (gm $plant^{-1}$) in spring and full season

Phosphorus fertilizer (kg h^{-1}) (P)	Spring season			Fall season		
	Cultivation system (C)		Mean (P)	Cultivation system		Mean (P)
	Zero- tillage	Ploughed		Zero- tillage	Ploughed	
100	43.77	45.31	44.54	52.88	52.95	52.92
200	51.09	51.13	51.11	57.41	58.61	58.01
300	53.71	54.71	54.20	60.17	60.14	60.15
Mean (C)	49.52	50.38		56.82	57.23	
LSD 0.05 (P)		2.63			1.82	
LSD 0.05 (C)		NS*			NS	
LSD 0.05 (P×C)		NS			NS	

NS: Non significant

ha^{-1} level recorded highest average 39.73, 39.59 and 43.88, 44.33 mg gm^{-1} fresh weight in spring and seasons, respectively with no significant differences between them. This may be due to the effect of phosphorus on root system and plants growth which, in turn, reflected in the increased of plants highest (Table 2) and leaf area (Table 3), which increased photosynthesis. This result was in agreement with the findings of Salih (2013).

Concerning interaction the highest level of phosphorus 300 kg ha^{-1} in tilled area gave the highest values in both seasons (42.61 and 47.37 mg gm^{-1} fresh weight) compared with 32.63 and 38.83 mg gm^{-1} fresh weight for the 100 kg ha^{-1} in both seasons, respectively.

Phosphorus ratio of leaves (%): Table 7 illustrates the significant effect of both factors and their interaction except the interaction in the spring season. Plants of tilled areas recorded the highest average 0.576 and 0.392% in both seasons compared with the plant of untilled areas. This may be due to the effect of tilling in the improving of plant root system as a result of breaking down the sub layers of soil which improves the absorption of nutritive element by plants. It is also clear from Table 7 that 200 kg ha^{-1} level of phosphorus gave the highest averages 0.620 and 0.42% in both seasons with no significant differences with 300 kg ha^{-1} in the fall season. This may be due to the effect of increasing application phosphorus in the soil which increased the available phosphorus in the soil and the absorption via root system. This result was in agreement with the finding of AL-Dilaimi (2006). Plants growth in the tilled area fertilized with 300 kg ha^{-1} gave the highest value 0.454% in the fall season compared with untilled area fertilized with 100 kg ha^{-1} which gave 0.274% in the fall season.

Plant seed yield (gm $plant^{-1}$): Results of Table 8 show significant effect of phosphorus fertilizer on seed yield of plants in both season with no significant effect of interaction. Increased phosphorus level from 100 to 300 kg ha^{-1} increased seed yield by 21.69 to 15.55% in both season, respectively. This was due to the role of phosphorus in improving growth characters and increasing leaf content of chlorophyll which in turn, increased plant seed yield.

CONCLUSION

There was no significant differences between tilled and untilled soil in respect of number of days from sowing to the

50% flowering in both seasons, plant height in the in the fall season, plant dry weight and root dry weight in the spring season and seed yield of plant in both seasons. However, tilled treatment was significantly superior in the other characters. Despite that the differences in both tilled and untilled treatment were significant in those characters we suggest that further studies may be needed to find the economical feasibility. Results also showed the positive role of phosphorus in both high level, compared with the lowest one, which suggest the possibility of using 200 kg ha^{-1} in improving plant growth and increasing seed yield.

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