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ORIGINAL ARTICLE

EFFECT OF ORGANIC RESIDUES SOURCE AND NPK LEVELS ON SOME SOIL PROPERTIES AND YIELD OF SUNFLOWER (*HELIANTHUS ANNUUS* L.)

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Abstract: A field experiment was carried out in the fields of College of Agriculture, University of Anbar for the spring season 2018 in soil with a silty loam texture to study the effect of organic residues at a level of 10 ton.ha^{-1} from three sources (reed, cows, sheep). Besides, their interaction with the chemical fertilization (NPK) at a levels of 50 and 100% of the fertilizer recommendation on the growth and production of the sunflower Shumoos CV using the randomized complete block design (RCBD with three replications. The results were analyzed statistically at a probability level of 0.05 to choose the least significant difference. The study results showed that the source of added organic residues achieved a significant increase in the studied characteristics. Furthermore, the addition of sheep residues caused the highest significant increase compared to the control treatment (without addition) in the characteristics of plant height, dry weight, leaf area, chlorophyll content and seed yield as well as the availability of P and K elements in soil and K, P, N concentrations in seeds with an averages of 172.7 cm, 185.9 g, 77.90 dm^2, 41.92 mg/L, 4.69 ton.ha^{-1}, 9.46 mg.kg^{-1}, 97.74 mg.kg^{-1}, 1.622%, 0.399%, and 0.751% for each of them respectively. On the other hand, the reed residues gave the highest average of available nitrogen in the soil amounted to 74.70 mg.kg^{-1}, while the added cow residues was superior by the highest average of leaf area amounted to 77.90 dm^2. Moreover, it was noticed that the levels of fertilizer recommendation had a significant effect on some of the above characteristics and the level (100%) of the full fertilizer recommendation exceeded in the chlorophyll content, grain yield, availability of (NPK) in the soil. In addition to its concentration in the seeds with the highest average reached 42.64 mg.L^{-1}, 3.95 ton.ha^{-1}, 75.10 mg.kg^{-1}, 7.51 mg.kg^{-1}, 82.21 mg.kg^{-1}, 1.337%, 0.358%, and 0.717%, respectively. Finally, the interaction between the two study factors had a significant effect on all the studied characteristics.

***Key words*:** Organic residues source, NPK fertilizers, NPK availability, Sunflower.

Cite this article

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1. Introduction

The soils of dry areas are characterized by the fact that most of their soils are calcareous soils, including Iraqi soils, which reached 75-80% due to their high content of calcium carbonate and the alkalinity soil reaction. Therefore, most plant crops suffer from a lack of nutrients, especially (NPK) due to their exposure to loss in various ways, such as fixation, adsorption, and precipitation reactions [Tisdale *et al.* (1997)]. However, the use of chemical fertilizers, especially macronutrients (NPK), may cause an increase in the yield up to 50 % or more, with the availability of other growth factors, with compensation for the shortage of nutrients in the available form [Muhammad (2014)]. The massive use of mineral fertilizers in large quantities in planting without taking into account their side effects has a negative impact on health and environmental aspects. Thus, there must be alternatives that reduce this effect by adding natural compounds to the soil that give a similar effect to chemical fertilizers and reduce their use [Abo Arab *et al.* (1998)]. Among these alternatives is the use of organic residues, whose effect is in two directions; the first is to improve the physical properties

