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The Effect of Irrigation Water Salinity, Organic Matter, and Zinc Nano-Fertilizer on the Productivity of Sunflower (*Helianthus annuus* L.)

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Abstract. In accordance with the randomized full block design, In the Al-Mahaweel district, Al-Imam hand, and Al-Birawi region, a field experiment was conducted in a soil with a texture of silty clay loam categorized as the primary typic torrifluvent group (RCBD), Examining the effects of irrigation water quality, organic matter, the amount of zinc nano-fertilizer sprayed on the plant, and the interaction of the research components on sunflower crop production using a split plot experiment with three replications, Three separate factors were used in the experiment: irrigation with four various amounts of organic fertilizer (zero), 20 tons/ha of cow and sheep dung, and three different concentrations of zinc nanofertilizer (0, 1.5, and 3 g). Organic matter significantly improved the yield characteristics of sunflowers, such as disc diameter, number of seeds per disc, weight of 500 seeds, and overall yield, as compared to spraying with nano-Zinc. The three elements' interplay significantly affected sunflower productivity. On March 5, 2022, the seeds were sown using cork dishes and a midwife-led method. The seeds were luleo varieties from a French breeder. The midwives were transferred to the permanent location after 30 days. The findings showed that increasing the salt content of the irrigation water significantly decreased the values of disc diameter, number of seeds per disc, weight of 500 seeds, and overall yield of sunflower plants.

Keywords. Irrigation water quality, Organic fertilizer, Zinc nano-fertilizer, Sunflower.

1. Introduction

One of the most crucial elements for the development of every nation's agriculture is water and its natural resources. Due to the increasing expansion of the agricultural sector to solve the growing global food problem, the availability of water has emerged as the key factor of agricultural production. Due to the local climate, this is particularly true in dry and semi-arid locations [1,2]. And the problem of water scarcity is a global problem, as the world witnessed, especially in the past two decades and in many countries, a remarkable and sharp decline in precipitation, which led to a major problem in the amount of fresh water, as the problem of water scarcity is one of the major problems facing Iraq because of the drought that He was exposed to it in recent years, Together with abuses in the bordering nations where the sources of the Tigris and Euphrates rivers are located, as well as the growing population and increased demand for food, so there was an expansion in the agricultural area that corresponds to the large increase in the population, and the amount of water consumed by the agricultural sector in Iraq is estimated to account for more than 90% of the total water consumed [3]. It caused the need for water to rise, which in turn caused people to use inferior substitute materials and sources to make up for the lack of fresh water, including Puncture water and wells. They assist in lowering soil pH [4]. The concentration of ions in the irrigation water is the main factor in determining the amount of salts delivered, which determines soil salinity and the concentration of positive and negative ions in it. The ionic composition of irrigation water affects the quality of the ions predominating in the soil solution depending on their concentration in the irrigation water. This is because the use of water with a high concentration of a specific ion can result in that ion's dominance on the surfaces of the exchange complex and consequently affect the readiness and absorption of other nutrients [5,6].

Saline water must be used in a way that ensures good crop productivity and the maintenance of the physical and chemical properties of the soil if we are able to achieve a balance between the salinity of the soil solution and the irrigation water. Numerous agricultural crops that can withstand salt well handle salty irrigation water in the same way. When compared to non-saline irrigation water, saline irrigation water was found to significantly reduce sunflower growth and yield [7].

[8] It was discovered. When irrigation water salinity increased, the germination rate decreased by 50% while the values of plant characteristics and crop yield dramatically increased [9]. [10] It was found that the 5% increase in organic matter enhanced soil structure and increased porosity, which facilitated a high movement of water through the soil, preventing the buildup of salts, increasing the amount of water available, and enhancing the growth and productivity of the sunflower crop. The effectiveness of nano-zinc fertilizer is significantly influenced by saline water and the quality of the dominant ions in the water, particularly monomers like chloride and sodium, which dissolve calcium carbonate and release more calcium, speed up the zinc precipitation mechanism, and cause a decrease in the availability of zinc for the plant with an increase in calcium [11].

In order to understand how the sunflower plant's development and output are affected by the quality of the irrigation water, organic matter, the quantity of zinc nano-fertilizer sprayed on the plant, and their interactions, this study was conducted.

2. Materials and Methods

From March 2022 to June 2022, a field experiment was carried out on one of the private peasant farms in Al-Mahaweel district / Babil Governorate (about 30 km north of Babil Governorate). In order to determine the impact of irrigation water quality, organic fertilization, and nano-fertilizers on soil characteristics and sunflower development, an area of (18 m128 m= 2304 m2) was used. Clay loam texture with silt. The experiment was carried out in a split-plot configuration using a randomized complete block design (RCBD) and three replications, with the main plots occupying the salinity levels of the irrigation water They are (2, 4, 6, 8) de Siemens.m-1 and are represented by the symbols (a1, a2, a3, a4), respectively. The type of organic waste occupied the sub-blocks and is represented by the symbols (b1.b2, b3), while the processors are represented by the symbols (b1.b2, b3) and occupy the sub-plots that Zinc nano-fertilizers contain (c1, c2, c3).

Three replicates of each treatment were planted using the Marouz method, and the 108 treatments were scattered in the field using the randomized full block design. There were 1.5 m gaps between the primary units in each sector and 1 m gaps between the secondary and sub-secondary panels. One board was 3 m x 4 m (12 m2) in size, with a 1 m shoulder distance between each board.

2.1. The Studied Factors

The first factor: the quality of the irrigation water, which represents the main factor, the Main-Plot, which has four types and a symbol for them.

- a1: Irrigation with river water of electrical conductivity (EC= 2 dSiemens.m^{-1})
- a2: Irrigation with water of electrical conductivity (EC= 4 dSiemens.m^{-1})
- a3: Irrigation with water of electrical conductivity (EC= 6 dSiemens.m^{-1})
- a4: Irrigation with water of electrical conductivity (EC= 8 dSiemens.m^{-1})

Table 1. Some chemical properties of the water used in the experiment.

Adjective	Irrigation water quality				Unit
	a1	a2	a3	a4	
Ec	2	4	6	8	dSiemens.m^{-1}
Ph	7.82	7.69	7.18	7.03	
Ca	4.76	6.63	7.52	9.89	
Mg	3.49	5.75	6.04	7.06	
Na	7.84	12.33	16.44	21.38	
K	0.12	0.16	0.28	0.35	mmol. L^{-1}
Cl	8.48	12.54	13.65	22.63	
SO_4	5.57	6.78	7.34	9.45	
CO_3	1.25	2.92	2.42	3.15	
HCO_3	2.51	5.43	4.88	6.21	
SAR	2.73	3.5	4.47	5.19	mho's
water quality	C_3S_1	C_4S_1	C_4S1	C_4S1	

The water has been categorized in accordance with the American Salinity Laboratory (USDA) classification indicated in [12].

The second factor: the levels of organic fertilizer represent the secondary factor SUB- PLOT, which has three levels and their symbol:

- B0: comparison treatment (without adding organic fertilizer)
- B1: It represents the addition of 20 tons.h^{-1} of cow manure.
- B2: It represents the addition of 20 tons.h^{-1} of sheep manure.

The third factor: the levels of ZN nano fertilizer, and it represents the sub-secondary factor (SUB-SUB-PLOT)), which has three levels and their symbol:

- C0: Comparative treatment (without adding zinc nanofertilizer)
- C1: represents an addition of 1.5 g. L^{-1} (Zinc Nano Fertilizer)
- C2: represents an addition of 3 g. L^{-1} (Zinc Nano Fertilizer)

Before planting, soil samples at a depth of 0 to 30 cm were randomly selected from various locations and subjected to the necessary tests to determine the soil's physical and chemical characteristics. Table (1) lists some study soil properties in accordance with techniques) and the method described [13] for evaluating soil texture.

The bulk density of the soil was calculated using the core method, which is discussed in [13]. Richards, 1954 reported that the amount of calcium and magnesium dissolved by stirring with Na2-EDTA and the amount of potassium and sodium dissolved using a flame photometer. The electrical conductivity (EC) and pH (pH) of the saturated soil paste extract were measured using the EC-meter and pH meter devices, respectively, as mentioned in [10]. Carbonates and bicarbonates were measured by saturating the sample with sulfuric acid, according to [12]. (0.01 N). According to [12], silver nitrate litheation was used to estimate the chloride (0.05 N). According to [12], sulfates were determined using the precipitation method using barium chloride and the sodium adsorption ratio SAR.

$$\text{SAR}=\frac{Na^{+}}{\sqrt{Ca^{+2}+Mg^{+2}}}\ (\text{mmol. L}^{-1})$$

The method of dry digestion, Black, Walkly, as indicated in [14], was used to determine the organic matter.