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of the soil such as the ability of the soil to retain moisture, porosity, and permeability, increase the movement of water and air, the spread and distribution of the roots. The second is considered a good soil fertilizer by increasing the availability of nutrients in the soil in addition to its action as a chelating substance that reduces the loss of elements and increases its availability according to the stages of plant growth. Also, its leads to an increase in the cation exchange capacity of the soil while reducing the degree of soil reaction (pH) in the rhizosphere. In an experiment Esawy *et al.* (2009) observed that the addition of mineral fertilizers, sheep residues and decomposed plant residues that the sheep residues was significantly superior in increasing the available nitrogen and phosphorous in the soil compared with the control. Matome *et al.* (2019) noted that the addition of organic fertilizer (cows, poultry, sheep) led to a difference in all parameters of plant growth and yield, and the effect of sheep was the best compared to poultry and cow residues. Further. Sunflower plant (*Helianthus annuus* L.) is one of the oil crops that is widely cultivated in middle and North Iraq for its great importance as it is a source of oil because its seeds contain a high amount of oil up to 50% as well as it has a good taste, where it is widely used in the manufacture of high-quality vegetable oils and is used in the production of bread and biscuits. Besides, in the manufacture of glues and soap, it can also be used as a source of good fodder for animals because it contains a good proportion of proteins, carbohydrates, and unsaturated fats. Consequently, this study aims to compare the effect of the organic fertilizer source on some growth and yield characteristics of the sunflower plant and its role in rationing the quantities of chemical fertilizer added.

2. Materials and Methods

A field experiment was conducted in one of the fields of College of Agriculture, University of Anbar in a silty loam soil classified Typic Torrifluvent, random samples were taken from the surface layer of soil (0-30) cm. Then these samples were air dried and milled then sieved through 2 mm diameter sieve, mixed well for homogeneity, while a sample was taken for the purpose of selected chemical and physical analysis of the soil before planting as shown in Table 1. The land was prepared by plowing and the process of leveling and harrowing was conducted and then divided into experimental units of 4 m^2. The experimental unit contained 4 rows, the distance between one row 0.5 m and between hole and another in the same row 0.25 m, in order to obtain a plant density 80,000 plant.ha^{-1}, with a distance of 0.5 m was kept between one experimental unit and another.

A factorial experiment was designed according to the randomized complete block design (RCBD) with three replications and two factors

The first is the type of organic matter, which is completely decomposed (reed, cows, sheep residues) with a percentage of 2% of soil weight and a depth of 15 cm symbolized as (O_1, O_2, O_3) for each of them respectively. The second factor represents the fertilizer recommendation of the (NPK) elements with a percentage of 100% and 50% of the recommendation, F_1 represents the full recommendation (100%), and F_2 represents half recommendation (50%), while the interactions of factors to the replications result in 18 experimental units. Sunflower seeds Shumoos CV., which were obtained from the Department of Field Crops, College of Agriculture, Anbar University in mid-March for the spring season of 2018 were planted However, the irrigation was carried out whenever depleting 50% of available water, the plants were reduced into one plant at the stage of the emergence of four leaves. The fermented organic residues and manufactured by researchers was mixed with the soil before planting. Table 2 shows the most important specifications of these residues. The chemical fertilizers were added according to the treatments with a full recommendation (100%) and a half recommendation (50%) from NPK. Nitrogen was added from urea fertilizer (46 N%) at a level of (100) kg.ha^{-1}, while potassium was added from potassium sulfate fertilizer (50 K_2o%) at a level of 120 kg.ha^{-1}, nitrogen and potassium fertilizers were added in two batches and both factors (F_1, F_2). The first after the germination stage for 21 days and the second batch in the flowering stage.

Then, the fertilizer recommendation for the two treatments was calculated based on area and according to the amount of fertilizer to be added to each experimental unit. The service operations were carried out from weeding and control until the end of the experiment, and the heads were wrapped after the flowering process was completed in mesh bags to protect them from birds. The harvest was conducted on July 15, 2018, and field measurements of growth

Table 1: Some physical and chemical characteristics of the soil before planting.

Characteristics*	Unit	Value	Characteristic*	Unit	Value
PH	–	7.24	CEC	CmoL kg^{-1}	18.36
EC	dsm^{-1}	3.25	Bulk density	Mg m^{-3}	1.36
Ca^{+2}	m mole L^{-1}	16.12	Gypsum	gm kg^{-1}	40
Na^{+1}		5.25	Calcium Carbonate		233
Mg^{+2}		7.88	Sand		392
$So4^{-2}$		15.64	Silt		500
Hco_3		4.23	Clay		108
Cl		9.14	Texture class		
Available N	mg.kg^{-1}	85		Silty Loam	Silty Loam
Available P		9.4			
Available K		144			

*Estimated according to the methods presented in [Page *et al.* (1982) and Black (1965)].