Determine the available nitrogen (mg.kg^{-1} soil) extracted with a KCL 2N solution using a microcaldal apparatus, the pH was raised using MgO, and the nitrate ion was reduced using Devarda alloy in accordance with the method described in Lindsay and Norvel (1978) after extraction with the chelated compound DTPA [14].

The color phase was determined using a method involving ammonium molybdate and ascorbic acid, and it was estimated using a spectrophotometer. The available phosphorus (mg. kg^{-1} soil) was estimated by extracting it from the soil by (Olsen and Sommers, 1982) using sodium bicarbonate at a half-molar concentration (0.5M-NaHCO3). According to, at a wavelength of 882 nm [14]. Ammonium acetate (1N-NH4OAC) was used to extract the potassium (mg.kg-1 soil) and estimate it using a flame-retardant device [14].

Table 2. Chemical and physical characteristics and properties of the study soil before planting.

Adjective		Value	Unit
The pH of the soil pH suspended 1-1		7.8	
Electrical conductivity EC 1-1		3.23	desi siemens.m^{-1}
Cation-exchange capacity CEC		35	Cmol
dissolved Cations	Calcium	10.22	
	Magnesium	7.66	
	Sodium	15.28	
	Potassium	0.59	mmol. l^{-1}
dissolved Anions	Carbonate	Nil	
	Bicarbonate	3.35	
	Sulfites	10.63	
	Chloride	20	
Organic Matter		1,7	%
Available Nitrogen		40	
Available Phosphorous		8,9	PPM
Available Potassium		180	
soil separates	Sand	49	
	Silt	20	%
	Clay	31	
Soil Texture		Silty Clay Loam	
Bulk Density		1.27 mcg.m^{-3}	
Sodium adsorption ratio SAR		2.84 (mmol. $l^{-1})^{-1/2}$	

Sunflower seeds of the luleo cultivar produced by the French company Panam were used. The seeds were sown on 3/5/2022 in cork dishes after filling them with (German) peptmus, where one seed was placed in each sample to produce single seedlings, respectively. The plates were placed in a nursery in the study area of Al-Imam district, Babylon Governorate, and after 30 days they were ready for cultivation. On 4/4/2022, the plants were transferred to the experimental site after watering them with irrigation, where they were planted in the lower third of the field. Two days after planting, it was irrigated in a nearby wilderness to activate the root, then the irrigation process continued according to the recommended water quality (2, 4, 6, 8 dSiemens.m^{-1}) which is denoted (a4, a3, a2, a1) in the experiment and to flowering stage. Zinc nano-fertilizer from the Green Iranian Company (chelated zinc fertilizer 12%) was used (1 kg package) using the foliar spray method for the purpose of fertilizing with zinc nano-fertilizer. high temperatures, and the number of sprays was 3 times during the growth stages, starting from the height of the plant 25 cm until the flowering stage. Due to the occurrence of dust storms during the season of implementation of the experiment, the washing process was carried out continuously, especially before spraying the nano-zinc fertilizer, to make sure that the plants benefit from the fertilizer and for the purpose of conducting irrigation operations in the experimental area, four salinity levels for irrigation water were prepared by mixing puncture water Ec = 10 dSiemens.m^{-1} with river water Ec = 2 dSiemens.m^{-1}. The puncture water was drawn from one of the research area drains, and an Ec-meter was used to gauge the salt of the irrigation water utilized for each irrigation.

The process of decomposing the two organic fertilizers (sheep and cows) was completed on 7/3/2022 by placing them in two basins (a basin for each fertilizer) with dimensions (2 x 3 x 1) m3. The pit was filled with organic fertilizer in layers and moistened with water until the appropriate humidity was reached, and 2 kg of fertilizer was added. Urea fertilizer was added to speed up the degradation of the organic fertilizer and increase the activity of microorganisms. Then, to encourage anaerobic reactions and reduce nitrogen loss throughout the decomposition process, it was covered with clear nylon.

Finally, it was removed from the hole and spread out in the form of a thin layer to dry aerobically before being added to the experimental soil. A sample from each fertilizer was taken for post-decomposition analysis prior to grinding and in accordance with the experiment's suggested amounts [10].

Table 3. Some chemical properties of the organic waste used in the experiment.

Properties	Measuring unit	Organic waste	
		Sheep	Cows
electrical conductivity	desi siemens.m^{-1}	4.51	4.3
pH		6.50	7.4
organic carbon	g. Kg^{-1}	455.01	345.06
N total		18.10	17.50
P total		6.86	6.36
K total		5.00	4.50
C/N Ratio		17	20

2.2. Characteristics of Vegetative Growth

From the plant's point of contact with the earth to the base of the flower disc, the height of the plant (in centimeters) was measured. Using a SPAD Meter, the leaf chlorophyll content (g) was calculated.

To compare the averages and find the difference between them, the least significant difference (LSD) was used at a significant threshold of 0.05 [10]. In accordance with the used design, the data were statistically analyzed using the Excel statistical analysis tool.

3. Results and Discussion

3.1. Disc Diameter (cm)

Table No. 4's findings revealed that decreasing the salinity of irrigation water had a discernible impact on the diameter of the sunflower plant's disk, with the irrigation water quality treatment (4 dSi.m^{-1}) producing the greatest average of 22.94 cm (8 dSi.m^{-1}). The smallest average, 21.38 cm, had a growth of 1.56%. The accumulation of salts that have toxic and osmotic effects on plants can be blamed for the decrease in the sunflower plant's ability to absorb water and nutrients necessary for its biological activities. This decrease in disc diameter is correlated with an increase in irrigation water salinity. Regarding the impact of organic fertilizer, the treatment (20 tons.h^{-1} sheep manure) was noticeably better and produced a sunflower plant with a disk diameter of 24.10 cm, which was higher than the treatment (without addition), which produced a sunflower plant with a disk diameter of 20.16 cm. The reason is that the addition of organic waste caused the disc diameter to drastically rise. This rise is related to the fact that adding organic waste to the soil enhances its physical, chemical, and fertility aspects, boosts plants' ability to absorb some essential nutrients, and lessens the negative impacts of water salinity. This outcome is in line with what was discovered in [15,16], and additional research has confirmed it.

According to the results of the aforementioned table, spraying zinc nano-fertilizer significantly increased the diameter of the sunflower plant's disk. The level of spraying (3 g.L^{-1}) produced the highest value, which was 23.63 cm, as compared to the treatment (without addition), which produced the lowest value, which was 21.72 cm. It is due to zinc nanoparticles' role in promoting plant growth because it activates the essential reactions that result in chlorophyll formation inside the plant to carry out the process of photosynthesis, which results in increased vegetative growth and nutritional balance in addition to its role in many essential processes in the plant and subsequently increasing the yield. This result is consistent with [17-20].

The results of table (4) demonstrated that there were significant differences caused by the bilateral overlap between the levels of organic matter and irrigation water quality, as the treatment with the highest value of the plant's disc diameter—24.58 cm—was achieved with the addition of sheep manure (4 dSi.m^{-1} and 20 tons.h^{-1}); the treatment with the lowest value, 18.93 cm, was achieved with the addition of 8 dSi.m^{-1} without fertilizer. The treatment (2 dSi.m-1 and 3 gm.L^{-1}-zinc fertilizer nanoparticles) recorded the highest value for disc diameter and reached 24.39 cm compared to the treatment (8 $dSi.m^{-1}$ without adding nano-zinc fertilizer), which gave the lowest value and was 20.8 cm. This is due to the bilateral interaction between irrigation water quality and spraying with nano-zinc fertilizer. The interaction between the addition of organic matter and spraying with nano-zinc fertilizer was significantly affected by the treatment (20 tons.h-1) of sheep manure and 3 gm L^{-1}), which had the highest value and a height of 25.63 cm in contrast to the control treatment (without adding organic fertilizer and nano-zinc fertilizer), which had the lowest value and a height of 19.34 cm. A considerable impact was seen as a result of the triple interactions between the irrigation water's quality, organic additions, and fertilizer sprayed with nano-zinc. The treatment recorded (4 $dSi.m^{-1}$ and 20 $tons.h^{-1}$ sheep manure and $3g.L^{-1}$) had the highest value, reaching 26.43 cm, while the treatment recorded (8 dSiemens M^{-1} without adding organic fertilizer and nano-zinc fertilizer) had the lowest value and reached 17.93 cm. This distinction can be linked to the beneficial effects of irrigation water salinity reduction and the increased availability of nutrients that both organic fertilizers and nano-zinc have on crops. This backs with the findings of [21], whose research showed that using organic fertilizers considerably enhanced the overall amount of seeds produced.