Table 2: Characteristics of the organic Residues used in the experiment.

Studied characteristics	Value			
	Unit	Reed residuce	Cow residuce	Sheep residuce
Ec(1: 5)	ds.em^{-1}	3.24	3.55	6.96
PH(1: 5)	-	7.89	7.00	7.20
C:N Ratio	%	18.20	15.30	14.90
Nitrogen	mg.kg^{-1}	12.82	20.64	22.43
Phosphorous		5.60	6.68	7.90
Potassium		7.68	14.00	23.80

and total yield were taken as follows:

- The leaf area (ds.m^2): it was calculated by measuring the sum of the squares of the leaves of a single plant length multiplied by 0.65 and according to the equation presented by EL-Sahookie and EL-Dabas (1982)

$$L.A. = 0.65 \times Li^2$$

where, Li^2 represents measuring the sum of the squares of the leaves of a single plant length

- Chlorophyll (mg.L^{-1}): The SPAD device was used to measure chlorophyll in leaves directly in the field by making calibration of the device, taking three readings for each leaf, and giving the average directly.
- Plant height (cm): The plant height at maturity was measured from the surface of the soil to the base of the head, and the average of ten plants taken from the two midlines for each unit is measured using a tape measure.
- Dry weight (g.$plant^{-1}$): Five plants were identified from the midlines after the plant reached maturity, the leaves, stems, and the empty heads each were separated separately. Then the ingredients were dried after cutting them into small pieces
- One plant yield (g): Ten plants were harvested at maturity randomly from the midlines for each unit and weighed, and the average of one plant yield (g) was extracted and multiplied by the plant density to extract the total yield.

2.1 Estimation of NPK elements in seeds

A 0.2 g was taken from the seeds of the plant and digested by adding a mixture of concentrated sulfuric acid and perchloric acid of (1:1)

- After completing the digestion process. The plant seed extracts were preserved and the following was estimated according to the method described by Page *et al.* (1982).
- Nitrogen concentration in seeds %: The concentration of nitrogen in the seeds was estimated using a micro-kjeldahl device.
- Phosphorus concentration in seeds%: The concentration of phosphorus in seeds was estimated by the method of ammonium molybdate and ascorbic acid using a spectrophoto-metre.

Table 3: The effect of the organic fertilizer and chemical fertilization (NPK) on some growth and yield characteristics of the sunflower plant.

NPK fertilizer level	Source of organic fertilizer	Plant height cm	Dry weight g.plant^{-1}	Leaf area dsm^2	Chlorophyll mg.L^{-1}	Seed yield ton.ha^1
$F_1$100%	O_0	109.30	99.30	51.20	40.83	1.90
	O_1	115.30	116.30	63.10	41.28	3.25
	O_2	163.10	150.00	82.90	41.38	4.74
	O_3	188.40	213.30	89.90	45.56	5.89
$F_2$50%	O_0	135.80	126.00	67.80	44.45	3.62
	O_1	132.20	103.30	59.60	37.61	2.88
	O_2	123.70	186.20	77.50	35.23	2.95
	O_3	157.00	158.20	65.90	38.27	4.02
$LSD_{0.05}$	11.87	30.35	6.25	4.339	0.89	
NPK averages						
F_1 100%		144.00	144.70	71.80	42.26	3.95
F_2 50%		137.20	143.50	67.70	38.89	2.99
$LSD_{0.05}$		NS	NS	NS	3.068	0.44
Fertilizer source averages						
O_0		122.50	112.70	95.50	24.64	2.76
O_1		123.80	109.80	61.30	39.44	2.92
O_2		143.40	168.10	80.20	38.31	3.84
O_3		172.70	185.90	77.90	41.92	4.96
$LSD_{0.05}$		16.79	42.92	8.84	6.136	0.89

F = Fertilizer NPK Levels, *O* = Organic Mater Source

- Potassium concentration in seeds %: The concentration of potassium in seeds was estimated using a flame photometer.