Table 4. The effect of irrigation water quality, organic fertilizer and nanoparticle zinc and the interaction between them on the disc diameter of sunflower (cm).

Irrigation water quality	Organic fertilizer 20 $tons.h^{-1}$	Nano-zinc fertilizer $g.L^{-1}$			A*B
		without spraying	1.5	3	
2 dsm^{-1}	nwithout additio	19.90	20.17	22.50	20.86
	Cow manure	22.80	23.43	24.37	23.53
	Sheep manure	23.60	23.93	25.77	24.43
4 $ds.m^{1}$	without addition	19.80	20.13	22.53	20.82
	Cow manure	22.73	23.33	24.20	23.42
	Sheep manure	23.63	23.67	26.43	24.58
6 dsm^{-1}	nwithout additio	19.73	19.53	22.43	20.57
	Cow manure	22.63	23.23	23.67	23.18
	Sheep manure	23.37	23.40	25.47	24.08
8 dsm^{-1}	without addition	17.93	18.73	18.50	18.39
	Cow manure	22.17	22.30	22.80	22.42
	Sheep manure	22.30	22.80	24.87	23.32
LSD 0.05		1,088			0.672
A*C					
2 dsm^{-1}		22.10	22.51	24.21	22.94
4 dsm^{-1}		22.06	22.38	24.39	22.94
6 dsm^{-1}		21.91	22.06	23.86	22.61
8 $ds\ m^{1}$		20.80	21.28	22.06	21.38
LSD 0.05		0.628			0.668
B*C					
without addition		19.34	19.64	21.49	20.16
Cow manure		22.58	23.08	23.76	23.14
Sheep manure		23.23	23.45	25.63	24.10
LSD 0.05		0.544			0.336
Average		21.72	22.06	23.63	
LSD 0.05		0.314			

3.2. Number of Seeds Per Disc (seed. $Disc^{-1}$)

The salinity of irrigation water had a substantial effect on the sunflower plant's capacity to produce more seeds per disc, as shown by the results in Table No. 5. The maximum average number of seeds per disc were produced by the irrigation water quality treatment (2 $dSi.m^{-1}$), while the lowest average number of seeds per disc were produced by the irrigation water quality treatment (8 $dSi.m^{-1}$). The explanation is related to the fact that irrigation with saltwater reduces all vital activities and, as a

result, causes an increase in osmotic effects, which interfere with cell division and elongation and reduce water absorption [22]. The result using [23].
The treatment (20 tons.h^{-1} sheep manure) greatly outperformed the control (without addition), which produced the lowest value and equaled (1025.72 seed.$disc^{-1}$, for the number of seeds per disk of sunflower plants, in terms of the impact of organic fertilizer. The cause is cited as organic fertilizers' importance in enhancing the chemical and physical characteristics of the soil.
The results of the table above showed that spraying zinc nano-fertilizer increased the number of seeds in the tablet by a significant amount, with the level (3 g.l^{-1}) giving the highest value and amounting to 1125.22 seed.$disc^{-1}$, as opposed to the treatment (without addition), which gave the lowest value and amounting to 1048.47 seed.$disc^{-1}$. This is because nano-zinc fertilizer plays a role in improving photosynthesis efficiency and the production of cellulose. which is due to the role of nanoparticles in boosting the activity of enzymes, particularly chlorophyll oxidation enzyme and stimulation of metabolism enzymes during photosynthesis, which improves the plant's response and increases its capacity to absorb the most nutrients through the leaves, and this is consistent with what has been accomplished [20,24,25].
The treatment (2 dSi.m^{-1} and 20 tons.h^{-1} sheep manure) gave the highest value for the number of seeds per disc, which amounted to 1282.56 seed.$disc^{-1}$. This was in contrast to the treatment (8 dSi.m^{-1} and without adding fertilizer), which gave the lowest value and amounted to 748.89 seeds per $tablet^{-1}$, and the treatment (2 dSi.m^{-1} and 20 tons.h^{-1} sheep manure), which gave the highest value and (2 dSi.m^{-1}). compared to the treatment, and (3 g. L^{-1} zinc nano-fertilizer), which equaled to 1323.56 seeds of $tablet^{-1}$ (8 dSi.m^{-1}) (without adding zinc nano-fertilizer), which produced a score of 787.56 seed.$disc^{-1}$, the lowest value.
Regarding the interaction between the addition of organic matter and spraying with nano-zinc fertilizer, the treatment (20 tons.h^{-1} sheep manure and 3 gm.L^{-1}) had a significant impact and produced the highest value, amounting to 1166.42 seed.$disc^{-1}$ as opposed to the control treatment (without adding organic fertilizer and nano-zinc fertilizer), which produced 1166.42 seed.$disc^{-1}$. Seed.$disc^{-1}$ has the lowest value of 1001.75. The three interactions between the spraying of nano-zinc fertilizer, organic additives, and irrigation water quality had a discernible impact, with the treatment (2 dSi.m^{-1}, 20 tons.h^{-1} cow manure, and 3 g.L^{-1}) recording the highest value of 1339 tablet $seeds^{-1}$. These findings are consistent with those of [26].

Table 5. Effect of irrigation water quality, organic fertilizer and nano-zinc and the interaction between them on the number of seeds per disc of sunflower plant. (Seed. $Disc^{-1}$).

Irrigation water quality	Organic fertilizer 20 tons.h^{-1}	Nano-zinc fertilizer g.L^{-1}			A*B
		without spraying	1.5	3	
2 dsm $^{-1}$	without addition	1170.33	1185.67	1280.67	1212.22
	Cow manure	1195.33	1250.67	1339.00	1261.67
	Sheep manure	1235.00	1261.67	1351.00	1282.56
4 ds.m ^{1}	addition without	1163.33	1173.33	1180.33	1172.33
	Cow manure	1188.33	1201.67	1259.00	1216.33
	Sheep manure	1226.67	1255.00	1263.33	1248.33
6 dsm $^{-1}$	without addition	933.33	980.00	995.00	969.44
	Cow manure	953.33	1125.00	1201.33	1093.22
	Sheep manure	1153.33	1163.33	1166.67	1161.11
8 dsm $^{-1}$	without addition	740.00	743.33	763.33	748.89
	Cow manure	771.67	791.67	818.33	793.89
	Sheep manure	851.00	881.67	884.67	872.44
LSD 0.05		42,588			29,077
	A*C				
2 dsm $^{-1}$		1200.22	1232.67	1323.56	1252.15
4 dsm $^{-1}$		1192.78	1210.00	1234.22	1212.33
6 dsm $^{-1}$		1013.33	1089.44	1121.00	1074.59
8 ds m ^{1}		787.56	805.56	822.11	805.07

Irrigation water quality	Organic fertilizer 20 tons.h^{-1}	Nano-zinc fertilizer g.L^{-1} without spraying	1.5	3	A*B
	LSD 0.05		24,588		12,719
	B*C				
	without addition	1001.75	1020.58	1054.83	1025.72
	Cow manure	1027.17	1092.25	1154.42	1091.28
	Sheep manure	1116.50	1140.42	1166.42	1141.11
	LSD 0.05		21,294		14,538
	Average	1048.47	1084.42	1125.22	
	LSD 0.05		12,294		

3.3. Weight of 500 seeds.gm^{-1}

The weight of 500 sunflower seeds dramatically dropped when the salt content of the irrigation water was raised, as shown in Table No. 6's results. The irrigation water quality treatment reported (8 dSi.m^{-1}) only produced a 34.54 g average, while the irrigation water quality (4 dSi.m^{-1}) produced a 43.11 g average, which is the highest average. This is due to the fact that [27] shows that many crops that are regarded to as salt-tolerant can handle rather high saline levels in irrigation water. because the salinity levels in irrigation have grown This result is in accordance with [28] and has a negative effect on the physical and chemical properties of the soil as well as all indicators of plant development and output.

In comparison to the treatment (without addition), which provided the lowest value and weighed in at 37.71 gram for the weight of 500 sunflower seeds, the treatment (20 tons.h^{-1} sheep dung) was substantially superior and produced returns that were significantly different. This is because organic fertilization was more effective at boosting vegetative growth traits and leafy area, which raised nutrient production in the plant and improved its capacity to represent carbs and proteins and transport them to the seeds during the seed filling stage. The weight of 500 seeds increased as a result of the disc's diameter growing, which was also a good sign. This is in line with the findings of [29], and the findings of the table mentioned above demonstrated that spraying zinc nano-fertilizer increased the weight of 500 sunflower seeds by a significant amount, giving the level (3 g.L^{-1}) the highest value of 40.38 g, in contrast to the treatment (without addition), which gave the lowest value and totaled 38.20 gm. The treatment (2 dSi.m^{-1} and 20 tons.h^{-1} sheep manure) gave the highest value for the weight of 500 grain per plant and amounted to 45.14 gm, in contrast to the treatment (8 dSi.m^{-1} and without adding fertilizer), which gave the lowest value and amounted to 33.69 gm, and (3 gm.L^{-1} zinc nano-fertilizer). The findings of table (6) showed that there were notable variations in the two-way analyses of the relationship between incorporating organic matter and using zinc fertilizer spray. The nanotechnology treatment (20 tons.h^{-1} of sheep dung and 3 grams per liter), which created the highest value of 43.02 grams, had a significant impact on the palm factor, which produced the lowest value of 37.17 g without the addition of organic fertilizer and nano-zinc fertilizer.