The data were analyzed statistically using the Genstat program to analyze the variance, the arithmetic averages were compared according to the selection of the least significant difference (L.S.D) at the level of probability 5%.

3. Results and Discussion

3.1 Characteristics of vegetative growth and yield

It was noticed from Table 3 that the addition of various organic residuce (reed, cow, sheep) has achieved an increase, and that increase was significant, and all organic fertilization treatments were superior over the control treatment (without addition). The addition of sheep residues achieved the highest average in the characteristic of plant height, dry weight of shoot, chlorophyll content, and total yield at an average of (172.7 cm, 185.9 g, 41.92 mg.L^{-1}, 4.96 ton.ha^{-1}) respectively. However, the addition of cow residues achieved the highest value in the average leaf area of 80.2 dsm^2, and it was observed from the results that there is a clear effect of adding cow and sheep residues on the above characteristics compared to the addition of reed residues. This increase may be attributed to the fact that organic matter has an important role in improving the physical and chemical properties of the soil and its nutrients availability [Abo Arab *et al.* (1998)]. Consequently, it encouraged the formation of a strong root, which was reflected in an increase in most of the morphological characteristics of growth, which in turn led to an increase in the efficiency of elements absorption by the plant as shown in Table 4. This was reflected in increasing the efficiency of biological processes, as well as that the residuce contains humic and non-humic compounds that has a direct effect on various processes such as respiration, photosynthesis, protein synthesis. Besides, various enzymatic reactions, which results in increased absorption and accumulation of carbohydrates, and thus led to an increase in the yield, this result is consistent with Adeniyan *et al.* (2011) of that the addition of animal organic residues had a significant effect on morphological growth characteristics.

Table 3 showed that the addition of mineral fertilizer (NPK) with the level of full recommendation (100%) led to an increase in the characteristic of plant height,

Table 4: The effect of the organic fertilizer and chemical fertilization on the concentration of (NPK) in the seeds and the its availability in the soil.

NPK fertilizer level	Source of organic fertilizer	Available N mg.kg-1	Available P mg.kg-1	Available K mg.kg-1	N in seeds (%)	P in seeds (%)	K in seeds (%)
$F_1$100%	O_0	76.30	4.26	84.47	1.080	0.312	0.801
	O_1	86.00	7.13	60.77	1.203	0.328	0.577
	O_2	83.30	6.93	71.54	1.250	0.345	0.707
	O_3	54.0	12.23	113.28	1.817	0.447	0.794
$F_2$50%	O_0	38.70	6.56	75.32	1.213	0.340	0.668
	O_1	63.30	5.17	59.86	1.150	0.310	0.467
	O_2	54.00	5.47	66.40	1.117	0.261	0.685
	O_3	76.70	6.64	82.20	1.427	0.351	0.708
$LSD_{0.05}$		21.90	21.90	4.28	0.124	0.050	0.048
NPK averages							
F_1 100%		75.10	7.51	82.51	1.337	0.358	0.717
F_2 50%		58.20	5.96	70.95	1.227	0.316	0.632
$LSD_{0.05}$		10.95	0.65	3.28	0.087	0.036	0.034
Fertilizer source averages							
O_0		75.50	5.41	79.89	1.147	0.326	0.734
O_1		74.70	6.15	60.31	1.177	0.319	0.522
O_2		68.70	5.93	68.97	1.183	0.303	0.696
O_3		65.70	9.46	97.74	1.622	0.399	0.751
$LSD_{0.05}$		15.49	1.29	6.06	0.175	0.714	0.068

F = Fertilizer NPK Levels, *O* = Organic Mater Source

leaf area, and dry weight of the shoot, but this increase was not significant. However, the increase in chlorophyll content and seed yield were significant compared to the level of the addition (50%) with an average of 42.26 $mg.L^{-1}$ and 3.95 $ton.ha^{-1}$, with an increase of 8.66 and 19.9% for each. This increase in the two characteristics of the chlorophyll content and the yield is attributed to the fact that the addition of chemical fertilization with the level of full recommendation (100%) led to an increase in the availability of nitrogen, phosphorus and potassium elements in the soil as shown in Table 4. Furthermore, it was reflected in increasing the amount of uptake and thus led to accelerated vital processes and reflected positively on increasing the shoot then the yield increased, this result is consistent with the findings of Taiz and Zeiger (2010). Finally, the interaction effect between the addition of organic matter of its various types with the chemical fertilization was significant, and the interaction of the treatment F_1O_3 achieved the highest average for all the studied characteristics compared to the treatment F_1O_2 which achieved the lowest average for all the studied characteristics. Besides, the treatment F_2O_3 exceeded the highest average for all characteristics compared to the treatment F_2O_1.

3.2 The concentration of elements in seed and the available in soil from NPK

Table 4 showed that adding various types of organic residuce (reed, cow, sheep) has achieved a significant increase, and all of them exceeded the control treatment. Moreover it was noted that all sheep residues (O_3) was superior with highest average in the values of (*K*, *P*) and the concentration of elements (*K*, *P*) in seeds with the highest average of (9.46 $mg.kg^{-1}$, 97.74 $mg.kg^{-1}$, 0.399% and 0.75%.), respectively. Similarly, the addition of cow residue achieved a significant superiority in the concentration of nitrogen in seeds with the highest average of 1.183%. Whereas the addition of reed residuce was superior by the highest average in the characteristic of available nitrogen in soil, amounted to 74.70 $mg.kg^{-1}$.The reason for this is that the addition of organic matter improves the chemical properties of the soil and increases the availability of the elements.

Thus, encourages the formation of a good root, consequently led to a positive effect on the morphological and biological characteristics such as (respiration, photosynthesis, protein synthesis, which

leads to an increase in plant growth). This is consistent with Al-Zuhairi (2019) which found that the addition of organic residues from different sources led to an increase in the available nitrogen, phosphorus, and potassium in the soil.

Table 4 showed that the addition of mineral fertilizer (NPK) with the level of full recommendation (100%) led to an increase, and that increase was significant in the characteristic of available nitrogen, phosphorus, and potassium in the soil. Along with, the concentration of nitrogen, phosphorus, and potassium in the seeds by an average of (75.10 $mg.kg^{-1}$ and 7.51 $mg.kg^{-1}$ and 82.51 $mg.kg^{-1}$, 1.337%, 0.358%, and 0.717%) for each of them. Including, an increase percentage when adding half recommendation (50%) reached (29.03%, 26.00%, 16.29%, 8.96%, 3.29% and 13.44%), respectively. The reason for this increase is because the addition of chemical fertilizers has led to an increase in the available nitrogen, phosphorous, and potassium in the soil. Therefore, this led to an increase in the uptake of it by the plant. These results were consistent with Muhammad (2014) findings. The addition of organic matter from its various sources and chemical fertilization has a significant effect. As the interaction F_1O_3 achieved an average of available phosphorous and potassium from the soil and the concentration of nitrogen, phosphorus, and potassium in the plant compared to the treatment F_1O_0. The treatment F_2O_3 for the half recommendation exceeded in all studied characteristics compared to the comparison treatment F_2O_0.

4. Conclusions

1. The use of various types of organic residue has increased plant growth, yield, and availability of NPK elements in the soil, and sheep residuce exceeded other residuce.
2. The addition of the mineral chemical fertilizers to the soil has led to an increase in the growth and yield of the sunflower plant at the full recommendation.
3. The use of organic residue with chemical fertilization has led to the rationing of chemical fertilizers.

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