A considerable impact was seen from the three interactions of zinc nanofertilizer spraying, organic additives, and irrigation water quality. 33.08 gm was the lowest value recorded for the treatment (8 dSi.m^{-1} without the addition of organic fertilizer and 3 g.L^{-1}); 48.66 gm was the highest value recorded for the treatment (2 dSi.m^{-1} with 20 tons.h^{-1} sheep dung and 3 g.L^{-1}).

Table 6. Effect of irrigation water quality, organic fertilizer, nano-zinc and their interaction on the weight of 500 seed.gm^{-1}.

Irrigation water quality	Organic fertilizer 20 tons.h^{-1}	Nano-zinc fertilizer g.L^{-1} without spraying	1.5	3	A*B
2 dsm $^{-1}$	without addition	40.87	41.23	42.52	41.54
	Cow manure	41.21	43.03	43.74	42.66
	Sheep manure	41.20	45.55	48.66	45.14
4 ds.m ^{1}	without addition	38.15	39.33	40.00	39.16
	Cow manure	42.33	43.18	43.09	42.87
	Sheep manure	40.33	42.70	43.52	42.18
6	without addition	35.00	37.00	37.33	36.44

Irrigation water quality	Organic fertilizer 20 tons.h^{-1}	Nano-zinc fertilizer g.L^{-1} without spraying	1.5	3	A*B
dsm $^{-1}$	Cow manure	37.67	38.00	38.67	38.11
	Sheep manure	38.33	38.67	42.15	39.72
8 dsm $^{-1}$	without addition	34.67	33.33	33.08	33.69
	Cow manure	33.67	34.00	34.08	33.92
	Sheep manure	35.00	35.33	37.74	36.03
LSD 0.05			1,531		1,404
	A*C				
2 dsm $^{-1}$		41.09	43.27	44.97	43.11
4 dsm $^{-1}$		40.27	41.74	42.20	41.40
6 dsm $^{-1}$		37.00	37.89	39.38	38.09
8 ds m ^{1}		34.44	34.22	34.97	34.54
LSD 0.05		0.884			2,705
	B*C				
without addition		37.17	37.72	38.23	37.71
Cow manure		38.72	39.55	39.90	39.39
Sheep manure		38.72	40.56	43.02	40.77
LSD 0.05		0.765			0.702
Average		38.20	39.28	40.38	

3.4. Seed Yield. tons.h^{-1}

The salinity of irrigation water significantly reduced the sunflower plant's ability to produce seeds. The highest average was created by the irrigation water quality treatment recorded (2 dSi.m^{-1}), while the lowest average was produced by the irrigation water quality treatment recorded (8 dSi.m^{-1}). and the cause is ascribed to irrigation with saline water, which resulted in a decline in vital processes and an increase in the osmotic effect, which inhibits water absorption and affects cell division and elongation before the onset of wilting signs on the leaves. Due to the low amount of water absorbed, it also impacts the lack of transfer of nutrients and growth hormones from the roots to the other plant parts [30,22].

Regarding the impact of organic fertilizer, the treatment (20 tons.h^{-1} of sheep dung) produced the best value and had a seed yield of 2.67 tons.h^{-1}, whereas the treatment (without addition) yielded the lowest value at 2.10 tons.h^{-1}. The reason is thought to be due to the fact that organic fertilizers increase the nutrients' readiness, which causes them to decompose more quickly and increase the plant's ability to absorb them, increasing the indicators of vegetative growth, yield, disc diameter, number of seeds per disc, and weight of 500 grains, among other things. It in turn has a good impact on improving the overall yield of seeds; the results were exactly the same. To him [21] who discovered that the addition of organic matter results in a noticeably higher overall seed production.

According to the results of the table above, spraying zinc nano-fertilizer increased seed yield significantly. The level (3 g.L^{-1}) that produced the highest value and amounted to 2.67 tons.h^{-1} was different from the treatment (without addition), which produced the lowest value and amounted to 2.34 tons.h^{-1}. This difference can be attributed to the role that nano-fertilizers play in enhancing plant growth, as these particles have a large surface area because of their small size. With the treatment (2 dSi.m^{-1} and 20 tons.h^{-1} sheep manure) yielding the highest value of 3.70 tons.h^{-1} and the treatment (8 dSi.m-1 and without adding fertilizer) yielding the lowest value of 1.71 tons.h^{-1}, the results of table (7) showed that there were significant differences due to the bilateral overlap between the levels of irrigation water quality and organic matter. The highest yield was reported after treatment when there was a bidirectional relationship between the quality of the irrigation water and the use of zinc nano-fertilizer (2 dSi.m^{-1} and 3 gm. L^{-1}). The amount of zinc nano-fertilizer used in the treatment (8 dSi.m^{-1} without the addition of nano-zinc fertilizer), which produced the lowest value and was 1.88 tons/h^{-1}, was 3.40 tons/h^{-1}. As shown by the three-way interactions, the therapy was significantly more effective than the treatment and produced the highest value, which is equivalent to 3.07 tons h^{-1} (without the addition of organic fertilizer and nano-zinc fertilizer). The therapy produced the lowest value, which is equivalent to 2.01 tons h^{-1}. The quality of the irrigation water, organic additions, and the addition of nano-zinc to the fertilizer all made a significant difference. The treatments with the lowest value (8 $dSi.m^{-1}$, no organic fertilizer added, and 1.5 mg L^{-1}) and greatest value (3 $dSi.m^{-1}$, 20 $tons.h^{-1}$ sheep dung, and 3 gm L^{-1}) measured 1.67 tons h^{-1} and 3.92 tons h^{-1}, respectively. The experiment factors specifically the role of organic fertilizers in reducing the detrimental effects of salts in irrigation water and soil, as well as the role of nano-Zinc in boosting plant growth, and this is proven. between [31] and [32], as well.

Table 7. the effect of irrigation water quality, organic fertilizer and nanoparticle zinc and their interactions on the total seed yield of sunflower plants $tons.h^{-1}$.

Irrigation water quality	Organic fertilizer 20 $tons.h^{-1}$	Nano-zinc fertilizer $g.L^{-1}$			A*B
		without spraying	1.5	3	
2 dsm^{-1}	without addition	2.32	2.50	2.79	2.54
	Cow manure	2.31	3.25	3.50	3.02
	Sheep manure	3.37	3.81	3.92	3.70
4 $ds.m^{1}$	without addition	2.20	2.25	2.38	2.28
	Cow manure	2.72	2.95	3.18	2.95
	Sheep manure	3.45	3.58	3.75	3.59
6 dsm^{-1}	without addition	1.80	1.85	1.95	1.87
	Cow manure	2.02	2.15	2.23	2.13
	Sheep manure	2.28	2.33	2.40	2.34
8 dsm^{-1}	without addition	1.70	1.67	1.75	1.71
	Cow manure	1.85	1.95	2.02	1.94
	Sheep manure	2.08	2.15	2.20	2.14
LSD 0.05		0.167			0.160
	A*C				
2 dsm^{-1}		2.67	3.19	3.40	3.09
4 dsm^{-1}		2.79	2.93	3.11	2.94
6 dsm^{-1}		2.03	2.11	2.19	2.11
8 $ds\ m^{1}$		1.88	1.92	1.99	1.93
LSD 0.05		0.096			0.115
	B*C				
without addition		2.01	2.07	2.22	2.10
Cow manure		2.22	2.58	2.73	2.51
Sheep manure		2.80	2.97	3.07	2.94
LSD 0.05		0.083			0.080
Average		2.34	2.54	2.67	
LSD 0.05		0.048			

Conclusions

We draw the conclusion from this study that organic matter plays a beneficial role in reducing the negative effects of irrigation water salinity and improving the physical, chemical, and biological characteristics of the soil, which was positively reflected in the productivity of the sunflower crop, and that the nano-zinc fertilizer plays a role that is no less significant than organic fertilizers in improving plant growth and increasing the efficiency of the photosynthesis process.

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